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The Evaluation of Geochemical Analysis Techniques for Forensic Provenance and Interpretation

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PhD in Forensic Science

Declaration

I, Kelly Cheshire, hereby declare that this dissertation is my own original work and that all source material used has been clearly identified and acknowledged. No part of this dissertation contains material previously submitted to the examiners of this or any other university, or any material previously submitted for any other examination.

Signed:

Date:

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Abstract

This thesis investigates the feasibility of geochemical analysis techniques in forensic investigation, the issues associated with interpreting mixed provenance geochemical evidence and factors that could potentially influence the conclusions drawn. Two forensically relevant locations in the UK were selected for the study. Within these locations three sites were selected with differing land-use characteristics to assess the feasibility of X-ray Fluorescence Spectroscopy, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Inductively Coupled Plasma-Mass Spectroscopy, Isotope Ratio Mass Spectroscopy and Quantitative Evaluation of Materials by Scanning Electron Microscopy techniques in distinguishing between geographically similar samples. The ability of these techniques to provide intelligence from material recovered from exhibits that are pertinent to a forensic investigation, e.g. footwear, was also assessed through the analysis of artificially created mixtures containing material from these sites. Sampling was conducted at quarterly intervals over a 12 month period to monitor the degree of temporal variation between samples from each site. Additionally, differences in the plastic sample bag packaging and storage conditions were explored to identify the optimum packaging, sample state, storage temperature and storage duration for soil/sediment material that is to undergo chemical analysis. Statistical analysis of the geochemical data revealed inter-site variation to be significant while intra-site variation and temporal variance was non-significant at each location and no significant difference was identified between packaging material, storage conditions and storage duration.

The interpretation of mixed provenance samples was far more complex and identified the potential for false negative and false positive conclusions to be drawn. This thesis presents the first systematic empirical data set that addresses the issue of mixed and single source sample comparison by geochemical analysis, outlines a procedure for the handling of geological evidence, and provides a basis upon which to build future research that addresses the interpretation issues that have been identified.

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Acronym List

Acronym	Acronym Meaning
AAS	Atomic Absorption Spectroscopy
CDFA	Canonical Discriminant Function Analysis
CSI	Crime Scene Investigation
DNA	Deoxyribonucleic Acid
EA-IRMS	Element Analyser Isotope Ratio Mass Spectroscopy
EMM	End Member Modelling
FTIR	Fourier Transform Infrared Spectroscopy
GC-IRMS	Gas Chromatography Isotope Ratio Mass Spectroscopy
GCMS	Gas Chromatography Mass Spectroscopy
HPLC	High Performance Liquid Chromatography
IBA	Ion Beam Analysis
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma Mass Spectroscopy
IRMS	Isotope Ratio Mass Spectroscopy
LA-ICP-MS	Laser Ablation Inductively Coupled Plasma Mass Spectroscopy
LCMS	Liquid Chromatography Mass Spectroscopy
LIBS	Laser Induced Breakdown Spectroscopy
LOI	Loss On Ignition
MC-ICP-MS	Multiple Collector Inductively Coupled Plasma Mass Spectroscopy
NAS	National Academy of Sciences
PCA	Principal Component Analysis
PTFE	Polytetrafluoroethylene
QEMSCAN	Quantitative Evaluation of Materials by Scanning Electron Microscopy
SEM	Scanning Electron Microscopy
SEM-EDX	Scanning Electron Microscopy with Energy Dispersive X-ray
TOF-MS	Time-of-Flight Mass Spectroscopy
XRD	X-ray Diffraction Spectroscopy
XRF	X-ray Fluorescence Spectroscopy

Chapter 1 Introduction

This thesis addresses a pressing issue within forensic geoscience regarding the interpretation of geochemical evidence. The research seeks to identify the extent to which geochemical analysis is able to discriminate between soil/sediment samples from sites that are of close proximity to one another (i.e. forensically relevant), and the degree to which it is possible to compare samples of single and mixed source provenance for the purposes of forensic investigation. These two factors are critical within forensic geoscience as crime events tend to occur over short distances in an area familiar to the offender (Felson, 2008). There is consequently often a need to establish which sites have and have not been frequented by the suspect within a discrete location in order determine if they are connected to the crime event. Previous studies assessing the performance of geochemical analysis in distinguishing between soil/sediment samples (e.g. Croft and Pye, 2004; Pye *et al.*, 2006a; Pye *et al.*, 2006b; Pye *et al.*, 2007; Pye and Blott, 2009), have involved comparing samples from sites that are separated by large distances and therefore are geologically very different to one another i.e. different parent material and land-use. The effectiveness of chemical assessment of sites that are of closer proximities, often with the same underlying bedrock geology and therefore of direct forensic relevance, must also be determined to ensure that the geochemical analyses are correctly applied to sediment samples in an investigation (Bull *et al.*, 2008).

The samples recovered in an investigation are typically from items such as shoes, tyres, carpets and clothes, and are therefore often composed of material from more than one location (Pye and Blott, 2009). The interpretation of the data derived from the analysis of sediments from these artefacts needs to be accurate to avoid the possibility of false positive or false negative conclusions. Currently physical assessment of particles within such samples by, for example, binocular microscopy of soil/sediment samples, is considered the most effective means of discriminating mixed provenance samples (Murray, 2004). However, this is dependent upon the knowledge and experience of the analyst and can often be time consuming. Chemical analysis offers the advantage that it is fast, has the ability to be automated, and can give qualitative and quantitative data using a minimal amount of material, which is often necessary in a forensic investigation (Pye *et al.*, 2006b). There are however, a number of issues regarding the interpretation of elemental data for mixed provenance samples that, as of yet, have not been fully addressed in the published literature (Morgan and Bull, 2006). Two main issues are:

1. False negative or false positive conclusions when comparing single and mixed source samples (i.e. the incorrect inclusion or exclusion of samples due to comparisons made between single and mixed source samples).
2. How to determine if a sample is of mixed provenance, and the number of contributors within that sample, without *a priori* knowledge.

If these issues remain unresolved there is a great potential for incorrect inferences concerning sample provenance to unknowingly reach court, which can have significant impact upon the justice system. For example, the case of R v White and Hyatt 2001 where the two suspects were convicted for their roles in the murder of Rachel Manning. The defendants were subsequently exonerated when it was demonstrated that assumptions had been made about the significance of particulate evidence, which led to a reconstruction of events that was not possible once those assumptions were tested and shown to be unfounded.

This thesis aims to answer the research question:

'To what extent can inorganic geochemical analysis techniques be reliably implemented for the accurate assessment and interpretation of single and mixed provenance soil/sediment samples in forensic investigation',

and seeks to address this question by undertaking experimental studies that focus on the following objectives:

1. Establish potential factors that may impact sample integrity and consequently the findings of geochemical analysis of soil/sediment samples
2. Establish the geochemical properties of known single source soil/sediment samples through X-ray Fluorescence (XRF), Inductively Coupled Plasma Mass Spectroscopy (ICP-MS), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Isotope Ratio Mass Spectroscopy, QEMSCAN and Loss-on-Ignition (LOI).
3. Establish the geochemical properties of known mixed source soil/sediment samples through XRF, ICP-MS, ICP-AES, IRMS, QEMSCAN and LOI.
4. Establish the feasibility of geochemical analysis techniques to discriminate between known single and mixed source soil/sediment samples.
5. Establish a time- and cost-effective protocol that provides reliable geochemical data for the discrimination of forensically relevant soil/sediment samples.

6. Explore the degree to which a reliable statistical method can be identified to address the interpretation issues of mixed provenance soil/sediment evidence.

This thesis is therefore structured in the following manner:

- **Chapter 2: Literature Review**

  This begins by introducing forensic science and outlining the current issues within in the field. These include; the availability of funding, accreditation, training, evidence contamination and interpretation and probabilistic nature of evidence. The review then explores how these issues can impact forensic trace evidence before focusing explicitly on geological trace evidence.

  Forensic geoscience is defined, together with what soil/sediment material is and how it can assist in an investigation. The conceptual framework adopted to provide structure and guide decisions from the conception of evidence to its presentation in court is explained. The issues within forensic geoscience are identified, and related back to this conceptual framework, to demonstrate how they affect each stage. An evaluation is made of existing studies to identify the methods available for the assessment of different geological evidence types (e.g. pollen, diatoms, soil/sediment) and where knowledge gaps exist to direct research towards.

  Geochemical analysis is the focus for the rest of the review, as knowledge gaps have been identified, and the suitability of geochemical analysis within forensic investigation over recent years has come under great question in the literature. The current issues include the lack of consistency between the appropriate sample collection methods, packaging material, storage conditions and laboratory protocols (including both preparation and analysis) which complicates data comparison between laboratories. Also of concern are statistical methods used to interpret the data, absence of a *priori* knowledge to assist interpretations, bias, and interpretation of mixed provenance samples from close proximity locations which are commonly encountered within forensic investigation. This review highlights the importance of establishing a reliable means in which to utilise this evidence effectively, and hence the implementation of this research, which seeks to investigate the issues surrounding interpreting geochemical data for single and mixed provenance samples of close proximity. To clarify the causality of these complications and where resources need to be directed in order to provide a solution to this issue, if a solution is indeed possible.

- **Chapter 3: Methodology**

This chapter provides details of the sample sites and the rationale for their selection, procedures for sample preparation, sample analysis (elemental, stable isotopes and mineralogical), and data treatment. The sites selected were deemed to be forensically relevant as they provide sufficient foliage to conceal illicit activities, are easily accessible, and are of a close proximity to one another along a realistic route that an offender could potentially take. Also included is method development for the packaging and storage of soil/sediment, and sample digestion. The manner in which soil/sediment material is digested for certain analyses is variable across different laboratories both in industry and academic institutions, and is based on permissions and capability of the facilities. The digestion protocol established in this study is an adaptation of Thomson and Wood (1982) and Cheshire *et al.* (2016), that accommodates the regulations set by UCL Department of Geography Laboratories whilst also catering for materials that are available to forensic and/or geological analytical suites. Techniques used in this thesis include XRF, ICP-MS and ICP-AES for elemental analysis and IRMS for stable isotope analysis, as these methods are utilised in other areas of forensic science and within the traditional geosciences on soil/sediment material. QEMSCAN was used for mineralogical analysis it is a relatively new technique that has received attention recently in the literature for its potential within forensic geoscience, and therefore has been included to establish its effectiveness on mixed provenance samples. Quality assurance (QA) and quality control (QC) measures have been taken throughout the analyses, by measuring certified reference materials and procedural blanks, alongside samples of interest, to ascertain the reliability and effectiveness of the results produced for each technique. QA and QC measures are important for all scientific analyses, but bare a particular importance in forensic science, as once data generated is published it is then accepted in a court of law. Therefore, any evidence analyses presented in court that is based upon erroneous publications, can result in the incorrect verdicts being reached. This has serious ramifications on the criminal justice system, e.g. miscarriages of justice, and negative impacts on the lives of those persons associated with the case, such as, the victim and/or suspect and their family members and friends.

- **Chapter 4: Packaging and storage effects**

  There is currently no agreed upon standard approach to the collection, packaging and storage of geological evidence. Suggestions are made in the literature for these various stages, e.g. sampling depth, and how to retain and store samples. However, these are speculative, at best, as there are no published studies that provide an evidence base to support the selection of one approach over another. This chapter explores the effect of different manufactured sample bags and storage conditions (i.e. sample state, temperature and duration), on the geochemical composition of soil/sediment samples. The purpose of which is to identify whether these factors cause sufficient variance to impact on the interpretation of single and mixed source geochemical evidence. Moreover, this analysis facilitates the establishment of optimum packaging and storage conditions for the preservation of soil evidence. This study has enabled an effective means for the packaging and storage of evidence, to ensure it is suitable for the chemical analysis, to be proposed.

- **Chapter 5: Elemental Analysis**

  Elemental analysis is commonly adopted on a range of evidence types within forensic laboratories, including fibres, glass, paints and accelerants. It is also used to assess geological material but under more traditional geological applications as opposed to forensic applications. Elemental analysis offers great benefit to assist in forensic investigation due to its speed, and the capacity to provide qualitative and quantitative data from small amounts of material. Therefore, it would be advantageous if it could be applied to the types of geological material encountered in a forensic investigation i.e. trace level, mixed provenance material from close proximity sites. Consequently, this chapter explores the feasibility of elemental analysis for discriminating forensically relevant samples. This includes between single source soil samples from close proximity sites, and between known single and mixed source soil samples. ICP-MS and ICP-AES were selected as they require a minimal amount of material to conduct the analysis (0.1g), which is essential when working within the forensic domain. XRF was selected to compare the accuracy and reliability of the findings. This study has identified the significance of temporal variation within sites on the elemental composition of soil/sediment samples, the feasibility to discriminate single source sites of close proximity, and single versus mixed soil samples and the interpretation issues encountered.

- **Chapter 6: Stable Isotope Analysis**

  Isotopes are considered a desirable proxy in environment reconstruction due to their predictable changes in abundance. Isotopes are often employed within traditional geosciences to characterise and monitor changes in the environment that could be indicative of climate change or other environmental processes. They have also been utilised in forensic investigation as a means of tracking movement or identifying provenance, and therefore could prove useful in discrimination of forensically relevant soil/sediment samples. Stable isotope analysis can be conducted using a minimal amount of material while still providing quantitative data, involves little sample preparation, and can often identify differences in cases where the elemental composition is seemingly identical. While isotope analysis has shown success, it is typically involving isotopes obtained from bone, teeth, hair, or geological materials that are at greater distances to one another. It would therefore be advantageous if it could successfully be applied to geological evidence from close proximity sites and/or mixed provenance. This chapter investigates the role of stable isotope analysis to discriminate forensically relevant samples in order to identify whether isotopes may be employed as another route of enquiry in forensic geoscience. IRMS has been employed to evaluate $\delta^{13}C$ and $\delta^{15}N$ isotope ratios within single and mixed source samples due to its simple (and therefore quick) sample preparations and small amount of material (6 mg and 10 mg used in this study) which is advantageous as minimal material is usually available in forensic investigation and time is restricted. The study identifies the feasibility of using stable isotope data to discriminate single source samples and single versus mixed source samples of known close proximity sites.

- **Chapter 7: Mineralogy**

  Mineralogy is commonly used to characterise a site and establish sediment provenance. In previous studies, mineralogy is determined through more traditional techniques, such as XRD, XRF, IBA or SEM, and usually on single source samples that are of large distances to one another and in more rural locations. However, forensic geological evidence is usually composed of material from multiple sources (Croft and Pye, 2003), over shorter distances (Eck *et al.* 2015), and also includes urban locations (Pirrie *et al.*, 2009). Urban locations can be particularly distinctive due to the assemblage of anthropogenic contributions in the soil/sediment, both man-made and natural (e.g. pollen or plant matter). QEMSCAN technology is relatively new and can be used not only to identify and quantify the mineral, but also to provide mineral maps, grain size analysis, elemental composition, and to automatically assess both natural and anthropogenic contributions in the sample. These additional data provide potential for site discrimination through the identification of site-specific particles and mineral group associations. This chapter therefore investigates the potential of mineralogy determined by QEMSCAN to discriminate between forensically relevant samples. The promise for site discrimination was demonstrated based on secondary minerals and the potential for the distinction between single and mixed source samples is illustrated particularly through mineral associations identified in the mineral maps generated.

- **Chapter 8: Critical Elements and End-Member Modelling**

  The complexities associated with interpreting geochemical data for mixed provenance samples have been discussed extensively in the literature, but until now there has been no data to illustrate this complexity. Work conducted in chapters 5 to 7, where elemental, isotopic and mineralogical analysis of single and mixed source soil/sediment material has been performed, and the findings of statistical assessments applied to the data obtained from these analyses, has confirmed this. There are a number of factors that can contribute to these complications within a forensic investigation, including the absence of *a priori* knowledge, errors in sample preparation or analyis, an overabundance of data overwhelming the interpretations or the statistical method adopted to interpret the data. Statistical analysis is commonly employed to identify trends or patterns in data, which could assist in the understanding of mixed provenance soil/sediment material, provided the appropriate method is selected. Implementing statistical analysis is becoming progressively more complex, especially as the literature is directed towards other experts in the field, and therefore do not translate well for those who are not statistical experts (Curran, 2013). Improper use of statistics can result in erroneous conclusions being drawn and the evidence being discredited in court (Isphording, 2004). This can also impact how other evidence perceived, even if it is independent of the discredited evidence (Lagnado and Harvey, 2008). An understanding of the statistical methods, where they are appropriate to use, and a good understanding of what they demonstrate is crucial if issues with mixed provenance sample interpretation are to be addressed. This chapter investigated two factors to address the interpretation issues using the geochemical data generated in chapter 5. The first was to establish a common reduced number of elements to assess, which would reduce analysis time, expense, and potential data errors stemming from an increased number of element variables. Second, the effectiveness of end-member modelling (EMM) is explored to resolve issues regarding the statistical interpretation of mixtures. It was found possible to discriminate samples with reduced element sets. However, the combination of elements chosen are site-specific, and other sites should be investigated to get a more comprehensive overview of elements that would be suitable in more than one location. The potential for EMM to assist in interpreting geochemical signatures of mixed provenance samples is identified, and highlights inconsistencies that need to be addressed before it can be considered for implementation into forensic investigation.

- **Chapter 9: Discussion and Conclusion**

  In this chapter the findings from the previous chapters are synthesised, the issues summarised, and the implications of using geochemical evidence within forensic science discussed. The feasibility of geochemical analysis in forensic evidence has been determined, and potential factors that could have impeded findings have been eliminated. However, an effective means by which to interpret mixed provenance material has not been established, and suggestions for future research projects to address this are provided. Guidelines for the appropriate procedures, where appropriate, for managing geological material in forensic investigation are presented. Components of the procedure include the manner by which to collect, package and store soil/sediment for geochemical assessment, protocols for the preparation and analysis of material and communicating where issues exist in the interpretation so that necessary precautions can be taken and decisions regarding when best to use geochemical evidence in an investigation can be made.

Chapter 2 Literature Review

2.1 Forensic Science

2.1.1 Overview

Forensic science is the application of scientific disciplines to the law in both civil and criminal investigations (Caddy and Cobb, 2009; Saferstein, 2010). Many different disciplines contribute to forensic science (Gökdoğan and Erkol, 2005), including pathology, anthropology, entomology, toxicology, genetics, analytical chemistry, and geoscience (NRC, 2009; AAFS, 2006-14). The application of these disciplines to forensic investigations enables crime reconstructions to be undertaken to establish the relationships between scene(s), suspect(s), victim(s), and pertinent artefacts, in both space and time, and at each stage of the forensic science process (scene, analysis, interpretation and presentation) (Ribaux and Margot, 2000; Brown, 2006; Morgan and Bull 2007).

2.1.2 Key Issues

There are a number of factors that can have a negative impact on the forensic assessment and integrity of evidence (see figure 2.1). Level 1 denotes issues affecting education and research, level 2 affecting the collection and analysis of evidence and level 3 issues are those that impact upon the presentation and understanding of evidence in the courtroom.

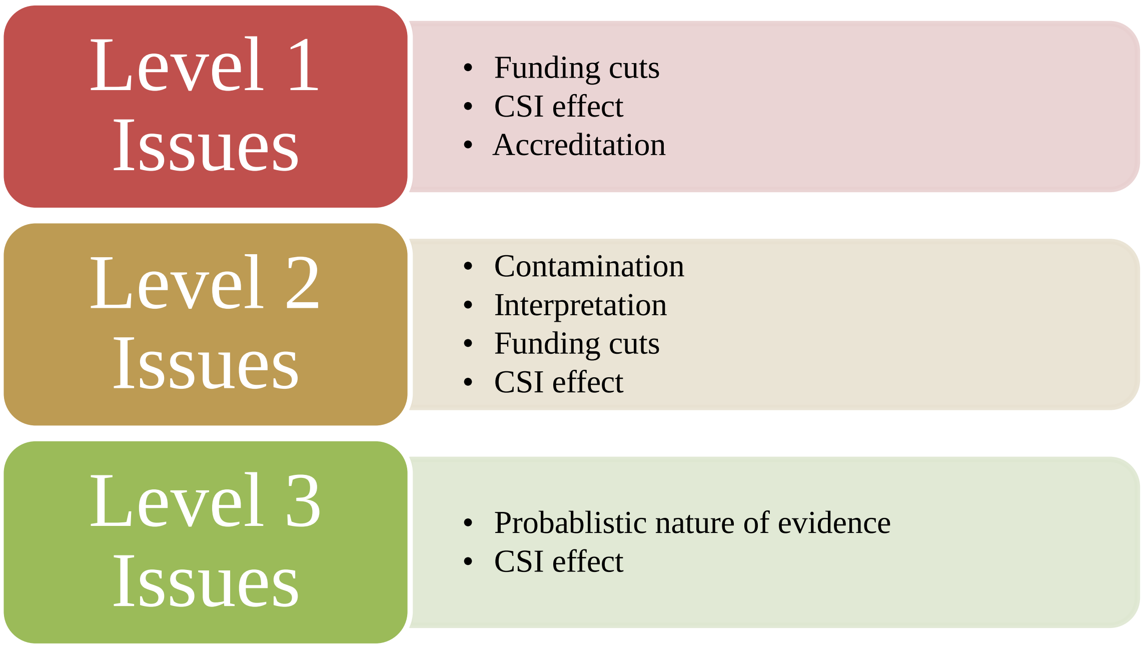


Figure 2.1 Issues affecting the forensic science process

Each level impacts the whole or particular parts of the forensic science process, i.e. collection, storage, analysis, interpretation and presentation. For instance, level 1 impacts the entire process, as research and education provide the foundations for forensic investigation. Level 2 issues affect evidence treatment (i.e. storage and analysis), and the understanding of the evidence (i.e. interpretation). Level 3 issues involve the presentation of evidence in the context of the law.

2.1.2.1 Level One Issues

Funding cuts have had a major impact on the education practices, research and practice of forensic science. Since the closure of the Forensic Science Service (FSS) in 2011, the casework originally undertaken by the FSS has been transferred to other private forensic laboratories such as LGC (Laboratory of the Government Chemist), which held the next biggest share of the forensic market at around 20%, and Cellmark (House of Commons, 2011). However, the number of staff in this sector has been significantly reduced (Chidzoy and Byrne, 2011; House of Commons, 2011). This can mean that case turnaround is longer due to a backlog of forensic evidence to process (House of Commons, 2013). The FSS were also responsible for conducting a significant amount of research in forensic science related fields. However, these projects have now been suspended, and it is unclear when or if they will be continued (House of Commons, 2013). This places the responsibility of research and development of forensic science practice on academia, research councils and privately funded laboratories (Koehler and Saks, 1991). This in itself can have its issues due to the plethora of disciplines within forensic science. For instance, concern has been raised as to how to determine which discipline should get priority and how to monitor progress in the various fields for which forensic applications have not been the focus of the study (Daeid, 2010; House of Commons, 2013).

Accreditation of forensic laboratories and their staff is essential to provide confidence in the analytical work being carried out (Einseln, 2011). ISO 17025 is the international standard, and there are a number of criteria that the laboratory must satisfy to achieve this (House of Commons, 2013). Proficiency tests are undertaken to establish if the proceedings of the laboratory protocols are appropriate and followed correctly. However, it has been asserted that analysts are generally aware that these tests are being performed and so may adjust their modes of operation to achieve the standards required (Prichard and Barwick, 2007). Blind tests that have been performed to assess the day-to-day running of the laboratories in the past have highlighted some inconsistencies that are a cause of concern and cast doubt upon the ability of the scientist and their conclusions and presentation of the evidence (Roane and Morrison, 2005). Accreditation may also be acquired for forensic science degree programs to provide confidence in the quality of the course content and training being received, though is not a necessity for employment within the field. For instance, the Forensic Science Society (FSSoc) provides accreditation assessments in crime scene investigation, laboratory analysis, interpretation, evaluation and presentation of evidence, digital evidence recovery and analysis, computer network evidence analysis, forensic archaeology and forensic anthropology (FFSoc, 2014). It is also possible to be assessed by the Royal Society of Chemistry (RSC) and Forensic Skillmark (University of Wolverhampton, 2014). There are many forensic science degree programs available that offer different forms of training. For instance, some focus on the analytical processes and perhaps less upon the forensic interpretation, whereas others focus more on training students on the forensic practices so that they are able to integrate directly within a forensic provider scientific firm. Acquiring accreditation for the degree program supplies a certain level of transparency over the course content and can therefore indicate the training and education likely to have been received by the student.

There have been a growing number of students pursuing paths in forensic science careers due to the glamorous and exciting portrayal of this work in popular television shows such as CSI (Ferguson, 2013). A forensic science degree is not essential to pursue a career in forensic science. Quite often a degree in a core science subject, such as biology or chemistry, is obtained and then training in the forensic science application follows once in employment with a forensic science provider. Despite this, there has been a documented increase in student applications to university forensic science programs (Bergslien, 2006), which coupled with funding cuts could result in universities becoming overwhelmed by the increase in students accepted onto these courses. Care must be taken not to compromise the training of the students so as not to diminish the quality of the forensic research or investigation being conducted by these individuals following the completion of a forensic science degree program (Evison, 2010). Roane and Morrison (2005) provide an example of how serious the consequences can be when inadequate forensic analysis is carried out; blood evidence that had been found on sheets at a crime scene where an attempted murder had taken place were not subjected to DNA analysis. As a result, the suspect of the crime was acquitted of the charges then, upon his release, he re-visited his ex girlfriend and murdered her, it was later found that the DNA from the crime scene belonged to him.

2.1.2.2 Level Two Issues

One important issue is the contamination or loss of material through errors in the collection procedure, packaging and/or transportation of the samples from the crime scene to the laboratory (Houck, 2003). In forensic investigation, the minimal available sample size already poses an issue as it limits the number or type of analyses that the sample may be subjected to. If further material is then lost, the amount of available analyses is even further restricted (Murray and Solebello, 2002). Contamination can lead to incorrect interpretations and assumptions of the evidence data collected, which can in turn affect the direction of the investigation or the verdicts reached in court (Gallop and Stockdale, 2009). Chain of custody from the minute of collection to the time the evidence is brought before a court of law must not be broken (Saferstein, 2010). This ensures that all handlers and treatments associated with that piece of evidence are known so that if any errors become apparent, the point at which it has been introduced may be identified and accounted for, thus maintaining evidence integrity (Sutton and Trueman, 2009).

Interpretation of the data obtained from evidence analysis so that it may be presented in an unbiased and understandable manner still poses one of the greatest issues within forensic investigation (NAS, 2009; Law commission report, 2011). Should the interpretation of evidence be incorrect, serious consequences, such as miscarriages of justice, may follow. For example, fingerprints are said to be unique to each individual and hold a lot of weight in a court of law. However, fingerprint interpretation has a subjective element to it which allows for errors to be made. Recently there have been a number of cases where fingerprint evidence has been questioned in court by the judge e.g. R. v. Buckley [1999], Mayfield v. United States [2009] and R. v. Smith [2011], and even not admitted as evidence (US Courts, 2009; Kaye, 2011; Stockdale *et al.*, 2012). In 1997 Shirley McKie was incorrectly accused of leaving her fingerprint at a murder scene after being instructed not to enter the premises. A fingerprint recovered from the doorway of the crime scene had been declared a match to her own by three fingerprint analysts from the Aberdeen Fingerprint Bureau. It was not discovered until 1999 that the fingerprints were in fact not a match to McKie. This was established when the fingerprints were re-examined by US specialists who unanimously agreed that the prints were different. As a result McKie was then acquitted of the charges (Aberdeen Bureau, 2005).

The public has shown a growing curiosity in forensic science due to the plethora of televised dramas with a forensic science theme, including CSI, NCIS and Dexter. The public are consequently becoming more aware of the types of evidence generated during a crime and how this might be used (Schweitzer and Saks, 2007). This causes a number of problems within forensic investigation due to the inaccuracies in the practices portrayed in the shows in order to provide entertainment for viewers, also known as the CSI effect (Roane and Morrison, 2005). For instance, law enforcement (e.g. police officers) may believe that they can collect evidence themselves, having seen it in the media, but may not be aware of the correct collection procedures thereby losing or contaminating evidence.

Additionally offenders may take measures to conceal their involvement with the crime by hiding evidence (figure 2.2) or impeding investigative techniques and analytical processes (Ferguson, 2013). For example, an offender may use bleach in an effort to remove blood; this affects the performance of luminol, used to detect the presence of blood, as it reacts with the bleach, and impedes DNA analysis (Nilsson, 2006). An offender may also wipe down surfaces they have come into contact with to remove fingerprints, making it harder to identify their guilt or innocence. Concealment of trace evidence, however, is much more complex. Trace evidence is often unobservable to the naked eye and therefore has greater potential to go unnoticed (Houck, 2009; Robertson and Roux, 2010; Ruffell and Sandiford, 2011). As a result, trace evidence can often be the most informative of the evidence types and provide crucial intelligence to lead an investigation (Houck, 2001; Houck, 2003; Jantzi and Almirall, 2011).

Figure 2.2: The categories of physical trace evidence and examples of each.

2.1.2.3 Level Three Issues

Level three issues involve the manner in which evidence is understood and presented, both prior to and during its appearance the court room. Generally jurors desire an absolute, i.e. that the evidence presented is 100 % accurate and the only possible explanation. However, in reality it is not possible to provide jurors with an absolute (Jasanoff, 1992). Koehler (1992, pp. 167) states that "We live in a probabilistic world" and forensic evidence is no exception to this. When comparing two forms of evidence to establish if there is an association, and they are deemed indistinguishable from one another, it may be assumed that they have originated from the same source and have therefore identified what that source is. However it cannot be definitively said that this is the exact and only explanation for the evidence without comparisons to other potential sources globally (Koehler and Saks, 2009). An assessment of this scale is not feasible and therefore the evidence is assigned a probability of its occurrence given the circumstances of the crime (McQuiston-Surrett and Saks, 2007). Members of the jury must therefore acknowledge that there is room for statistical and mathematical error surrounding these conclusions, and that other potential explanations may exist, whilst acknowledging that this does not necessarily mean that the evidence collection and analysis is flawed (Christensen *et al.*, 2014). For instance, if when comparing DNA profiles of a biological sample collected from the crime scene to a suspect(s) and the alleles tested are identical between the two profiles, there is a temptation to say that this is an exact match and that the perpetrator of the crime has been identified (Saks and Koehler, 2008). However, this only accounts for the 16 alleles tested for, which may indeed be a match, but does not include the rest of the genome or the number of others who may also have these alleles in common. Without testing the entire global population it is not known how unique the profiles are (Koehler and Saks, 2009).

Evidence probabilities can also lead to the occurrence of the prosecutor's or the defender's fallacy. This happens as a result of the probability meanings not being communicated clearly to the court of law clearly and so incorrect assumptions as to what the evidence is telling them or not telling them are made (Koehler and Kaye, 1991; McQuiston-Surret and Saks, 2007). Continuing on from the DNA example given previously, if the DNA profile of a suspect is given a probability of one out of 20 billion of occurring based on the similarity of the alleles tested, the members of the jury may take this to mean that the suspect is guilty, but this is not necessarily the case as:

a) the uniqueness of the profile cannot be accurately identified without knowing the DNA samples of each individual globally.
b) even if the DNA does belong to the suspect, this only places them at the scene but not necessarily guilty of committing the crime.

The phenomenon described above is known as prosecutor's fallacy (Balding and Donnelly, 1994). With the defender's fallacy the opposite occurs; associative evidence here is considered to be irrelevant even if it is regarded as being unique (Thompson and Schumann, 1987). Going back to the DNA example, for defender's fallacy to be committed, the defence would claim that the DNA results prove only that the suspect and perpetrator share the same DNA profile and is not evidence of their guilt. This is based on the assumption that all those who have this DNA profile are equally likely to have committed the crime and does not account for how many are situated within the vicinity of the crime area (Aitken, 1995; Fung, 2001). It would be wrong to assume this based on a singular piece of evidence. Instead it should be taken into context amongst the other intelligence provided from other forms of evidence to determine its significance.

As outlined in section 2.1.2.2, the CSI effect gives incorrect portrayals of the practices within forensic investigation. This becomes a level 3 issue when it results in law enforcement and jurors having unrealistic assumptions of the time frames required for evidence analysis and interpretation or the amount of information that can be gleaned from the evidence which could impact on the verdicts reached (Robbers, 2008).

2.1.3 Trace Evidence

Kirk (1963) describes forensic science as being the individualisation of trace evidence, either physical or biological in nature. The more distinctive this form of evidence is, the more diagnostic it can be, and therefore, have a fundamental role within an investigation. Examples of trace material include hair, fibres, biological fluids, paint, glass, pollen, soils, and sediment (Deedrick, 2001). Inman and Rudin (2002) set out five fundamental concepts involved in the process of assessing such evidence (figure 2.3). Since its inception concerns in the literature have been raised regarding the individualisation and association stages (Saks and Koehler, 2008; Budowle *et al.*, 2009; Cole, 2009).

Figure 2.3: Processing forensic evidence (Inman and Rudin, 2002).

Locard's (1910) Principle of Exchange denotes the foundation for the presence of trace material at a crime scene, and states "when two objects come into contact, each will leave a trace of itself upon the other" (Sutton and Trueman, 2009, p. 17) for which the shorthand has come to be known as 'every contact leaves a trace' (Pounds and Smalldon, 1975; Chisium and Turvey, 2000; Saferstein, 2010). There are a number of factors that can influence this transfer, including the duration of contact, the nature of the material, and the nature of the recipient surface (Deedrick, 2001; Sutton and Trueman, 2009). It is vital to understand these factors in order for the trace evidence to be collected correctly (Robertson and Roux, 2010), and to avoid loss of material or contamination from other sources. To achieve this, it is essential to know where to locate the evidence so that it is not missed for collection (Gallop and Stockdale, 2009). If it is not collected initially, it may be assumed that it had never been present (Bisbing, 2001). The analysis must then be executed correctly to avoid erroneous results and wasting what is already a minimal amount of material available (Murray and Solebello, 2002). Accurate interpretation of the results is key, as even if everything has been performed correctly up to this point, an incorrect conclusion may still be reached and consequently the value of the evidence will be lost (Kirk, 1953).

2.2 Forensic Geoscience

2.2.1 Overview

Forensic geoscience refers to the physical, biological or chemical assessment of soil, sediment or rock materials in order to establish a potential provenance or to identify if a relationship exists between a suspect(s), victim(s), artefact(s) and/or the crime scene (Rawlins *et al.*, 2006; Morgan and Bull, 2007a; Morgan *et al.*, 2008). It is sometimes referred to as environmental profiling, which incorporates other disciplines such as entomology and archaeology, in addition to other aspects of forensic geoscience, to give an indication of the temporal and spatial factors that can be incorporated into crime reconstruction (Brown, 2006). George Popp was the first person to present geological evidence in a court case in 1904 which was then used to secure a criminal conviction (Murray and Tedrow, 1975). Since this, the discipline has seen rising interest in the literature, particularly within prestigious journals such as Forensic Science International and the Journal of Forensic Sciences. Ruffell and McKinley (2004) note this increase in articles on forensic geoscience published since 1999, and from a brief search in these journals, a steadily rising number of publications in this field in the 10 years following can be observed. Soil is of particular interest to forensic cases due to its presence in nearly every environments. Trace amounts of soil can readily transfer and persist upon a recipient surface, and go unnoticed by an offender, unlike rocks which are typically larger in size and therefore efforts may be taken by an offender to remove such evidence.

2.2.2 Soil Evidence

An understanding of what soil is and how it is formed is essential for the appreciation of soil evidence (Theocharopolous *et al.*, 2004). Soil is the biological layer of the earth's crust that comprises an organised combination of organic and mineral matter. Its formation involves the transformation of parent material into a soil body through a series of pedogenic processes. These stages include generation, selection, accumulation and differentiation (Targulian and Krasilnikov, 2007), which are influenced by a variety of factors such as climate, geological processes, response to organisms, and the chemistry of the atmosphere above ground. Mineral weathering processes, i.e. biogenic acidification, turns rock into soil and releases the elements previously bound within the rock (Richter and Markewitz, 1995). Soil development is a time-dependent process, and not only includes the transformation of materials within the immediate environment, but also involves the accumulation of material from adjacent environments transported through various mediums such as wind, water and glaciers, which form layers. These layers are known as horizons, and each typically has different properties to the adjacent horizons (Soil Science Society, 2014). There are six types of soil horizon (Malo *et al.*, 2014):

1. O Horizon - Contains a high volume of organic material such as twigs and leaves
2. A Horizon - A mineral layer with a high humus content
3. E Horizon - A mineral layer with a loss of either clay, humus, salts or iron/aluminium oxides.
4. B Horizon - A mineral layer that forms beneath an O, E or A horizon and referred to as subsoil. Usually there has been a gain of either clay, humus, salts or iron/aluminium oxides.
5. C Horizon - Soft bedrock that forms underneath A, B, E or O horizons. Also known as parent material.
6. R Horizon - Hard bedrock such as granite or sandstone

Soil is a particularly effective form of evidence due not only to its ubiquity, high retention and transferability, but also the simplicity in the collection, separation and characterisation (Reidy *et al.*, 2013). It is a particularly good indicator of provenance, the key piece of information sought from this form of trace evidence in a forensic investigation. Sediments and other anthropogenic materials can be especially good at further discriminating the area of origin, particularly if they are of a distinctive and characteristic nature and therefore make them distinctively different from other soils (Eswaran *et al.*, 2003). In relation to soil, anthropogenic substances typically tend to be environmental contaminants created by human activity such as heavy metal pollutants for instance (Tabor, 2001; Tyszka *et al.*, 2012). However there are other forms of anthropogenic material, both natural and synthetic, that can be found in forensic soil samples that are indicative of the human activity that took place there. For example, hair, fibres from clothing, and fragments of man-made material carried and deposited from shoe soles (Bull *et al.*, 2006a). In addition to human activity, there are other external influences that may be responsible for the presence of anthropogenic trace material, for example, wind dispersal for pollen or dust particles (Okubo and Levin, 1989; Griffin *et al.*, 2001).

Sediments, however, are not a product of pedogenic processes themselves but rather accumulate in, or on, the surface of soils by deposition through water or air (Mudge, 2008). Thus soil may contain sediments as an anthropogenic substance, but sediments are not soil.

The sediment type and accumulation is influenced by physical, biological and chemical conditions in the environment and as a result can be very distinctive (Bridge and Demicco, 2008).

Forensic soil/sediment samples are typically recovered from shoes, tyres, car foot-wells, clothing, and carpets, and are then compared to sites or samples of interest (Pye and Blott, 2009). As these artefacts are likely to have frequented multiple sites, there will be an accumulation of materials from these areas. The formation of horizons on items, such as shoe soles or tyres, can lead to the creation of a succession of layers which can help determine the locations frequented by a suspect, victim or artefact pre-, syn- and post forensic event (Croft and Pye, 2003). Approaches for identifying traits of soils examined include elemental signatures, isotopes, organic compounds, mineralogy, colour, particle size distribution which will be explored in more detail in section 2.3.2.

2.2.3 Conceptual Framework

Morgan and Bull (2007a) propose the following conceptual framework (figure 2.4) for the forensic geoscience discipline, which builds upon the framework put forward by Inman and Rudin (2002) seen previously in figure 2.3:

Figure 2.4: Conceptual framework for Forensic Geoscience (after Morgan and Bull, 2007a)

The occurrence of each of these stages is dependent upon the existence and success of the prior stage(s). For instance, if there is no transfer of materials between two surfaces, or if the materials do not persist, they will be unavailable for collection and then the subsequent stages will not be necessary. Just as if stages 1 - 6 have been satisfied, and then stage 7, the presentation, is not executed efficiently then the members of the court may misunderstand the meaning of the evidence and the value or significance of the evidence may not be realised.

2.2.4 Key Issues

In section 2.1.2, the key issues of forensic science at a general level were discussed. There are also specific issues within forensic geoscience that have been articulated and debated within the literature.

Interpretation, stage 6 of the framework, still poses one of the greatest problems in forensic geoscience and other forensic science disciplines. Kirk (1953, p. 4) stated "physical evidence cannot be wrong; it cannot perjure itself, it cannot be wholly absent, only in its interpretation can there be error". It is essential to get the interpretation correct so that the results can be presented in an unbiased and understandable manner for members of the court (NAS, 2009; Law Commission Report, 2011). Interpretation accuracy is subject to a whole host of factors including inadequate knowledge of the analytical techniques applied to samples, errors in the preparation and/or analytical procedures leading to erroneous results, an over reliance on or an inappropriate amount (i.e. too little or too much) contextual information accompanying the evidence or confirmation bias. An example of a case where analytical errors were identified was a case in 1981 in which three members of the Ku Klux Klan were sentenced to life in prison for their involvement in a murder. Despite being guilty of the crime, the geological evidence that connected them to the crime was discredited due to errors in the sample preparation procedure, improper use of statistics on the elemental data, and the neglect by the analyst to use mineralogy information to ascertain whether an association between the suspects and the crime could be excluded or not (Ipshording, 2004).

Complexities surrounding the analysis and data acquisition further complicate the interpretation procedure in forensic geoscience, especially where samples of mixed provenance are concerned (Morgan and Bull, 2007a). For instance, in the chemical analysis of mixed provenance material, the sample needs to be subjected to homogenisation. As mentioned previously, the succession of soil and sediment on evidential items follows the same principles as those that produce different horizons in soil. However, homogenisation evenly distributes this sample material, consequently preventing the analyst from distinguishing between the layers of soil/sediment contributed from different sources (Bull and Morgan, 2008).

Presentation, stage 7 of the framework, can also be an issue. If not done correctly, it would render the success of the previous stages meaningless. Careful consideration should be given to how the findings are communicated to members of the jury to prevent misleading them (McQuiston-Surrett and Saks, 2007). The analytical process and the interpretations of the data acquired should be conveyed in an understandable manner which avoids the use of technical jargon whilst not influencing the court towards a particular outcome. Improper use of the terminology and incorrect phrasing could lead to confusion, and diminish the value of the evidence presented (Ruffell, 2010; Biedermann *et al.*, 2013). For example, when presenting findings from the analysis of mixed provenance soil and sediment samples, it would be misleading to describe the compared samples as a 'match' or 'not a match' as this may result in false negative or positive conclusions being drawn due to the vast complexities involved in the mixing of the material (Morgan and Bull, 2007b). A probabilistic approach, where likelihood of particular circumstances is assigned a numerical value based on specific components of the crime event, would be preferable as it avoids misleading members of the jury by describing things as absolutes and consequently committal of the individualisation fallacy (Saks and Koehler, 2008; Cole, 2009). An appropriate manner in which to then communicate conclusions derived in this manner could then be "an association between the samples from the suspect and the victim and/or scene can or cannot be ruled out" or "it can or cannot be excluded that the samples originate from the scene of interest".

Following on from this, is the match versus exclusion concept. There is often a temptation to identify samples of interest as a "match" when an exclusion approach would be more appropriate (Walls, 1968), as there are always going to be slight variations in the analytical results for the samples even if they are of the same origin (McQuiston-Surrett and Saks, 2007; Reidy *et al.*, 2013). This can be as a result of minor variations in the sample itself, measurements of sample material and reagents used, instrumentation readings, or differences between analysts or laboratories (Theocharopolous *et al.*, 2004; Pritchard and Barwick, 2007). An exclusion approach is simplified if rare or exotic particles are present in the sample, such as anthropogenic material or distinctive pollen grains. However, even this has problems associated with it. Rare or exotic particles may be in low abundance and therefore may be missed during collection even if the sample is "representative" of the site. It is also possible that these particles do not persist upon the recipient surface long enough to be collected for analysis and consequently are not included in the investigation (Morgan and Bull, 2007a).

The factors that cause variability within soil/sediment samples themselves can pose an issue as incorporating them into the interpretation, as whilst amidst a forensic investigation they may require additional study/experimentation to understand them, which may not be possible due to time constraints (Theocharopolous *et al.*, 2004). These factors include temporal and spatial variance within the site of interest, such as organic matter or wildlife activity, and particle type and/or size which affects the retention of the material on the recipients surface (Reidy *et al.*, 2013). When comparing samples from the same site it may be possible to infer from the elemental data that the samples do in fact originate from the same location with some degree of certainty. However, the results would not be an exact match with one another due to these forms of variation. Such information can be hard to convey to those who have a limited understanding of this concept, and are accustomed to the capabilities and terminology adopted for other forms of forensic evidence, such as DNA (Broeders, 2006). Another factor for consideration is the amount of material collected from the exhibits that is unrelated to the forensic event or could have potentially displaced the material collected from the crime scene, i.e. the ratio of pre- to syn- to post-forensic event material (Reidy *et al.*, 2013). For example, it is not known how much of the soil retained on shoes is from pre-, syn- and/or post forensic event. Therefore, it is possible that the majority of the soil recovered was contributed before or after the event. This would then influence the interpretations made when making comparisons between soil recovered from the exhibit (the suspect sample) and the crime scene (control sample).

Contamination is another issue to be aware of. Should material(s), external to the scene(s) or sample(s) of interest, be added to the geological evidence, the incorrect provenance could be arrived at which could exonerate a guilty party. Contamination could also incriminate an innocent party; if material is inadvertently transferred to exhibits recovered from a person of interest, it could incorrectly associate them with the crime scene and/or victim (Sutton and Trueman, 2009). It is therefore essential that the collection of evidence be executed with care and at the very least under the instruction of an expert in the field. This also insures the sample collected is representative so that meaningful conclusions may be drawn (Warren, 2005). In a similar manner to all other forensic evidence maintaining the chain of custody is crucial and should be thoroughly documented so that if contamination is suspected it may tracked to the time it occurred and the necessary actions to account for this can be executed (Evans and Stagner, 2003). Where possible the stages in sample treatment should be kept to a minimum to reduce the opportunities for contamination to arise (Langford *et al.*, 2005).

Inconsistencies between sample preparation and analytical procedures between laboratories can complicate the comparison of results and the assessments of analyst and technique competency (Croft and Pye, 2004). For example, the elemental analysis of soils requires a sample to undergo homogenisation, which may be done manually or mechanically (Pye and Croft, 2007). For techniques such as ICP-MS and ICP-AES the sample is also subjected to digestion, which can involve various combinations and quantities of reagents, and multiple different forms of apparatus that may be employed to regulate the temperature during the digestion (Thomson and Walsh, 1983; Diegor *et al.*, 2001; Somer and Nakişi Ünlü, 2006). Some laboratories may opt to use a mass spectrometer coupled to a laser ablation device; for this, lithium borate fusion of the sample into a disc may be required for analysis (Yu *et al.*, 2003; Lee *et al.*, 2003; Eggins, 2003), mounted onto glass slides or coarse fragments may even be placed directly into the sample chamber for analysis (Speakman and Neff, 2005).

The applicability of previous experimental studies to forensic casework is limited with regards to discriminating soil samples based on their elemental signature. In previous studies, (e.g. Croft and Pye, 2004; Pye *et al.*, 2006b; Pye *et al.*, 2007 and Pye and Blott, 2009), comparisons have been made on soil samples whose origins are of great distances from one another, based upon differing parent material, and which are likely to have accumulated different anthropogenic material. It is therefore not surprising to find that the elemental signatures of these samples differ significantly enough to discriminate. Even in cases where the underlying geology is identical, the anthropogenic contributions in these sites are unlikely to also be the same, therefore these attributions allow for distinction between otherwise seemingly indistinguishable samples. Though not impossible, it is unlikely that in a forensic investigation the crimes would occur over such a vast distance, but more likely to take place in a discreet location that the assailant is familiar with and therefore aware of the optimal places and routes for concealing their illicit activities (Felson, 2008). There is therefore a need to address this knowledge gap to identify the feasibility of elemental techniques on close proximity samples.

The accuracy and reliability of the methodology, techniques and forensic expert witness are under an extreme amount of scrutiny due to the repercussions of erroneous verdicts for suspect(s) and/or victim(s) stemming from in accuracies in any of these factors (Shelton and Donald, 2010; Koehler *et al.*, 2011). In order to provide confidence in the techniques proficiency tests in and between laboratories are conducted to insure that the methodologies are being executed correctly and the results obtained are both accurate and precise. Accreditation for both the laboratory and the analyst may also be sought to further pacify any concerns the members of the court may have with regards to who and how the analyses are conducted (Prichard and Barwick, 2007). Any methodologies or research must be based on sound scientific principles to ensure they are successful, and should be subject to peer review to identify any potential errors within them (Jones, 2007; Hanson, 2008; Koehler *et al.*, 2011). However, this in itself can be a problem in forensic geoscience as it is still a relatively new and small field within the forensic science domain, and therefore there are few who have expertise thus reducing the size of the peer review pool (Mudge, 2008; Shelton and Donald, 2010). Therefore, peer review can be conducted by those who have expertise in the techniques but lack knowledge of the foundations and principles of forensic science. Due to these differing approaches these reviewers may not appreciate or understand the necessary adjustments that are required to cater for the forensic application (Mudge, 2008; Morgan and Bull, 2007c).

2.2.5 Previous Studies

Experimental studies are a necessity within any scientific practice to further the discipline and the understanding and awareness of the scientists. In forensic science this is no different. Experimental studies facilitate the refinement of forensic science practices, allowing for more robust and reliable evidence to be presented for use in court. The National Academy of Sciences (NAS) Report (2009), the Law Commission Report (2011) and the Forensic Science Regulator Report (2014) all detail the importance of establishing validity for the techniques used within forensic investigation, and being able to provide significance to the findings in a forensic context. Experimental studies provide an ample opportunity for the assessment of hypotheses, the findings of which can then be employed to derive a theoretical framework to work by, identify new advancements or applications of techniques, and recognise where gaps in knowledge exist so that they may be addressed.

Experimental studies also present the opportunity within forensic geoscience to establish a balance between the existing knowledge acquired in parent disciplines (Mitchell and Soga, 1976; Page, 1982; Saferstein, 2010), and a forensically relevant evidence base to provide a context to accompany geoforensic evidence and provide a reference point to aid and provide accurate interpretation. As the techniques currently used within forensic geoscience were originally established for use in other geological domains (eg. Specht and Rundel, 1990; Chen *et al.*, 1991; Hill, 1998; Carr *et al.*, 2008), further work should be performed to address the demands of forensic scenarios. Implementation of the philosophical framework (Morgan and Bull, 2007a) would help to ensure that these geological techniques are employed effectively within the forensic domain. However, further work is necessary to gain a better understanding of the circumstances of specific real forensic events in order to inform appropriate collection and analytical procedures. For instance, if evidence dynamics are understood, i.e. the factors that may either change, obscure, obliterate or relocate evidence, then forensic scientists will be better equipped to locate and quantify the evidence at a particular place and time (Chisium and Turvey, 2000). Morgan *et al.* (2009) suggested that a secondary level of experimentation is required to cater for such factors, and present the findings of two cases where this has proven to be essential. Experimentation has also been conducted to observe the effects of mixing of sediments from different sources on shoe soles through the use of different coloured plasticine to observe the degree of mixing that takes place on the recipient surface and to identify which material (pre-, syn- or post-forensic event) is retained best and where on the shoe the most representative samples can be identified (Morgan *et al.*, 2008), further work of this nature is essential for the development of forensic investigation.

Gaps within previous experimental studies can be observed when considering the variations in conditions that may be involved in casework. In many studies the applicability and performance of elemental analysis of geological material has been assessed (e.g. Karstensen *et al.*, 1998; Cruvinel *et al.*, 2009; Croft and Pye; 2003; Croft and Pye, 2004; Rawlins and Cave, 2004; Ruffell and Wiltshire; 2004; Pye *et al.*, 2006a; Rawlins *et al.*, 2006; Pye and Croft, 2007; Rinnan and Rinnan, 2007; Pye and Blott, 2008; Pye and Blott, 2009; Singh *et al.*, 2011; Wielopolski and Doron, 2012). However, these studies have lacked relevance to forensic casework. These studies have used chemical composition to distinguish between soil samples that are of large distances apart from one another, and from areas of different underlying geology, which are therefore likely to be inherently distinctive from one another. In cases where comparisons are made on samples with the same parental material a high degree of similarity might be expected, and therefore be reliant on anthropogenic contributions to discriminate samples (Morgan and Bull, 2007c), such contributions are unlikely to be identical over such distances and therefore discrimination between samples may still be achieved. In theory, elemental variation would be smaller over shorter distances than larger distances (Rawlins *et al.*, 2006), but this does not necessarily mean that sites that are of a close proximity to one another cannot be distinguished. Data to establish the degree to which this is feasible are essential. Therefore, further investigation with a specific focus on distinguishing between samples that are of a close proximity to one another is required to incorporate the forensic aspect of establishing provenance.

Recovery of mixed provenance soil samples from evidential items, such as articles of clothing, footwear, or tyre treads, is very common in forensic investigation, and therefore it is vital to address the issues associated with the analysis and interpretation of such samples (Morgan and Bull, 2006). The difficulties associated with samples of this nature have been acknowledged (e.g. Morgan and Bull, 2007a). However, other than the promotion of particular techniques that can overcome this issue (such as microscopy), there has not been a focussed study to establish the extent to which other forms of analysis may be able to overcome it. For instance, chemical signatures for samples with multiple contributors compared to a single source sample may appear different due to elemental abundances varying between sites. However, without data to support this notion, it cannot be said definitively if this is the case despite the logic behind this assumption.

Working with trace material often means that the number of different forms of analysis that can be applied is limited, so it is beneficial to an investigation to be able to recover as much material as possible from exhibits to keep as many options for analysis available. Ruffell and Sandiford (2011) present a method in which to maximise particulate recovery from artefacts through the use of a kidnap case study. Even then there is a limited amount of material available for analysis. The only piece of evidence available to give an indication of the location in which the victim had been held captive was faint soil stains on the socks of the victim. Brushing and ultrasonic agitation were applied to the socks; brushing obtained 50 sand grains and with ultrasonic agitation over 300 sand grains were obtained.

Experimental studies also provide the opportunity to identify gaps in interpretation of evidential data in order to improve and develop the interpretation of evidence by forensic analysts. For instance, knowing how to deal with unanticipated findings can be problematic, and often such findings are attributed to errors in the preparatory procedure or within the instrumentation; this may not, however, be the case and so this needs to be understood (Rothman, 1990). Study into the interpretation of geochemical data has emerged in the forensic science literature more recently. For instance, Reidy *et al.* (2013) performed a study illustrating the value that geological evidence can offer to an investigation through the use of geochemistry and multivariate statistics. A forensic case study was presented to a group of students along with the details of the samples collected from the exhibits and sources of interest were given. From this, they were asked to deduce whether the soil sample collected from the suspect could be excluded from the crime scene based on geochemistry alone. It was found that bulk soil samples taken from each of the sites could be distinguished from one another. However, the forensic samples recovered from the exhibits were much more complicated and required a different level of scrutiny to that of routine geological and soil analysis. Highlighting that knowledge of how to handle geological material acquired under forensic conditions is required.

2.3 Analysis

2.3.1 Macro Scale

There are both macro- and micro-scale forms of assessment within forensic geoscience. Macro scale analysis is generally adopted for search and locate aspects of forensic investigation, and includes techniques such as resistivity and electrical tomography (Scott and Hunter, 2004), ground penetrating radar (GPR) (Davis *et al.*, 2000), electromagnetic surveying (EM) (Nobes, 1999), geomorphology and physical probing for detecting burial sites and buried objects (Owsley,1995), forensic remote sensing for forensic archaeological (Hanson, 2008), and environmental forensic applications and geographic information systems (GIS) to assess spatial patterns of criminal behaviour and ancestry (Canter, 2003). These forms of analysis within forensic geoscience have been covered extensively in the literature (Ruffell and Wiltshire, 2004; Morgan and Bull, 2007a; Pringle *et al.*, 2012). Given the remit of this thesis, micro-scale aspects will be the focus of this chapter and therefore macro-scale forms of assessment will not be discussed further.

2.3.2 Micro Scale

Micro scale analysis addresses the physical, biological and chemical characteristics of soil/sediment evidence, and allows for the comparison between sites of interest (i.e. the crime scene and scenes visited pre- and post- forensic event), and to samples obtained from the suspect(s), victim(s) and/or artefact(s) (Pye *et al.*, 2006a; Morgan and Bull, 2007a). It is important to adopt multiple techniques across the physical, biological and physical spectrum to allow for corroborative findings, in order to provide robust evidence that investigators and the court may have confidence in (Morgan and Bull, 2007a). The chemical micro-scale assessment of geological evidence will be the focus of this thesis.

2.3.2.1 Physical

Physical assessment of geological samples has been covered thoroughly in the literature and includes techniques such as particle size analysis (Pye *et al.*, 2006a), binocular microscopy and scanning electron microscopy (SEM) for the study of minerals and in particular quartz grains (Murray, 2011; Bull and Morgan, 2006), and colour analysis through spectrophotometry and munsell charts (Torrent and Barron, 1993; Barrett, 2002). Physical assessment has been shown to be particularly good for identifying samples that are of mixed provenance, which can be highly beneficial in forensic investigation when trying to establish if a suspect may or may not be excluded from the sites of interest (Saferstein, 2010). Binocular microscopy is still used for the initial assessment, then the sample may be subjected to other forms of independent analysis if required (Murray, 2011).

2.3.2.2 Biological

Biological assessment of geological material includes the use of fungi (mycology), pollen (palynology), plant wax signatures, bacterial DNA, and diatoms. The assessment of each of these entities are mostly used to give an indication of provenance, although some studies have been carried out on the transferability of the materials such as pollen, which can be used to identify contact between two parties i.e. the victim(s) and the suspect(s) (Horrocks, 2004). Bacterial DNA (MacDonald *et al.*, 2011; Young *et al.*, 2014) and plant wax signatures are used to illustrate characteristics of the soil, or in the case of the latter, the specific plants that are growing in a particular soil body, and thus the identifying features of a particular area that distinguish it from other sites (Horswell *et al.* 2002; Heath and Saunders, 2006; Mayes *et al.*, 2009; Dawson and Hillier, 2010). Diatoms are typically used in cases involving drowning (Auer, 1991; Krstic *et al.* 2002), as they are an indicator of the inhalation of water from a specific water body and transfer readily to clothing (Scott *et al.*, 2014). Diatoms can give an indication of provenance as individual species tend to be characteristic of a particular area (Peabody, 1977; Stoermer and Smol, 2001). Fungi can play a beneficial role in forensic investigation (Hawksworth and Wiltshire, 2011), and unlike other geological material can be used for estimating the post mortem interval of the deceased (Hitsogui *et al.*, 2006; Ishii *et al.*, 2006), and the growth of particular types of fungi can indicate a burial site for a body (Carter and Tibbett, 2003; Sagara *et al.*, 2008).

2.3.2.3 Chemical

Chemical assessment allows for elemental, isotopic and mineralogical composition within soil/sediment samples to be deduced in order to establish provenance through comparison to known samples (table 2.1). Elemental profiles may also be used to determine the provenance of plants and animals, as the trace elements in the plant material or waste from animals that feed upon them is influenced by the soils in which the plant communities grow (Watling *et al.*, 2010). Chemical assessment has been utilised extensively in the environmental and earth sciences. However, it still needs further development for successful application within forensic investigation. For instance, crime reconstruction should be considered within studies to account for the specific conditions involved in individual cases that may impact upon the analysis. This would include the interpretation of chemical data for mixed provenance samples, which is already a highly complex process.

Table 2.1: Geochemical techniques and applications

Assessment	Technique	Application	Reference
Elemental Profile	AAS ICP-AES ICP-MS LA-ICP-MS XRF SEM-EDX QEMSCAN LIBS	Estimating provenance and/or the comparison of samples of interest	Axelsson and Roduskin (2001) Lowe *et al.* (2001) Jarvis *et al.* (2004) Pye *et al.* (2006b) Pye *et al.* (2007) Bai *et al.* (2007) Pérez-Bernal *et al.* (2011) Schnek *et al.* (2012) Duffosse and Touron (1998) Trueman (2004) Goullé *et al.* (2005) Bell *et al.* (2009) Castro *et al.* (2010) Goullé *et al.* (2012) Alamilla *et al.* (2013) Reidy *et al.* (2013) Ferretti (2004) Arroyo *et al.* (2010) Singh *et al.* (2011) Sliwinski (2012) Cengiz *et al.* (2004) Croft and Pye (2004) Suzuki (2006) Woods *et al.* (2014b)
Mineralogy	XRD QEMSCAN		Ruffell and Wiltshire (2004) Rawlins *et al.* (2006) Pirrie *et al.* (2014)
Isotopes	IRMS ICPMS		Roelofse and Hortsmann (2008)
Organics	GCMS HPLC FTIR		Medeiros and Simoneit (2007) McCulloch *et al.* (2016) Woods *et al.* (2014a)

Atomic Absorption Spectroscopy (AAS) was the original preferred method due to its analytical accuracy and smaller maintenance and analytical costs compared to other techniques, but it is slowly being replaced by techniques such as ICP-MS and ICP-AES within the forensic field (Bell, 2006). AAS is used to detect and quantify metal elements in samples (Robinson, 1960) and is typically composed of a radiation source, atomisation cell, sample introduction system, wavelength selector and a detector. The radiation source is usually a hollow cathode lamp that is coated with the element that is being analysed within the sample. Types of atomisation cell which may be used include granite furnace, cold vapour, hydride generation or flame, the latter being the more commonly used. The sample must be in solution to be analysed, and is introduced to the flame through a nebuliser-expansion chamber which creates an aerosol. The aerosol enters the monochromator, which converts the wavelength of the photons to an electric current, which is then detected and a spectrum is produced (Langford *et al.*, 2005).

ICP-MS and ICP-AES have been receiving more attention in more recent forensic studies due to the requirement of a minimal amount of sample to achieve reliable results, which is of great benefit in forensic investigation where only trace amounts of material are usually available **(**Murray and Solebello, 2002**).** Both methods allow for simultaneous detection and quantification of major and trace elements, and in the case of ICP-MS, isotope ratios may also be deduced in a wide variety of sample matrices. The sample is first homogenised and digested, the sample solution is then introduced into the system through the nebuliser which produces an aerosol from the samples, to be then carried through to an Argon gas plasma. At this stage in the ICP-MS, the sample atoms are converted to ions, which the mass spectrometer separates and sorts based on their mass to charge ratio. These are then counted either by Faraday detectors or an electron multiplier (Reidy *et al.*, 2013). In ICP-AES, however, the energy emitted by the atoms in the sample is detected and counted in order to identify elemental concentrations (Langford *et al.*, 2005; Bell, 2006).

LA-ICP-MS has the advantage that it does not require the dissolution of the soil/sediment sample, and therefore acids are not required (Reidy *et al.*, 2013). This has the advantages of potentially reducing costs, as the acids can be expensive, in addition to the reduction of potential health risks from acid exposure, reduced analysis time, and no waste being generated. Furthermore, the information obtained is spatially resolved (Langford *et al.*, 2005). However, quantification is complicated and the precision of the results is poor in comparison to total dissolution or strong acid-leaching methods (Reidy *et al.*, 2013).

XRF has the benefit that it only requires a minimal amount of sample pre-treatment; samples only require homogenisation into a fine powder before they can be analysed (Bell, 2006). The powdered sample is transferred to an XRF disc, which sits inside the plate within the spectrometer. At this point X-rays then bombard the sample. Depending on the type of XRF the X-ray may be either energy dispersive or wavelength dispersive; it is the energy frequency emitted or wavelength measurement diffracted that determines the element identity, and the fluorescence intensity indicates the elemental concentration (Langford *et al.*, 2005).

In SEM-EDX analysis the sample, usually untreated, is mounted onto an adhesive carbon stub, inserted into the chamber and is magnified using an electron beam, which simultaneously emits radiation (Saferstein, 2010). In some cases the sample may be coated with either carbon or a suitable metal, such as gold, to make it conductive (Willis *et al.*, 2002). Each element has its own characteristic emission, which the energy dispersive x-ray separates and sorts to produce a read-out with the relative amounts and identity of these elements. The intensity of these emissions indicate the concentration present (Gallop and Stockdale in White, 2009; Saferstein 2010). It should be noted that SEM-EDX provides a point source measurement of a particular location on a particle on the stub, as opposed to an overall sample characterisation produced by other techniques (Willis *et al.*, 2002).

QEMSCAN system is an automated SEM-EDX; however, it not only allows for elemental assessment, but is able to provide rapid mineralogical assessment of the sample and perform particle size analysis (Pirrie *et al.*, 2004; Pirrie *et al.*, 2009). Originally it was developed for use in the mining industry, but has subsequently seen applications in archaeology (Hardy *et al.* 2006; Knappett, 2011), sedimentology (Pirrie *et al.*, 2003), and environmental analysis (Power *et al.*, 2009), as well as forensic science (Pirrie *et al.*, 2004; Pirrie *et al.*, 2009; Pirrie *et al.*, 2014). The semi-automated nature of this technique can have limitations in terms of the mineralogical assignments, and an experienced operator is generally required to facilitate appropriate interpretation of results. It can also be time consuming, particularly where using photomicrographs to identify grain boundaries. At present, the equipment is not available in all forensic laboratories (Rasbury *et al.*, 2012) thus requiring the analysis to be outsourced to a company with a competent analyst at a potentially high financial and time cost.

2.3.2.4 Sample preparation for chemical analysis

The type or amount of sample pre-treatment is dependent upon the form of inorganic chemical analysis the sample is being subjected to. Although the following techniques are established predominantly in geology and geomorphology, as opposed to specifically for forensic analysis, the same principles would apply. First and foremost the soil/sediment should be dried to prevent microbial growth and other soil processes from continuing, and the organic content should be removed; this can be achieved through freeze drying then handpicking or sieving to remove bulky organic material or through combustion (Theocharopoulos *et al.*, 2004). Next it must be homogenised to evenly distribute the material in order to acquire data that is representative of the entire sample and not a select part of it. This may be done manually with the use of an agate pestle and mortar, or mechanically, though the manual approach has been found to be more effective (Pye and Croft, 2007). Once homogenised the sample may then be subjected to XRF. However, for analysis via AAS, ICP-MS and ICP-AES, samples are required to be in solution, and so the sample is digested using either mineral or oxidising acids and subjected to heat (Langford *et al.*, 2005).

Various digestion protocols have been developed to target different forms of geological materials (Yu *et al.*, 2001). The variables between the different protocols include which reagent combinations are selected, whether a closed or open vessel is employed, and temperature source (Theocharopoulos *et al.*, 2004; Reidy *et al.*, 2013). Different acids are used for the dissolution of the powdered soil material (table 2.2), although a universal protocol for the combination and volume of these acids does not exist, and thus this depends on laboratory or analyst preference. Digestion in a closed vessel reduces the opportunity for contaminants to be introduced into the sample, and avoids the loss of volatile liquids, for instance, use of a closed vessel can prevent the loss of silica if HF is used to digest soil (Bernas, 1968; Langmyhr and Paus, 1968a; Langmyhr and Paus, 1968b).

Lithium borate fusions are another option in place of the digestion; samples prepared in this manner can be left in its disc form to be analysed through both LA-ICP-MS and XRF, or subject to dissolution in nitric acid to obtain a clear aqueous solution for analysis via AAS, ICP-MS or ICP-AES (Van Loon and Parissis, 1969; Verbeek *et al.*, 1982; Thomas, 2013).

Table 2.2: Acids used for the digestion of soil samples for elemental analysis via ICP-MS and ICP-AES

Acid	Use
HNO_3	Removal of organic compounds, digests metals, alloys or biological samples.
$HClO_4$	Removal of organic compounds.
HF	Used to break down silica-based compounds and remove silica from the sample.
H_2SO_4	Releases volatile products; removals of oxidising metals, ores, alloys, oxides and hydroxides
	Removal of carbonate salts and some oxides and sulphides.
HCl	Used in aqua regia (1:3 of HNO_3 and HCl) for the digestion of metals, alloys, sulphides and some ores.

(Thomson and Walsh, 1983; Zarcinas and Cartwright, 1987; Langford *et al.*, 2005; Somer and Nakişi Ünlü, 2006)

2.3.3 Advantages and Disadvantages of Chemical Analysis

Chemical analysis is a desirable form of evidence assessment within forensic investigation. This is due to its speed, ability to be automated, the minimal amount of sample required, and the capacity for simultaneous qualitative and quantitative analyses of multiple major and trace elements (Pye *et al.*, 2006b). By comparison, physical analysis is generally dependent on the knowledge and experience of the analyst and can often be time consuming (Langford *et al.*, 2005). Physical assessment through the use of a binocular microscope is, however, often used to give an initial assessment of the evidence, and is still the most reliable method for assessing samples of mixed provenance (Murray, 2011; Saferstein, 2010). Interpreting chemical signatures of mixed source samples is somewhat more difficult than physical assessment due to the preparatory treatments that the samples are subjected to before analysis, mentioned in section 2.3.2. For example, the issue with homogenisation is that it complicates the distinction between each of the multiple contributors within the sample as evenly distributed material within the sample, removing any evidence of layering that may previously have been present (Bull and Morgan, 2008). This issue is exacerbated further when this homogenised sample subsequently undergoes acid digestion to bring into solution for elemental analysis via techniques such as ICP-MS and ICP-AES. Here again no visual discrimination can be made between the contributors as the digestion results in a translucent aqueous solution and the techniques themselves do not identify the multiple sources and separate their chemical signals out as individual entities (Yu *et al.*, 2001).

Currently there is no universally accepted protocol for the chemical analysis of soil samples (Pirrie *et al.* 2014). This makes the comparison of results between forensic laboratories complicated, as it leaves the analysts unable to identify if any differences observed are a result of the protocol itself, the variation between/within samples, human error, or variation between the instruments used (Croft and Pye, 2004). This needs to be rectified to enable the analyst to execute a meaningful interpretation of the results, which can then be conveyed with confidence to members of the jury during trial.

Elemental analysis is also subject to certain interferences which can give fluctuations in the elemental identities or concentrations observed. For instance, for XRF there are three forms of interferences that can be expected; spectral, environmental, and/or matrix interferences (Watson *et al.,* 1999). Spectral interference involves the overlapping of the samples peak with another source, and environmental interferences refer to external sources interfering with the signal of lighter elements (Feather and Willis, 1976). For matrix interferences, there are two possible outcomes; the elements can absorb or disperse the signal produced by the element of interest, which is known as absorption, or an elements X-ray can excite another element within the sample causing an increase in the signal observed for this element, which is known as enhancement (Feather and Willis, 1976; Langford *et al.*, 2005). XRF is a semi-quantitative technique (Rothwell and Croudace, 2015) in that element values obtained are relative to the other elements in the sample. This can be problematic where elements prone to spectral (e.g. K and Ca) or environmental interference (e.g. lighter elements Na to Cl) are concerned as it can give disproportionate measurements (Langford *et al.*, 2005). Therefore, as with all analyses, appropriate quality control and quality assurance measures should be taken to ensure that these errors are reduced to provide confidence in the accuracy and precision of the analytical readings (Prichard and Barwick, 2007).

ICP-AES encounters two main forms of interference, spectral and matrix. Spectral interferences involve emission lines from elements, the carrier gas, impurities within or external to the sample, impacting the emission line of the element of interest (Danzaki *et al.*, 1998; Kostadinova *et al.*, 2000). Matrix interferences are usually due to the presence of ionisable elements within the plasma or factors that affect the introduction of the sample to the system such as the rate at which it is introduced as this can affect the sensitivity (Hoenig *et al.*l, 1998; Todolí *et al.*, 2002).

There are three forms of spectral interferences that may be experienced in ICP-MS, including isobaric interferences, polyatomic interferences, and doubly charged species (Evans and Giglio, 1993). Isobaric interferences are due to direct overlap of isotopes of different elements. Polyatomic interferences occur as a result of interactions between the elements of interest and mediums involved in the analysis such as the carrier gas or reagents used in the digestion of the sample, water or ambient air (May and Wiedmeyer, 1998; Pick *et al.*, 2010)

2.3.4 Data Analysis and Interpretation

Interpretation is still a key issue that requires addressing within forensic geoscience, especially with regards to elemental data derived from samples of mixed provenance (Morgan and Bull, 2007a). The initial problem to address is whether it is possible to identify whether there are multiple sources within the sample, based on the chemical composition alone. Following on from this there is then a need to establish how to separate out the chemical signatures, so that the sites that are responsible for a particular group of elements may be identified and their abundances established, which is an extremely complex matter (Morgan and Bull, 2006).

Typically multivariate statistics are applied to elemental data to aid the interpretation and determine the significance of the findings (Mudge, 2007). Multiple options are available, dependent on the nature of the data, including principal component analysis (PCA), discriminant analysis, and likelihood ratios (Aitken and Lucy, 2004). PCA and discriminant function analysis are popular data assessment methods, as they are accepted by the wider scientific community (Reidy *et al.*, 2013), and are already applied to other forms of evidence such as accelerants (Tan *et al.*, 2000), documents (Kher *et al.*, 2001), fibres (Morgan *et al.*, 2007), glass (Koons *et al.*, 1998), drugs (Jonson, 1994), and environmental data (Eriksson *et al.*, 2006). However, these statistical assessments do not aid the understanding of mixed provenance samples due to the nature of the data. More recently, the use of end member modelling has been applied to particle size data and elemental data in environmental research to gain a clearer insight into the complexities of the mixing (Weaver, 1991; Weltje, 1997, Tjallingii *et al.*, 2008; Mulitza *et al.*, 2010; McGee *et al.*, 2013). Although this is on a large scale, to assess the assemblage of sediments on lake or ocean floors, there may be some potential for its utilisation in forensic investigation. Some adjustments may be required to cater for the smaller scale nature of the mixing. However, should it be successful, the assemblage and interaction of materials on recipient surfaces of interest, like those mentioned in previous sections, could be understood more clearly and findings could be delivered to the court with conviction.

2.4 Synopsis

It has been identified that there are key broad areas that need to be addressed within trace geoforensic analysis, and specifically numerous complexities and issues associated with geochemical analysis for the purposes of forensic investigation, that must be addressed. These include the analysis and interpretation of mixed provenance samples, distinguishing between samples that are from close proximity, protocol inconsistency between forensic laboratories, and potential variables that can impact upon the analysis, such as temporal and spatial variance in the samples collected, the material of the exhibit packaging and the storage temperature and/or duration.

2.5 Aims and Objectives

2.5.1 Aims

Research Aim: establish to what extent can geochemical analysis techniques be reliably implemented for the accurate assessment and interpretation of single and mixed provenance soil/sediment samples in forensic investigation.

This research will target the issues associated with the chemical analysis and interpretation of soil/sediment samples that are of mixed provenances, and samples that are geographically similar. Other factors that may have an influence on this will be explored, including temporal and spatial aspects, storage duration, and the type of packaging used.

Specifically, the research will address the capabilities of ICP-MS, ICP-AES, and XRF for the elemental analysis, and IRMS for isotope determination, as these techniques are well established in the geological studies, and have proven to be successful on other forms of trace evidence. LOI will be used to provide an approximate determination of the organic content to act as a comparative tool for any differences or similarities observed in the samples elemental and isotopic signatures between collections.

2.5.2 Objectives

1. Determine the chemical properties of control samples through the use of multiple techniques.

2. Determine the chemical properties of known and unknown mixed provenance samples through the use of multiple techniques.
3. Assess the feasibility of the techniques employed to identify the provenance of the samples.
4. Determine the extent to which temporal and spatial effects on soil/sediment sample analysis could influence forensic analysis and interpretation of samples.
5. Determine the effects of packaging and storage on forensic soil/sediment analysis.
6. Provide appropriate universal guidelines of procedures for use in forensic laboratories for elemental analysis and interpretation of forensic soil/sediment samples.

Chapter 3 Methodology

3.1 Sampling

Two locations, one in Nottingham (Cropwell Bishop, figure 3.1) and the other London (Croxley, figure 3.2), were chosen for this study. Three close proximity sites were selected within each location, as crime events often take place over short distances (Eck *et al.*, 2015), and therefore it is important to ascertain if elemental, isotopic and mineralogical techniques can discriminate between sites within urban and rural areas such as these in order to establish their effectiveness in a forensic investigation (Morrison *et al.*, 2009). Each of the sites selected within these two locations were forensically relevant. This being characterised by ease of access with good transportation links, and offering good concealment of activities (as a result of a lack of natural surveillance either due to few people in the vicinity or due to coverage of the location by natural vegetation; Canter, 2003). These two different locations enabled the spatial variation of two different locations to be assessed, in addition to establishing the extent to which the sites chosen within these two locations may be discriminated using the analytical techniques selected. Sites were selected primarily due to the heterogeneity of land use types and soil properties over short distances. Additional motivations included the ease of access to the sites, both for the probability of an offender passing through and for sampling to take place unhindered at each collection time. Two additional locations in West London were selected, to assess the potential impact of different packaging and storage conditions upon geochemical evidence, and are described in chapter 4.

3.1.1 Sample Sites

The details of the two sites studied in chapters 5 to 8 are presented below (table 3.1, figure 3.1 - Nottingham; figure 3.2 - London). The sites selected in the Nottingham sample location are three pathways; the first (site A) surrounding a crop field, the second (site B) connecting sites A and C and also connecting two villages, and the third (site C) through a cattle field to various hiking routes in the area.

Table 3.1: GPS co-ordinates for the study sites

Study Sites		Decimal Degrees (DD)	
	Site	**Latitude**	**Longitude**
Nottingham	A	52.91827	-0.98814
	B	52.91831	-0.98827
	C	52.91773	-0.9886
London	A	51.64531	-0.43959
	B	51.64508	-0.43914
	C	51.6446	-0.4383

Figure 3.1: Nottingham sample sites (site A - path around crop field, site B - path between sites A and C, site C - field used for grazing cattle).

The sites selected in the London sample location include a section just off the pathway in a woodland (site A), a pathway alongside a canal (site B) and a pathway through a moorland used to walk dogs and to reach a number of residential areas and transport connections.

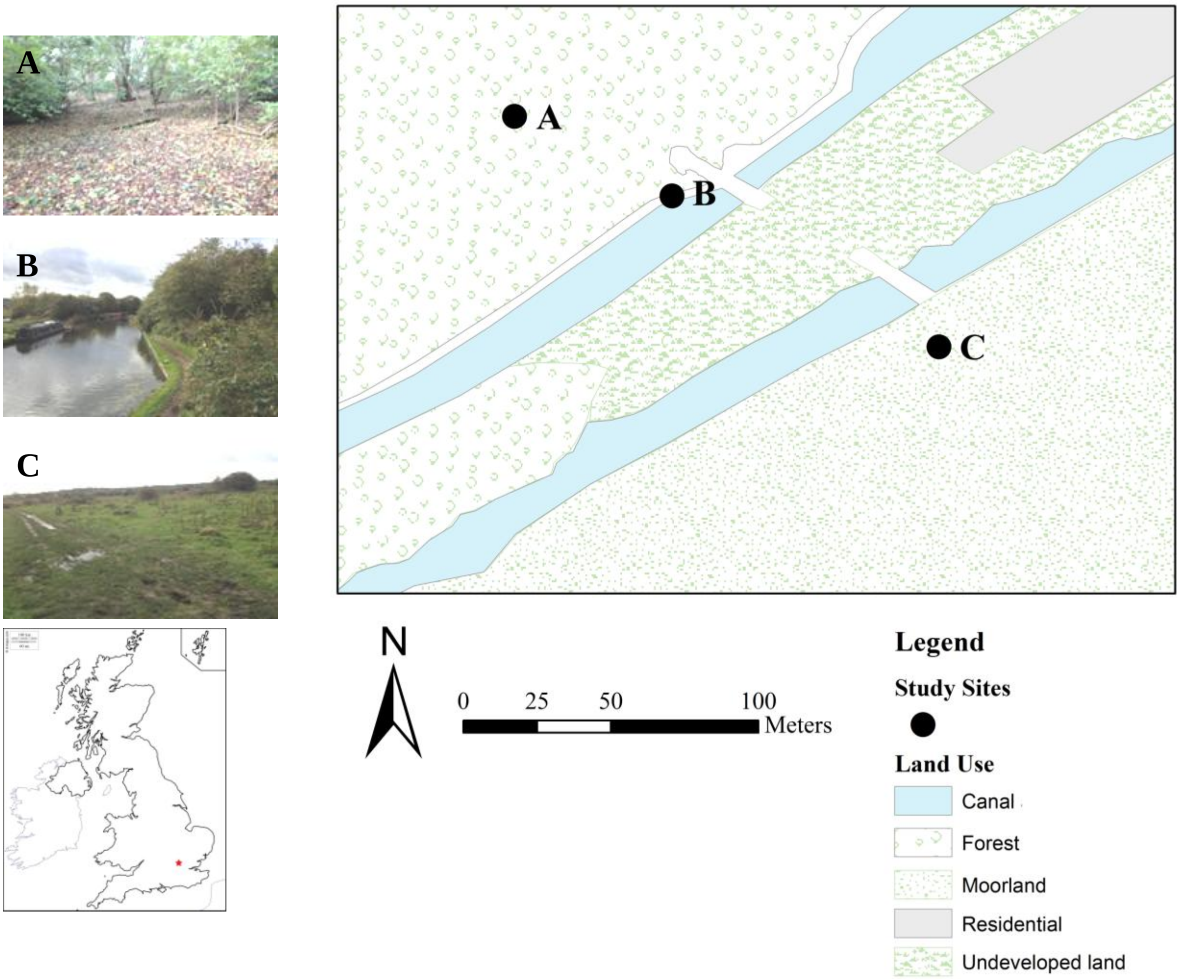


Figure 3.2: London sample sites (site A - woodland area, site B - canal path, site C - moorland).

3.1.2 Samples

Samples were collected from the locations described at quarterly intervals for one year in order to account for any temporal variation that could potentially be observed in the analytical results. This is necessary as often there is a time lapse between the forensic event occurring and the subsequent collection and analysis of evidence. Therefore, it needs to be established what effect this may have upon the findings. Quarterly intervals allowed for changes associated with each season to be accounted for as it is suspected that this is when the sites are expected to be subject to the most change (i.e. weather conditions, plant species and abundance, and human/animal activity). Therefore, will have the most impact on the site variation over this time scale than shorter time scales, e.g. monthly, and enable data to be generated in an efficient time scale necessary for this project, rather than over larger time scales, e.g. years. Five control samples were collected per site and the artificial mixtures were created using material from these sampling locations (table 3.2). The control samples were taken from the sites at perpendicular to one another in a grid pattern, with the first control sample being collected from the centre (figure 3.3); the number of samples collected is in accordance with Pye *et al.* (2006a) as this was tested in a pilot study (Cheshire *et al*., 2016) and found to provide a sufficient amount of information about intra-site variation. The control samples were taken from the surface up to 2 cm depth from a 5 cm by 5 cm area using a trowel. Antibacterial spray was used to clean the trowel after each collection to avoid cross-contamination between sites, and then rinsed thoroughly with deionised water to avoid potential interference in the analysis. Artificial mixtures were generated in the laboratory using equal proportions of material from the pertinent sites at each location (as outlined in Table 3.2).

Table 3.2: Samples collected at each quarter for each location

Sample Type/Location	**Nottingham**	**London**
Control	Site A (5 samples)	Site A (5 samples)
	Site B (5 samples)	Site B (5 samples)
	Site C (5 samples)	Site C (5 samples)
Artificial Mixture	AB (1:1)	AB (1:1)
	AC (1:1)	AC (1:1)
	BC (1:1)	BC (1:1)
	ABC (1:1:1)	ABC (1:1:1)

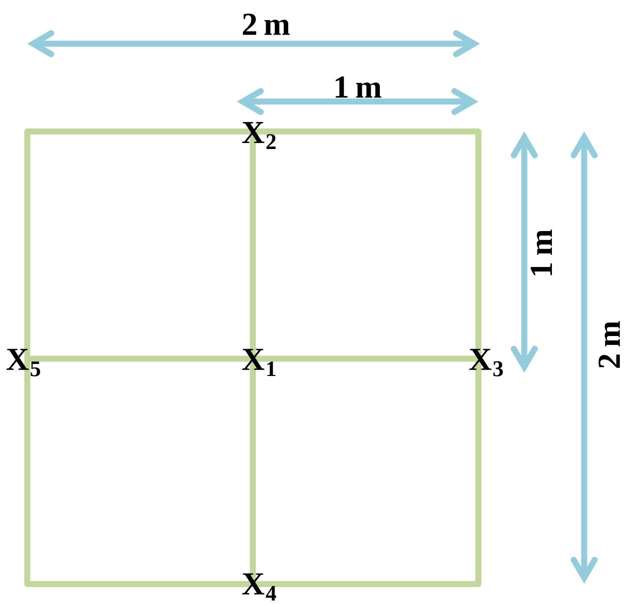


Figure 3.3: Sampling grid as seen from above (X1 through X5 mark the sample locations, sample depth 2 cm)

3.2 Sample Storage

Each sample was put into an individual plastic grip sealed bag and labelled then stored in the UCL Department of Geography cold room (0 - 4 ^{o}C) until the time of analysis, in order to preserve the organic content. Samples were then freeze-dried and stored at room temperature.

3.3Acid-washing

Prior to the analysis being carried out, all glassware and PTFE tubes were acid-washed using 2% HNO_3 (VWR analytical grade), in order to remove any potential contaminants that may be present. The apparatus was submerged in HNO_3 for 24 hours before being rinsed with deionised water, and then dried in a laminar flow cabinet for 24 hours.

3.4 Materials

The following materials are used in this study:

1. VWR Analar analytical grade concentrated HNO_3 for acid washing.
2. Merck Suprapur concentrated HNO_3 (65%) (sample digestion).
3. Fluke Analytical concentrated HF (51%) (sample digestion).
4. Deionised water with resistivity of 18.3 MΩ cm^{-1}.
5. CRM 1: Buffalo River Sediment (BRS; MBH Analytical Ltd).
6. CRM 2: S-SP Sediment (MBH Analytical Ltd).

3.5 Sample Preparation

3.5.1 Sub-sampling

10 g of material was sub-sampled to allow for three replicates to be assessed for organic content through Loss-on-Ignition (LOI). The rest of the material was then frozen and then freeze dried, in accordance with UCL Geography Laboratory Practices, for elemental analysis via XRF, ICP-MS and ICP-AES, isotope analysis via IRMS and mineralogical analysis via QEMSCAN. This amount of material would not be present in a real forensic investigation, but as this is an experimental study excess material has been used in order to gain a better understanding of the material assessed by these techniques and lay the foundations for future work,

3.5.2 Freeze-drying

Samples collected at each quarter were subjected to freeze drying using a Modulyod Freeze Dryer for 120 hours. Each sample was left in its original sample bag and put into the freeze dryer.

3.5.3 Homogenisation

Bulky plant and man-made (e.g. litter) materials were removed by hand. Manual homogenisation was then performed on 5 g of sample using an agate pestle and mortar, this method arguably provides better results as the sample is more homogenous (Pye and Croft, 2007). For elemental analysis via XRF, 4 g material was used; for ICP-MS and ICP-AES, 0.1 g sample was used; and for isotope analysis via IRMS, 10 mg for Nottingham and 6 mg for London were used.

3.6 Digestion

3.6.1 Method Development

HF/HNO_3 digest has been used in previous work (Cheshire 2013). However, the temperature in this digest protocol was regulated using a hot plate. For this study a hot block (model EDS4S) was used in an effort to improve the temperature regulation efficiency. Therefore, the digestion method needed to be modified. The following digestion methods have been developed and tested in order to adjust the previous methodology used, and in line with the digestion protocol with a hotblock in Thomson and Wood (1982).

Cheshire (2016) Protocol: HNO_3 and HF using a hot plate

Weigh 0.1 g of powdered sample to 4 decimal places into a clean dry PTFE beaker. Add to this 2 ml of HNO_3 and evaporate off to near dryness using a hot plate set to ~ 70^oC. Then carry out three HNO_3-HF fluxes involving the addition 4 ml of HNO_3 and 2 ml HF and evaporate off to near dryness for each flux. Following the final flux add 2 ml of HNO_3 and again evaporate off to near dryness before adding a final 2 ml of HNO_3 and making up to a 2% solution using deionised water.

Thomson and Wood (1982) Protocol: HNO_3, HF and $HClO_4$ using a hot block

Weigh 0.1 g of powdered sample to 4 decimal places into a clean dry PTFE tube. Add to each of the tubes 2 ml HNO_3, 1 ml of $HClO_4$ and 5 ml of HF. Place the tubes into the hot block and set to the following temperature program:

- 3 hours at 90^{o}C
- 3 hours at 140^{o}C
- 10 hours at 190^{o}C

Remove the tubes from the rack and allow to cool before adding 2 ml of HCl then leach for 1 hour at 70^{o}C on the hot block. Again allow to cool and add a further 2 ml of HCl, vortex the tubes then transfer to a clean dry vessel.

Protocol 1: HNO_3 and HF using a hot block

Weigh 0.1 g of powdered sample to 4 decimal places into 5 clean polypropylene and 5 PTFE tubes (this is to ascertain if the polypropylene tubes are appropriate in order to carry out digestions, as they may be utilised for making up to solution at the end of the digestion and are disposable reducing the chance of contamination being introduced from reuse). Add 4 ml of concentrated HNO_3 to each sample and out on the hot block for 3 hours at 60 ^{o}C until the HNO_3 has evaporated. Add to each tube 4 ml of concentrated HNO_3 and 2 ml of concentrated HF. Place the tubes into the hot block and set to the following temperature program:

- 3 hours at 60^{o}C
- 3 hours at 80^{o}C
- 10 hours at 100^{o}C *

Temperatures were adjusted for this protocol due to the working temperature limit of the polypropylene tubes being 130 ^{o}C. Once the temperature program has finished remove the tubes from the hot block and allow to cool before adding 1 ml of concentrated HNO_3 and 1 ml deionised water then return to the hot block at 70 ^{o}C for 1 hour (or until evaporated to near dryness). Allow to cool and add a further 1 ml of concentrated HNO_3 and then make up to 50 ml with deionised water, and thus resulting in a 2 % HNO_3 solution for the digested sample.

*Samples in the PTFE tubes were given 3 extra hours as the acids had not evaporated off in the preliminary 10 hours.

After leaching, it was evident that not all the powdered sample had fully digested, so to each sample a further 1 ml HNO_3 (total 2 ml in vessel) and 1 ml of HF was added and returned to the hot block on the following settings:

- 3 hours at 60^{o}C
- 3 hours at 80^{o}C

- 5 hours at 100°C

Protocol 2: *HNO_3 and HF using a hot block (amended)*

Weigh 0.1 g of powdered sample to 4 decimal places into 5 clean polypropylene and 5 PTFE tubes. Add 4 ml of concentrated HNO_3 to each sample and put in the hot block for 3 hours at 60 °C until the HNO_3 has evaporated. Add to each tube 4 ml of concentrated HNO_3 and 2 ml of concentrated HF. Place the tubes into the hot block, with the lids resting on top to prevent the acids from evaporating prematurely during the heating cycle and set to the following temperature program:

- 3 hours at 55°C
- 3 hours at 75°C
- 10 hours at 95°C

Once the program has finished, remove the lids from the tubes and evaporate off the acid at 95 °C. Once finished, allow to cool before adding a further 4 ml of concentrated HNO_3 and 2 ml of concentrated HF to each tube and repeat the process. Once finished allow the tubes to cool before adding 1 ml of HNO_3 and 1 ml of deionised water. Return to the hot block at 70 °C for 1 hour (or until acid has evaporated off to near dryness). Again, remove the tubes and allow to cool before adding 1 ml of HNO_3, and then making up to 50 ml with deionised water to give a 2 % HNO_3 digest solution.

After leaching for this protocol, a small amount of powdered material remained un-dissolved. To establish the impact this had upon the elemental concentrations, these test samples were assessed using ICP-MS. Although the rare earth elements appeared to be within the expected range (appendix 3.6), the other elements did not, and so the method was amended one further time.

Protocol 2: *HNO_3 and HF using a hot block (final amendment)*

Weigh 0.1 g of powdered sample to 4 decimal places into 5 clean polypropylene and 5 PTFE tubes. Add 4 ml of concentrated HNO_3 to each sample and put in the hot block for 3 hours at 60 °C until the HNO_3 has evaporated. Add to each tube 4 ml of concentrated HNO_3 and 4 ml of concentrated HF. Place the tubes into the hot block, with the lids resting on top, and set to the following temperature program:

- 3 hours at 55°C

- 3 hours at 75 ^{o}C
- 10 hours at 95 ^{o}C

Once the program has finished, remove the lids from the tubes and evaporate off the acid at 95 ^{o}C. Once finished, allow to cool before repeating the HNO_3-HF flux a further two times (for a total of three HNO_3-HF fluxes). Once finished, allow the tubes to cool before adding 1 ml of HNO_3 and 1 ml of deionised water, and return to the hot block at 70 ^{o}C for 1 hour (or until acid has evaporated off to near dryness). Again, remove the tubes and allow to cool before adding 1 ml of HNO_3 and then making up to 50 ml with deionised water to give a 2 % HNO_3 digest solution.

After completion of this digestion protocol, the reference material had fully digested and was subjected to assessment through ICP-MS to establish if the expected elemental concentrations were obtained (appendix 3.6). Digestion of the samples collected specifically for this study did not follow that observed for the reference material; though the Nottingham samples fully digested the London site samples did not, and instead left a black particle residue in the polypropylene tubes. Microscopic assessment of these particles identified them to be charcoal residues (which may be a result of the past industrial land-use of this site).

3.6.2 Digestion

0.1 g of sample powder was weighed out to 4 decimal places into a clean dry PTFE tube. To this 4 ml of HNO_3 is added initially and evaporated off. This was followed by 4 ml of HNO_3 and 4 ml of HF being added and the sample tubes placed into an EDS4S model hot block. The following temperature program was then used: 3 hours at 60 ^{o}C, 3 hours at 80 ^{o}C and 10 hours at 100 ^{o}C. This flux was repeated twice to allow for full digest and the tubes removed and allowed to cool. Then 1 ml of HNO_3 was added and left for 1 hour at 80 ^{o}C to leach, once cool a final 1 ml of HNO_3 was added then made up to a 2 % solution using deionised water. 10 % of the digests were blank runs to account for the introduction of contaminants, and 10 % of the digests were reference material to account for the accuracy of the digestion protocol.

3.7 Organic Analysis

A crude assessment of the organic content was determined via Loss-on-Ignition. Although this is not a forensic method, it is a good starting point for characterising basic soil/sediment properties. Ceramic sample crucibles were weighed at 4 decimal places before adding 2 g of sample material (also to 4 decimal places). These were then placed in a Memmert Beschickung Loading Modell 100-800 Oven for 24 hours at a temperature of 104.5 ^{o}C, allowed to cool then weighed. The samples were then placed into a SLS Carbolite Furnace at 550 °C for a further 4 hours in accordance with Heiri *et al.* (2001). Once cooled samples were weighed to 4 decimal places again and the percentage of material lost between the oven and the furnace (i.e. the organic content) was recorded.

3.8 Elemental Analysis

The following elemental techniques were selected for the study as they are readily available to forensic laboratories, and therefore could be easily implemented for the routine use on soil/sediment evidence. Analysis via these techniques is fast and produces quantifiable data from minimum amounts of material, which is essential in forensic investigations.

3.8.1 XRF

4 g of each of the 152 samples (homogenised) and the CRM were weighed to 4 decimal places directly into an XRF sample disc. Though this amount of material may not always be available in a forensic investigation, this technique has been included to monitor the performance of other methods presented in this thesis. These were labelled with their weight and identification number before being placed into the XRF plate and ran on a Spectro X-Lab 2000 XRF; 19 samples and 1 reference sample (for ascertaining the analysis accuracy) per run. Three runs were carried out in order to obtain replicate measurements for assessing precision and there was a recovery time of 180 seconds between each sample analysed.

The XRF instrument set up allowed for the following elements to be determined:

• Na	• K	• Co	• Mo	• Ga	• I	• W
• Mg	• Ca	• Ni	• Ag	• Ge	• Cs	• Hg
• Al	• Ti	• Cu	• Cd	• As	• Ba	• Tl
• Si	• V	• Sr	• In	• Se	• La	• Pb
• P	• Cr	• Y	• Sn	• Br	• Ce	• Bi
• S	• Mn	• Zr	• Sb	• Rb	• Hf	• Th
• Cl	• Fe	• Nb	• Zn	• Te	• Ta	• U

Though this is a substantial list, XRF does not have the capacity to measure all of these elements with the same success. For instance, measurements of lighter elements (highlighted yellow above, error range 9.6 % to 81.3 % - table 5.6) are less reliable as they emit weaker x-rays and whilst some (highlighted green above, error range -232.2 % to 31.3 % - table 5.6) are more prone to spectral interferences (Langford *et al.*, 2005).

3.8.2 ICP-MS

10 ml of each of the 152 digested soil sample solutions, 24 reference material solutions, and 24 blank solutions, were measured into flat bottomed tubes. These were then loaded into an SPS3 autosampler prior to analysis. Three standards of different concentration ranges in a 2 % HNO_3 matrix were used to calibrate the machine to enable quantifiable results to be obtained. One containing rare earth element (Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm, Y and Yb), one mixed element standard (Co, Cr, Cu, Mo, Nb, Pb, Sn, Sr, Tl, U, V and Zr) and one containing tungsten (W) only to avoid potential matrixing effects with other elements. The CRM were used to monitor the accuracy of the method and 5 replicates were measured to monitor precision which is presented in chapter 5. Due to the sensitive nature of the instrument, there was a rinse time of 30 seconds and uptake delay of 30 seconds between each sample, to ensure no interference between different samples during analysis.

The elements listed below will be assessed using a Bruker M90 ICP-MS following Pye *et al.* (2006b):

- V*
- Cr
- Co
- Cu
- Sr
- Zr
- Nb
- Mo
- Sn
- U
- Pb
- La
- Ce*
- Pr
- Nd
- Sm
- Eu
- Gd
- Tb
- Dy
- Er
- Tm
- Yb
- Lu
- Tl*
- Ho
- Y
- W

*elements with high error rate V - 73.9 %, Tl, -400 % and Ce -593 %.

3.8.3 ICP-AES

10 ml of each of the 152 digested soil sample solutions, 24 reference material solutions, and 24 blank solutions were measured into flat bottomed tubes. These were then loaded into an SPS3 autosampler prior to analysis. Two standards of different concentration ranges in a 2% HNO_3 matrix solution have been used to calibrate the machine to enable quantifiable results to be obtained. One mixed element standard (Al, Be, Ca, Fe, K, Mg, Mn, Na, Ni, P, Sc and Zn) and finally a separate element standard for Titanium (Ti) to avoid potential matrixing effects. The CRM were used to monitor the accuracy of the method and 5 replicates were measured to monitor precision of measurements which is presented in chapter 5. ICP-AES is less sensitive than ICP-MS (measures in ppm as opposed to ppb) and was therefore less

susceptible to interferences from previous samples therefore there was a rinse time of 20 seconds and uptake delay of 15 seconds between each sample to ensure no interference between different samples during analysis.

The elements listed below will be assessed using a Varian 720 ICP-AES (axial configuration) following Pye el al (2006b)*:

- Al_2O_3
- Be**
- Ca
- Fe_2O_3
- K
- MgO
- MnO
- Na_2O**
- Ni**
- P_2O_5
- TiO_2
- Zn

*Silica content was also assessed to determine the success of the HNO_3-HF digest in the removal of silicates from the assessed samples.

**Elements with high error rate - Na 89.6 %, Be 100 % and Ni 140.6 %

3.9 Isotopes via IRMS

The use of stable isotope analysis via IRMS has been used in this study as it has previously been demonstrated to show promise on forensic soil/sediment samples (e.g. Croft and Pye, 2003). However there is a limited amount of subsequent literature to show further exploration of this technique on geological evidence. Isotopes can identify differences where elemental concentrations are seemingly identical and could therefore prove beneficial in the discrimination of soil/sediment samples where elemental techniques are unable to identify a difference.

3.9.1 Method Development

Control samples for Nottingham and London (described in section 3.1.1 - figures 3.1 and 3.2) were initially screened to determine the weight of material and dilution factor required to obtain the optimum nitrogen and carbon isotope peaks within the linear range of the IRMS instrument (Carter and Barwick, 2011). It was identified that 10 mg of powdered soil sample from the Nottingham sample site and 6 mg of powdered soil sample from the London sample site were required to obtain the optimum isotope peaks due to differences in the organic content in each sample location.

3.9.2 Analysis

Isotope analysis was performed on bulk (i.e. combined organic and inorganic) material. The powdered soil/sediment was weighed into tin capsules and sealed. These were then placed into the autosampler (Costech ZeroBlank) where the sample is then introduced into the furnace using a pulse of oxygen and burned at 950 ^{o}C. A helium (He) carrier gas then transports the resulting gases through an oxidant to complete the burning, CO_2 and N_2 gases are then separated in a gas capillary column before going through an EA detector and a CONFLO IV interface into the mass spectrometer (Finnigan DELTA V Advantage). Samples were run at 95 % dilution against two N_2 and two CO_2 reference gases with a recovery rate of 60 seconds between samples. The instrument was calibrated using international laboratory standards IAEA-600, USGS40, IEA-N2 (δ^{15}N only), ANU (δ^{13}C only) and USGS24 (δ^{13}C only) then the drift was monitored throughout the analysis by assessing OEA Labs Alanine standard (both δ^{13}C and δ^{15}N). Standard error of 0.028 $^{o}/_{oo}$ (δ^{15}N) and 0.20 $^{o}/_{oo}$ (δ^{13}C) was caclulated for the Nottingham sample set run, and 0.07 $^{o}/_{oo}$ (δ^{15}N) and 0.12 $^{o}/_{oo}$ (δ^{13}C), for the London sample set run, based on OEA Labs Alenine standard.

3.10 Mineralogy via QEMSCAN

QEMSCAN is a relatively new technology, and its current use in forensic investigation is limited. However, it has been selected for determining mineralogy in this study as it poses a number of advantages and has seen some attention in recent literature (e.g. Pirrie *et al.*, 2009; Knappett *et al.*, 2011; Ruffell *et al.*, 2013). Such advantages include its ability to generate not only quantifiable data on the mineral composition, but also mineral maps to illustrate mineral associations, mineral morphology, elemental composition and particle size data. Additionally, unlike other techniques, it can assess both man-made and natural anthropogenic contributions in samples automatically which can be particularly useful when dealing with evidence from urban environments.

3.10.1 Sample preparation

0.5 g of each freeze-dried sample was weighed into separate mounting cups, each of which was labelled with the sample identification. Using two syringes, the resin and hardener (Struers EpoFix Kit) were added together into a beaker in a 15:2 volume ratio (15 parts resin to 2 parts hardener). This mixture was then heated on a hotplate at 50 - 80 ^{o}C for 2 minutes, whilst continuously stirring, and then removed. 8 ml of this resin was then carefully added to the samples in the mounting cups using a syringe, and gently tapped during this addition to remove bubbles in the mixture that could later interfere in the signals obtained from the QEMSCAN. The mounting cups, once filled, were then placed onto the hotplate for one hour at 50 ^{o}C to encourage the removal of any other small bubbles in the samples, before removing them from the hotplate and leaving them to solidify for 24 hours. The samples were then each labelled with their sample ID and product ID with an etching pen before being polished, cleaned for 3 minutes in an Ultrasonic Cleaner and carbon coated.

3.10.2 Analysis

The prepared samples are then placed into the sample holder and inserted into the FEI QEMSCAN for analysis. The samples were systematically mapped using the fieldscan mode where the entirety of the sample was imaged at a 10 µm stepping interval and a recovery rate of 180 seconds between each sample. For each 10 µm pixel, backscatter electron (BSE) and X-ray spectra are obtained then compared to a database of known values to enable the correct assignment of mineralogy and chemical composition. The data is then processed after analysis using FEI's iDiscover software.

3.11 Data Treatment

A one sample Kolmogorov-Smirnov test was performed on the data in SPSS in order to confirm that the data was normally distributed before proceeding with further statistical analyses (Miller and Miller, 2010).

3.11.1 Multivariate Statistical Analysis

Multivariate statistics were used to assess the data obtained for the elemental analysis via XRF, ICP-MS and ICP-AES, stable isotope analysis via IRMS and mineral analysis via QEMSCAN. This included Principal Component Analysis (PCA) and Canonical Discriminant Function Analysis (CDFA), as these methods identify within group and between group variations and allows for graphical outputs to be generated in order to illustrate these variances (Morrison *et al.*, 2009). Initial data assessment was conducted using Analysis of Variance (ANOVA), which is a statistical assessment of group means in order to identify variance within and between groups, and Paired t-tests which are used to compare two sample means to identify the significance of the variance (Explorable, 2009). These statistical analyses were selected to determine the significance of any variances present:

- Within each site through comparisons of the five control samples collected per site (ANOVA and CDFA)
- Between each of the single source sites (A, B and C) at each location (Nottingham and London; ANOVA and CDFA)

- Between mixed source samples (AB, AC, BC and ABC) and single source samples (A, B and C) that are both present (e.g. A-AB) and not present (e.g. A - BC) in the mixtures (paired t-tests and PCA)

ANOVA, CDFA and paired t-tests were performed in IBM SPSS Statistics 21 and PCA of the data was conducted using Canoco 5.0.

3.11.2 Statistical Modelling

Further assessment of the elemental data is presented in chapter 8 using end-member modelling (EMM), as a means to address the issues associated with the interpretation of mixed provenance samples. Appropriate end-members were selected based on the findings of ANOVA, CDFA and PCA presented in chapter 5. Elements that were consistently identified as significantly different, across these statistical methods and of the highest statistical significance (i.e. closest to a p-value of 0.000) were selected for the study. EMM was performed in R using the normative partitioning by least squares (also known as linear unmixing) approach, as both end-member composition and mixing proportions are known (Weltje, 1997) due to mixtures being generated in the laboratory using known single source material in equal measures (section 3.1.2).

Selection of the statistical methods used in this thesis were guided by the successful application of the statistics in other studies (e.g. Morgan and Bartick, 2007 - chemical data; Morgan and Bull, 2006 - sample discrimination; Mulitza *et al.*, 2010 - for mixtures) and the data met requirements for these statistical analyses to be performed.

Chapter 4 Packaging and Storage Effects on Soil/Sediment Material Subjected to Geochemical Analysis

4.1 Introduction

Soil can be an invaluable form of evidence in a forensic investigation due to its presence in a number of environments that may be frequented by the victim(s), suspect(s) and/or artefact(s) (Saferstein, 2010). In addition to distinctive organic and inorganic properties that make it particularly effective at indicating provenance (Pirrie *et al.*, 2014), and its ease of transfer and retention on recipient surfaces (Reidy *et al.*, 2013). Despite these benefits it is still a highly complex and heterogeneous entity (Tibbet, 2008), that requires careful study in order to obtain a thorough understanding of its various different properties and processes that occur simultaneously within it, for instance, nitrogen fixation or microbial activity (Brady, 1989).

Interpretation of singular soil characteristics is complicated further in forensic geoscience when dealing with samples of mixed provenance, in particular distinguishing between materials contributed pre-, syn- and post forensic event, the selection of the most suitable analytical technique(s), and the use of appropriate statistics (Morgan and Bull, 2007a). Additionally, there are a number of factors that may have an impact on the analytical data obtained, including the collection method, packaging material, storage conditions, sub-sampling inconsistencies, variances in sample pre-treatment protocols, and instrumental variation (Kobilinsky, 2011). The impacts of these factors on the results obtained need to be known in order to establish whether variances observed between mixed source samples and the controls are in fact purely a result of the mixing that has taken place, or if other factors are also responsible.

There is no standard approach in forensic geoscience to the appropriate manner in which to collect, package and store soil/sediment evidence. Various recommendations are put forward in the literature for the collection (e.g. Pye *et al.*, 2006a), packaging (e.g. Mildenhall *et al.*, 2006; Fitzpatrick, 2009; Dawson and Hillier, 2010) and storage (Fitzpatrick, 2009), in addition to overviews of the entire process from collection to assessment (e.g. Woods *et al.*, 2016). However, to date these recommendations are not based on systematic empirical studies. Difficulties in arriving at an agreed procedure are in part due to the multiple parameters that may be measured, the varying degree of expertise of the individual geoscientist, and the availability of analytical equipment. Consequently, decisions regarding the most appropriate manner in which to collect soil/sediment evidence are made on a case-by-case basis but general considerations include (Roberts and Márquez-Grant, 2012):

1. Where best to sample to avoid missing crucial evidence i.e. the likely path of approach/exit of the offender or deposition sites
2. The sample depth i.e. for drier samples a surface scraping around 1 millimetre is considered sufficient, but for muddier areas a sample depth of around 1 cm is more appropriate
3. Representativeness of site i.e. taking multiple control samples to account for variability within micro-sites of interest

For the packaging and storage of the material, a number of factors need to be considered, including the medium to which the material has adhered, convenience of transporting the evidence, the particular question(s) that need satisfying for the particular investigation, and subsequently the analytical technique(s) that it will be subjected to (Sáiz *et al.*, 2013). For example, items of clothing containing particulate material should be packaged in such a way that different parts of the clothing do not come into contact with one another, to avoid cross-contamination on the garment (Morgan *et al.*, 2010). Several publications detail the appropriate storage container and temperature for geological evidence. It is generally recommended that soil samples be collected and retained in sterile zip-lock plastic bags or screw-top plastic containers (Milne *et al.*, 2004), and then be frozen or dried as soon as possible to prevent continued microbial activity (Mildenhall *et al.*, 2006), with dried samples subsequently stored at room temperature (Fitzpatrick, 2009). There are some variations in suggested packaging type for soil/sediment material where the subsequent analyses of the biological or organic properties are being considered. For instance, Dawson and Hillier (2010) and Mildenhall *et al.* (2006) detail that the materials should be stored in clean paper envelopes and dried as soon as possible in a drying oven, whereas Fitzpatrick (2009) states that a clean cardboard box should be used. Elsewhere in the literature, plastic containers have been deemed preferable over glass containers (Mildenhall *et al.*, 2006). However, whether a specific manufacturer of plastic bag or container is preferable over another manufacturer is not identified. This may be a factor to consider as variances between batches (Phillips *et al.*, 2003; Kobilinsky, 2011), or errors in manufacturing processes such as treatments of the materials or the introduction of contaminants (Keaney *et al.*, 2009), may impact on the material it is intended to contain. Some studies have been conducted into the variances in the chemical differences between different packaging types (Carter *et al.*, 2004; Dobney *et al.*, 2002; Causin *et al.*, 2006), and the impact that the incorrect type can have on the chemical assessment of some forms of evidence (e.g. ballistic evidence (Ulrich *et al.*, 2004)), due to loss or contamination of material (Kobilinsky, 2011). However, none of these studies have been specifically directed toward the impact of different packaging types on the analyses of soil/sediment evidence.

There are also no readily available established guidelines for the recommended duration of storage for soil/sediment evidence. It has been established that the inorganic and mineral components of soils and sediments are less susceptible to change over time (including during storage), in comparison to the organic components (Pye, 2007). However, the variation of the elemental concentrations in the soil samples over time, and the significance of this, should be identified in order to determine whether future analysis of the samples may still provide the same evidential value as at the time of initial collection.

For the purposes of this study, different packaging types and storage conditions of soil/sediment samples were assessed over a 12 month period in order to ascertain any potential influence on the elemental composition of the sample. Soil samples from two different locations were collected into four differently manufactured plastic sample bags. The four bags were chosen given that they are readily used for traditional geological samples, and plastic evidence bags are used to collect a range of other different evidence types, and are therefore readily available to forensic practitioners. The use of paper bags or cardboard boxes to package geological evidence has been suggested in the literature. However, these packaging types were not the focus of this study as cardboard boxes or paper bags are ineffectual for retaining moist or waterlogged soil/sediment; the water would cause the packaging to lose structural integrity and thus compromise the evidence. To establish the potential impact of variances in storage conditions, samples were stored either dry at room temperature or wet in a refrigerator (0 - 4 ^{o}C), and comparisons in data obtained compared. Sub-sampling of samples for analysis was conducted at regular 2 month intervals for a period of one year.

Aims and Objectives

The research conducted in this chapter aimed to identify the impact of variations in the packaging and storage of soil/sediment material that may impact the interpretations of geochemical evidence.

In order to address this aim, the following objectives were identified:

1. To identify if there are any elemental or isotopic changes in the soil/sediment samples over time due to storage conditions.
2. To identify if there are any elemental or isotopic changes in the soil/sediment samples over time due to differences in the different packaging manufacturers used to retain samples.
3. To establish the most appropriate means for the packaging and storage of forensic soil/sediment samples undergoing chemical analysis.

4.2 Method

Two locations in West London (GPS coordinates - 51.501606, 0.242738 and 51.496582, 0.238963) were used for this study; site 1, a garden, and site 2, a parkland location (figure

4.1). Four soil/sediments samples weighing approximately 30 g were collected from the top 2 cm of the soil surface using a trowel and packaged immediately. Four different branded polyethylene sample bags were used to package the soil/sediment samples from the two London locations (garden - G, park - P; see table 4.1), in order to establish if the packaging type selected interferes with the elemental and isotopic composition of the material. All samples once freeze dried were stored at room temperature until time of analysis.

Figure 4.1: Sample sites used for study; parkland (left) and garden (right)

Table 4.1: Sample and packaging details

Month of Analysis	Time	Sample Bag	Sample ID	
January (collection)	0*	Forensic tamper proof evidence bag	KCG01a	KCP01a
		Sainsbury's ziplock bag	KCG02a	KCP02a
		Fischer	KCG03a	KCP03a
		VWR	KCG04a	KCP04a
March	1	Forensic tamper proof evidence bag	KCG01b*	KCP01b*
		Sainsbury's ziplock bag	KCG02b	KCP02b
		Fischer	KCG03b	KCP03b
		VWR	KCG04b	KCP04b
May	2*	Forensic tamper proof evidence bag	KCG01c	KCP01c
		Sainsbury's ziplock bag	KCG02c	KCP02c
		Fischer	KCG03c	KCP03c
		VWR	KCG04c	KCP04c
July	3**	Forensic tamper proof evidence bag	KCG01d	KCP01d
		Sainsbury's ziplock bag	KCG02d	KCP02d
		Fischer	KCG03d	KCP03d
		VWR	KCG04d	KCP04d
September	4*	Forensic tamper proof evidence bag	KCG01e	KCP01e
		Sainsbury's ziplock bag	KCG02e	KCP02e
		Fischer	KCG03e	KCP03e
		VWR	KCG04e	KCP04e
November	5	Forensic tamper proof evidence bag	KCG01f	KCP01f
		Sainsbury's ziplock bag	KCG02f	KCP02f
		Fischer	KCG03f	KCP03f
		VWR	KCG04f	KCP04f
January	6**	Forensic tamper proof evidence bag	KCG01g	KCP01g
		Sainsbury's ziplock bag	KCG02g	KCP02g
		Fischer	KCG03g	KCP03g
		VWR	KCG04g	KCP04g

*ICP-AES and ICP-MS analysis performed at times 0, 2, 3, 4 and 6 only

** IRMS analysis performed at times 3 and 6 only

Sub-sampling from the initial 30 g of sediment collected was conducted at 2 month intervals. Prior to the time of sub-sampling, the material was stored wet at 0 - 4 ^{o}C; post sub-sampling and freeze-drying, the samples were stored dry at room temperature as detailed in figure 4.2. Freeze-dried samples were subject to manual homogenisation using an Agate pestle and mortar. 4 g of the powdered material was subject to XRF (as detailed in section 3.8.1; 3 replicate measures taken), 0.1 g of the powdered material underwent digestion (as detailed in section 3.6.2) before analysis via ICP-MS and ICP-AES (sections 3.8.2 and 3.8.3 respectively; 5 replicate measures taken), and 0.6 g of sediment was subject to stable isotope analysis via IRMS (as detailed in section 3.9.2; 3 replicate measures taken).

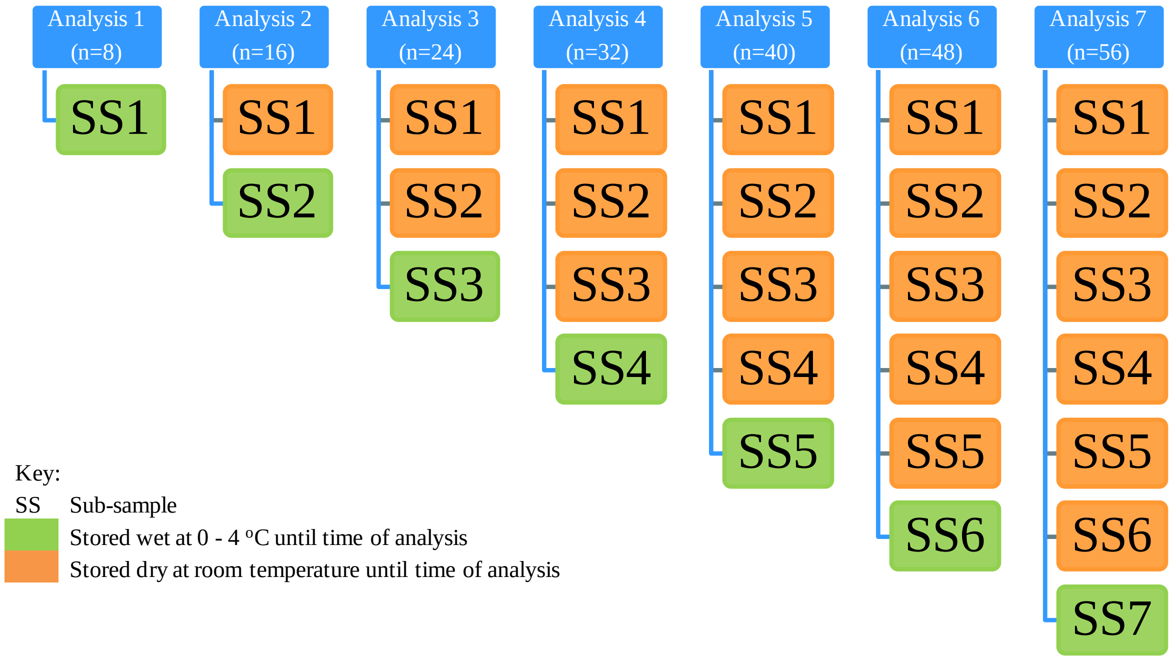


Figure 4.2: Sub-sampling and analysis timetable

Statistical assessment of the data was conducted using paired t-tests and principal component analysis (PCA). This test was chosen in order to assess the significance of any differences in sample composition as a result of:

1. different manufactured sample bags used to package the samples
2. different storage conditions
3. any temporal impacts on these first two factors

4.3 Results

The raw data collected from analysis of the samples is presented in appendix 4 for XRF (appendices 4.1 and 4.5), ICP-AES (appendices 4.16 and 4.20), ICP-MS (appendices 4.31 and 4.35) and IRMS analysis (appendices 4.46 and 4.50). Procedural blanks and reference material were analysed to screen for contaminants and monitor analysis performance (appendices 4.57 to 4.60). From the raw data, no differences could be observed in elemental concentrations, peak intensities, or isotope ratios, which could indicate that any of the packaging types, storage conditions, or duration was having a negative impact on the samples. Additionally plots of the raw data found no discernible differences in the elemental concentrations (appendices 4.2 - 4.4 and 4.6 - 4.8 for XRF; 4.17 - 4.19 and 4.21 - 4.23 for ICP-AES; 4.32 - 4.34 and 4.36 - 4.38 for ICP-MS), or isotope ratios (appendices 4.47 - 4.49 and 4.51 - 4.53), between packaging and storage types for both sites over the year that they were assessed. The only exceptions observed were Si in the XRF data; Al, Ca and K for ICPAES; Pb, Tl, and Zr for ICPMS, in addition to certain rare earth elements in samples stored wet at 0-4 ^{o}C, and δ^{13}C for IRMS, where marginal variation was observed between packaging types and over time. However, statistical assessment found this difference to be non-significant.

Paired t-tests were applied to the elemental and isotopic data to determine if a statistically significant difference could be identified between different packaging types (evidence bags), different storage conditions i.e. temperature (0-4 ^{o}C or room temperature) and sample state (wet or freeze dried), and temporal impacts upon each of these factors (see appendices 4.9 - 4.15 for XRF; 4.24 - 4.30 for ICP-AES; 4.39 - 4.45 for ICP-MS; 4.54 - 4.56 for IRMS). Paired t-tests identified that the differences between these factors were mostly non-significant (table 4.2) however, there were some exceptions where significant differences were identified for the elemental data (table 4.3).

Table 4.2: Summary of paired t-test statistics for packaging types and storage conditions

Parameter	Elemental Techniques			
	XRF	ICP-MS	ICP-AES	IRMS
Difference Between Packaging	Non-significant P = 0.059 - 0.917 >0.05	Non-significant P = 0.064 - 0.487 >0.05	Non-significant P = 0.073 - 0.913 > 0.05	Non-significant* P = 0.083 - 0.800 > 0.05
Temporal Variation (Freeze-dried samples, room temperature)	Non-significant P = 0.066 - 0.808 >0.05	Non-significant P = 0.066 - 0.979 >0.05	Non-significant P = 0.051-0.996 >0.05	-
Temporal Difference (Wet Samples, 0-4^{o}C)	Non-significant P = 0.050 - 0.998 > 0.05	Non-significant P = 0.055 - 0.918 > 0.05	Non-significant P = 0.051-0.931 > 0.05	Non-significant P = 0.082 - 0.605 >0.05
Difference Between Wet and Dry Samples	Non-significant P = 0.072 - 0.949 > 0.05	Non-significant P =0.051 - 0.712 > 0.05	Non-significant P = 0.060- 0.898 > 0.05	Non-significant P = 0.053 - 0.722 >0.05

*except for P01 and P02 where p = 0.037

Table 4.3: Cases where a significant difference was identified through paired t-tests*

Parameter	Elemental Techniques			
	XRF	ICP-MS	ICP-AES	
Difference Between Packaging	G01 v G04	G03 v G04 P01 v P03	G01 v G04 G03 v G04	
Temporal Variation (Freeze-dried samples, room temperature)	G01 (01/15-03/15) G01 (11/15-01/16) G04 (11/15-01/16) P01 (11/15-01/16)	P01 (05/15-09/15)	G01 (03/15-05/15) G01 (03/15-07/15) G01 (03/15-01/16) G01 (07/15-11/15) G01 (07/15-01/16) G01 (09/15-11/15) G01 (11/15-01/16) G02 (01/15-05/15) G02 (01/15-07/15) G02 (05/15-07/15) G02 (05/15-09/15) G02 (05/15-11/15) G02 (05/15-01/16) G02 (07/15-09/15) G02 (07/15-11/15) G02 (07/15-01/16) G02 (11/15-01/16) G03 (01/15-05/15) G03 (01/15-11/15) G03 (05/15-07-15) G03 (11/15-01/16) G04 (05/15-07/15)	P02 (01/15-05/15) P02 (01/15-07/15) P02 (05/15-07/15) P02 (05/15-09/15) P02 (05/15-11/15) P02 (05/15-01/16) P02 (07/15-09/15) P02 (07/15-11/15) P02 (07/15-01/16) P02 (11/15-01/16) P03 (05/15-07/15) P03 (11/15-01/16) P04 (05/15-07/15) P04 (07/15-11/15) P04 (07/15-01/16)
Temporal Difference (Wet Samples, 0-4^{o}C)	P01 (03/15-09/15) P03 (01/15-11/15)	P01 (01/15-01/16) P01 (05/15-09/15) P01 (05/15-01/16) P01 (09/15-01/16) P02 (01/15-05/15) P02 (01/15-01/16) P02 (05/15-09/15) P02 (05/15-01/16) P02 (09/15-01/16) P03 (05/15-01/16) P04 (05/15-01/16)	G01 (03/15-11/15) G02 (01/15-01/16) G03 (03/15-05/15) G03 (03/15-09/15) G03 (11/15-01/16) G04 (01/15-05/15) G04 (03/15-11/15)	P01 (01/15-05/15) P02 (01/15-05/15) P03 (01/15-05/15) P03 (03/15-11/15) P04 (01/15-05/15) P04 (03/15-05/15)
Difference Between Wet and Dry Samples	G04 (W1D1) P04 (W6D6)	G01 (W1 v D1) G01 (W3 v D3) G03 (W2 v D2) G04 (W1 v D1) G04 (W3 v D3) P01 (W3 v D3) P02 (W1 v D1) P02 (W2 v D2) P02 (W3 v D3) P04 (W2 v D2) P04 (W3 v D3)	G01 (W3 v D3) G03 (W6 v D6)	

*G = Garden, P = Park; 01-04 = bag number; analysis time (MM/YY); W = wet; D = dry.

Further statistical assessment of the data was performed using PCA (tables 4.4 to 4.9), which visualised any differences present (figures 4.3 to 4.14). The PCA biplots indicate that elemental variance is present between packaging types and in both of the storage conditions i.e. wet and refrigerated (0-4 ^{o}C) or dry at room temperature.

Table 4.4: PCA eigenvalues and cumulative percentage of variance between garden soil/sediment samples stored in different manufactured bags

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Jan-15	1 2 3	0.520 0.394 0.086	52.0 91.4 100.0	1.000
	Mar-15	1 2 3	0.515 0.387 0.098	51.5 90.2 100.0	1.000
	May-15	1 2 3	0.643 0.223 0.135	64.3 86.5 100.0	1.000
	Jul-15	1 2 3	0.642 0.309 0.049	64.2 95.1 100.0	1.000
	Sep-15	1 2 3	0.639 0.270 0.090	63.9 91.0 100.0	1.000
	Nov-15	1 2 3	0.714 0.223 0.064	71.4 93.6 100.0	1.000
	Jan-16	1 2 3	0.663 0.214 0.123	66.3 87.7 100.0	1.000
ICP-MS	Jan-15	1 2 3	0.638 0.235 0.127	63.8 87.3 100.0	1.000
	May-15	1 2 3	0.949 0.046 0.005	94.9 99.5 100.0	1.000
	Sep-15	1 2 3	0.657 0.231 0.112	65.7 88.8 100.0	1.000
	Jan-16	1 2 3	0.603 0.241 0.155	60.3 84.5 100.0	1.000
XRF	Jan-15	1	0.477	47.7	1.000

		2	0.272	74.9	
		3	0.251	100.0	
	Mar-15	1	0.485	48.5	1.000
		2	0.301	78.6	
		3	0.193	98.0	
	May-15	1	0.424	42.4	1.000
		2	0.352	77.6	
		3	0.224	100.0	
	Jul-15	1	0.592	59.2	1.000
		2	0.225	81.7	
		3	0.183	100.0	
				0.0	
	Sep-15	1	0.588	58.8	1.000
		2	0.257	84.5	
		3	0.155	100.0	
				0.0	
	Nov-15	1	0.526	52.6	1.000
		2	0.304	83.0	
		3	0.170	100.0	
				0.0	
	Jan-16	1	0.593	59.3	1.000
		2	0.234	82.7	
		3	0.173	100.0	
				0.0	
IRMS	Jul-15	1	0.570	57.0	1.000
		2	0.430	100.0	
	Jan-16	1	0.991	99.1	1.000
		2	0.009	100.0	

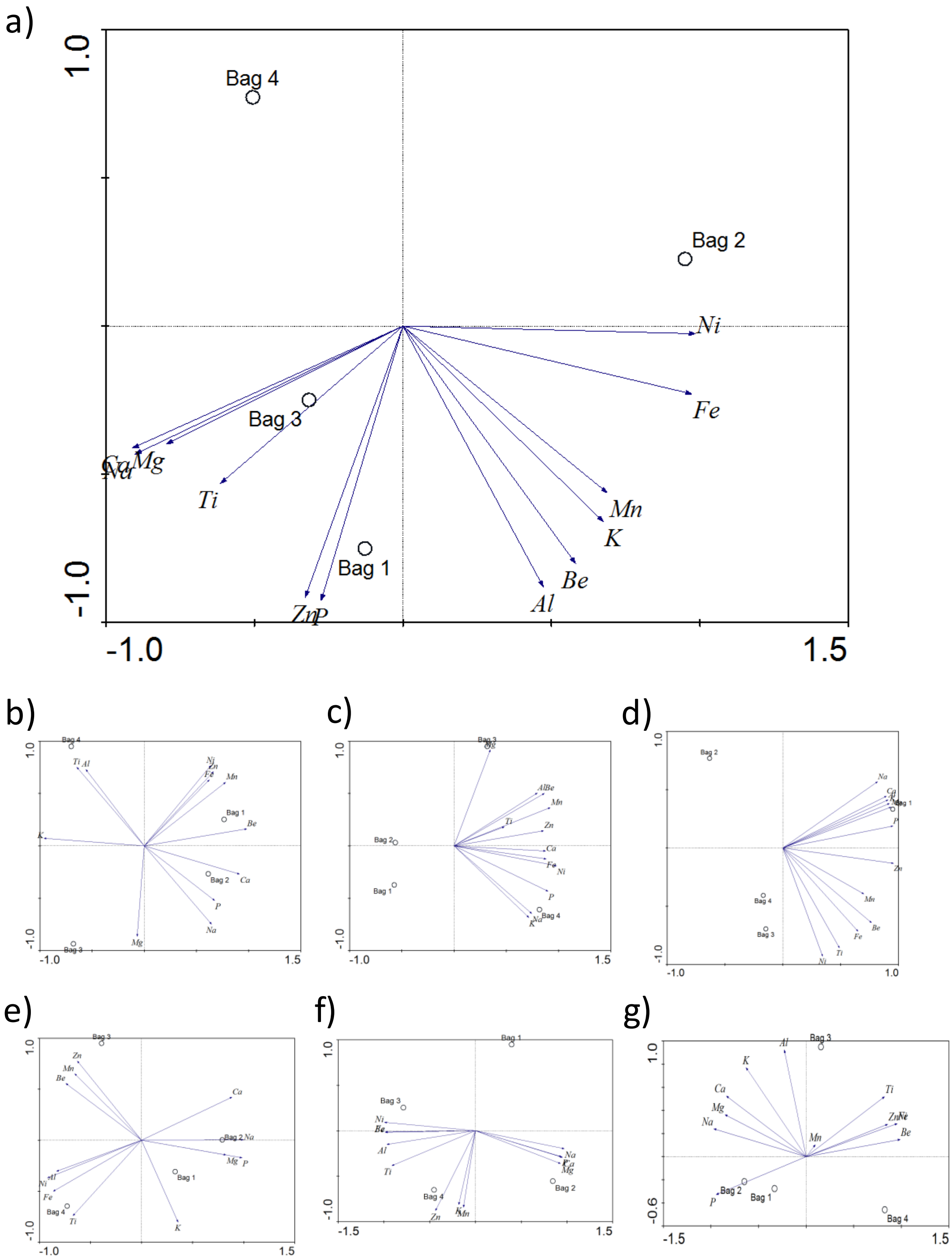


Figure 4.3: PCA output for ICP-AES data of garden soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

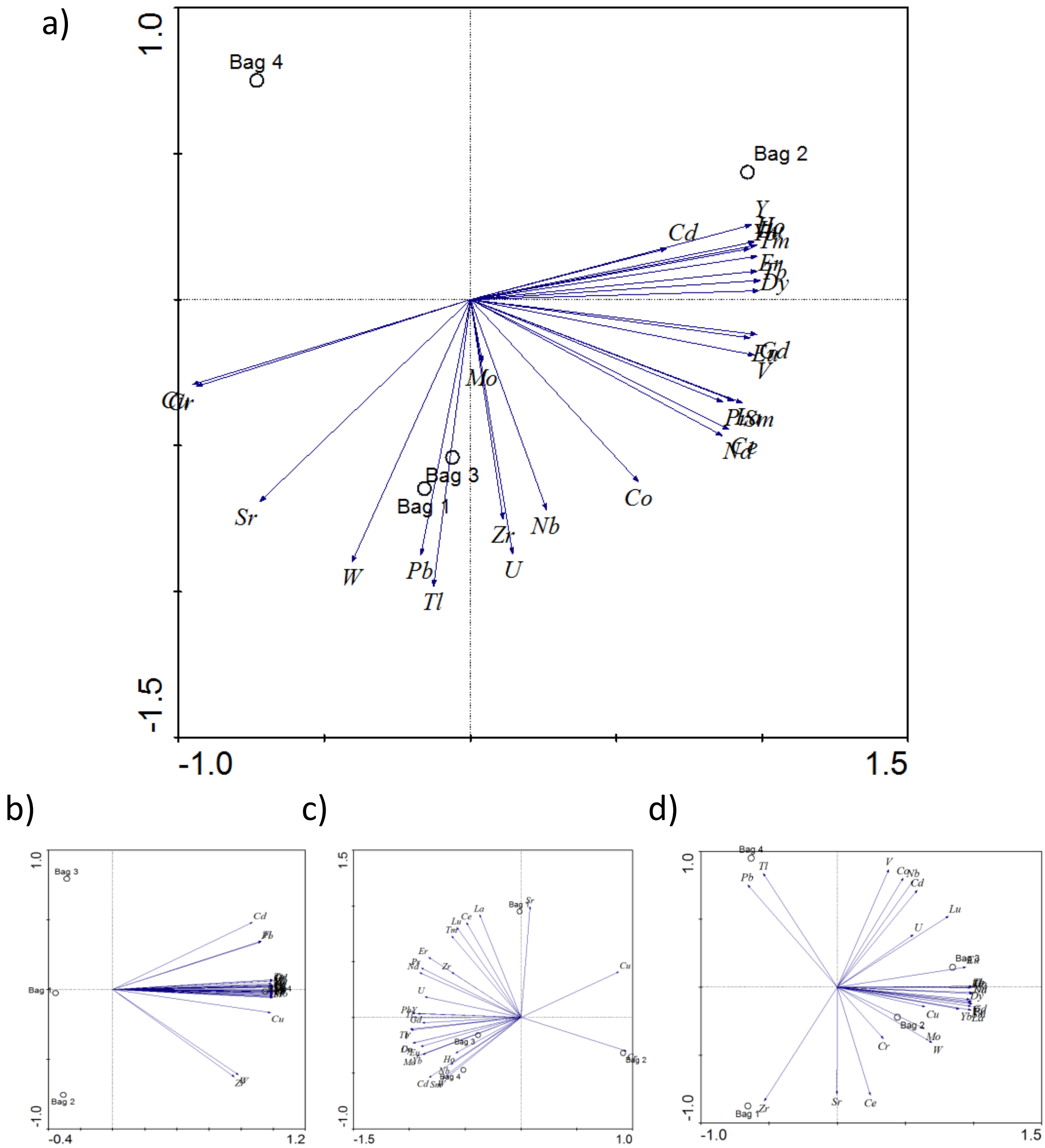


Figure 4.4: PCA output for ICP-MS data of garden soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

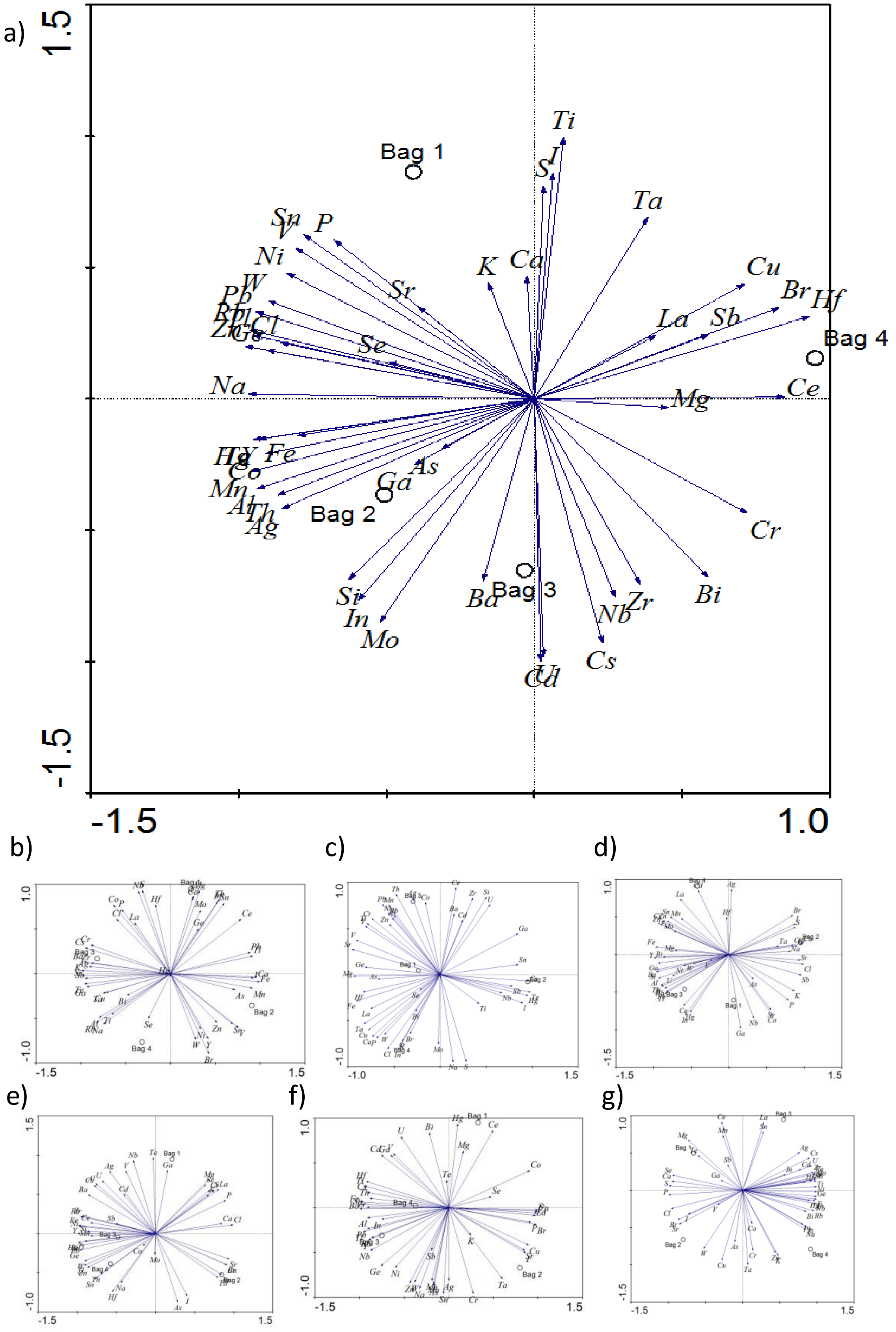


Figure 4.5: PCA output for XRF data of garden soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

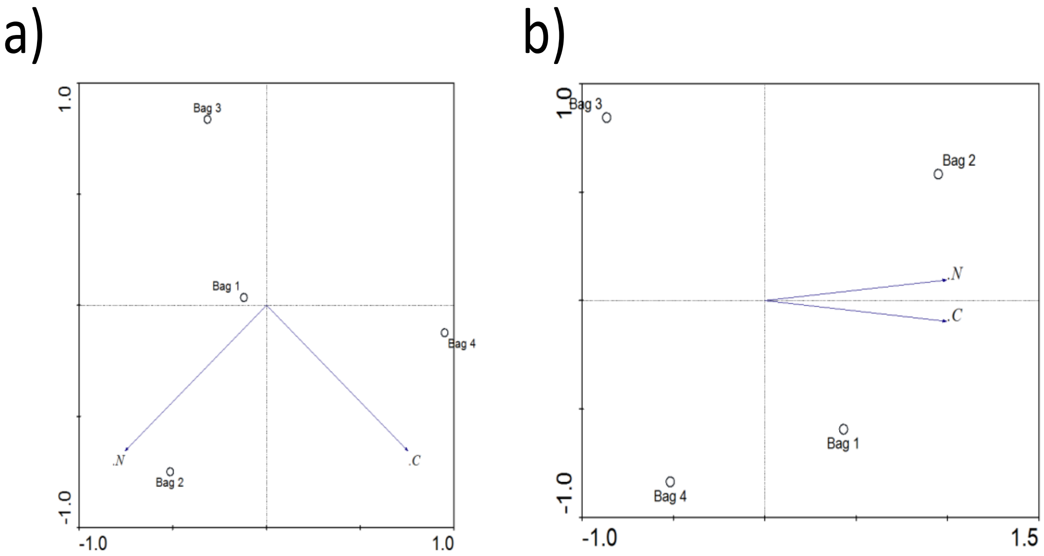


Figure 4.6: PCA output for IRMS data of garden soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

Table 4.5: PCA eigenvalues and cumulative percentage of variance between garden soil/sediment samples stored wet at 0 - 4 ^{o}C over time

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Bag 1	1	0.709	70.9	1.000
		2	0.175	88.4	
		3	0.065	94.8	
		4	0.033	98.1	
	Bag 2	1	0.789	78.9	1.000
		2	0.087	87.6	
		3	0.063	93.9	
		4	0.033	97.2	
	Bag 3	1	0.706	70.6	1.000
		2	0.152	85.8	
		3	0.079	93.7	
		4	0.049	98.6	
	Bag 4	1	0.704	70.4	1.000
		2	0.149	85.4	
		3	0.092	94.5	
		4	0.033	97.8	
ICP-MS	Bag 1	1	0.726	72.6	1.000
		2	0.157	88.3	
		3	0.085	96.8	
		4	0.032	100.0	
	Bag 2	1	0.687	68.7	1.000
		2	0.153	84.1	
		3	0.108	94.8	
		4	0.052	100.0	
	Bag 3	1	0.674	67.4	1.000
		2	0.188	86.1	
		3	0.082	94.4	
		4	0.056	100.0	
	Bag 4	1	0.796	79.6	1.000
		2	0.104	90.0	
		3	0.057	95.7	
		4	0.043	100.0	
XRF	Bag 1	1	0.374	37.4	1.000
		2	0.221	59.5	
		3	0.133	72.8	
		4	0.112	84.0	
	Bag 2	1	0.316	31.6	1.000
		2	0.299	61.4	
		3	0.172	78.6	
		4	0.108	89.4	
	Bag 3	1	0.413	41.3	1.000
		2	0.208	62.1	
		3	0.126	74.7	

		4	0.105	85.2	
	Bag 4	1	0.439	43.9	1.000
		2	0.217	65.7	
		3	0.121	77.8	
		4	0.103	88.1	
IRMS	All bags	1	0.870	87.0	1.000
		2	0.130	100.0	

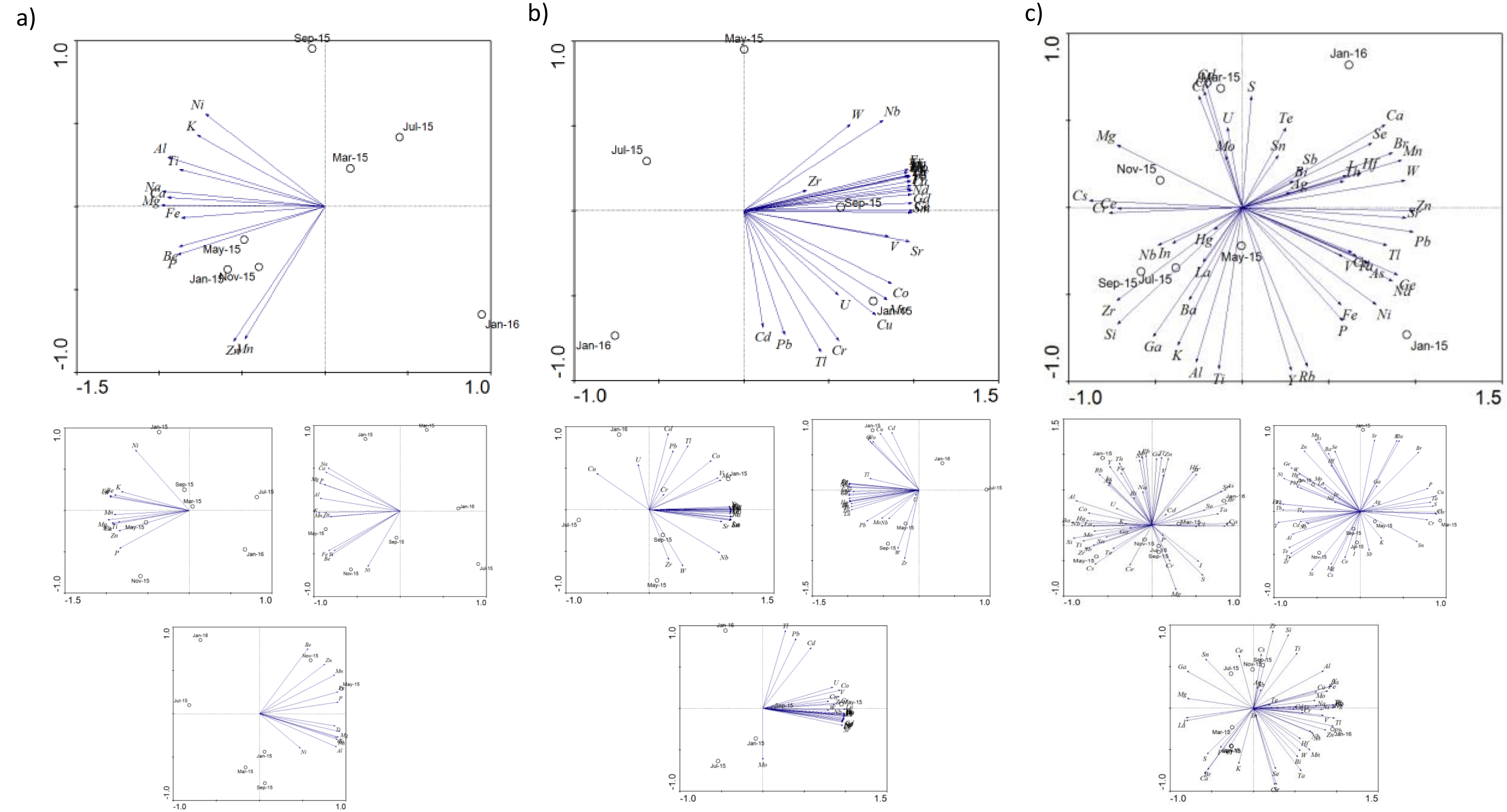


Figure 4.7: PCA output for temporal variation in garden soil/sediment samples when stored wet at 0-4 ^{o}C a) ICPAES b) ICPMS and c) XRF (Left to right: Bag 1, Bag 2, Bag 3 and Bag 4: axis 1 - horizontal, axis 2 - vertical).

Table 4.6: PCA eigenvalues and cumulative percentage of variance between garden soil/sediment samples stored dry at room temperature over time

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Bag 1	1	0.914	91.4	1.000
		2	0.080	99.4	
		3	0.005	99.9	
		4	0.001	100.0	
	Bag 2	1	0.940	94.0	1.000
		2	0.052	99.3	
		3	0.006	99.9	
		4	0.001	100.0	
	Bag 3	1	0.913	91.3	1.000
		2	0.073	98.6	
		3	0.009	99.5	
		4	0.004	99.8	
	Bag 4	1	0.871	87.1	1.000
		2	0.111	98.2	
		3	0.011	99.3	
		4	0.006	99.9	
ICP-MS	Bag 1	1	0.701	70.1	1.000
		2	0.221	92.2	
		3	0.078	100.0	
	Bag 2	1	0.690	69.0	1.000
		2	0.181	87.1	
		3	0.129	100.0	
	Bag 3	1	0.768	76.8	1.000
		2	0.156	92.4	
		3	0.076	100.0	
	Bag 4	1	0.742	74.2	1.000
		2	0.193	93.6	
		3	0.064	100.0	
XRF	Bag 1	1	0.350	35.0	1.000
		2	0.291	64.1	
		3	0.154	79.4	
		4	0.105	90.0	
	Bag 2	1	0.330	33.0	1.000
		2	0.253	58.4	
		3	0.129	71.3	
		4	0.115	82.8	
	Bag 3	1	0.279	27.9	1.000
		2	0.270	54.9	
		3	0.194	74.4	

		4	0.109	85.3	
	Bag 4	1	0.369	36.9	1.000
		2	0.264	63.3	
		3	0.130	76.3	
		4	0.103	86.6	
IRMS	All Bags	1	0.716	71.6	1.000
		2	0.284	100.0	

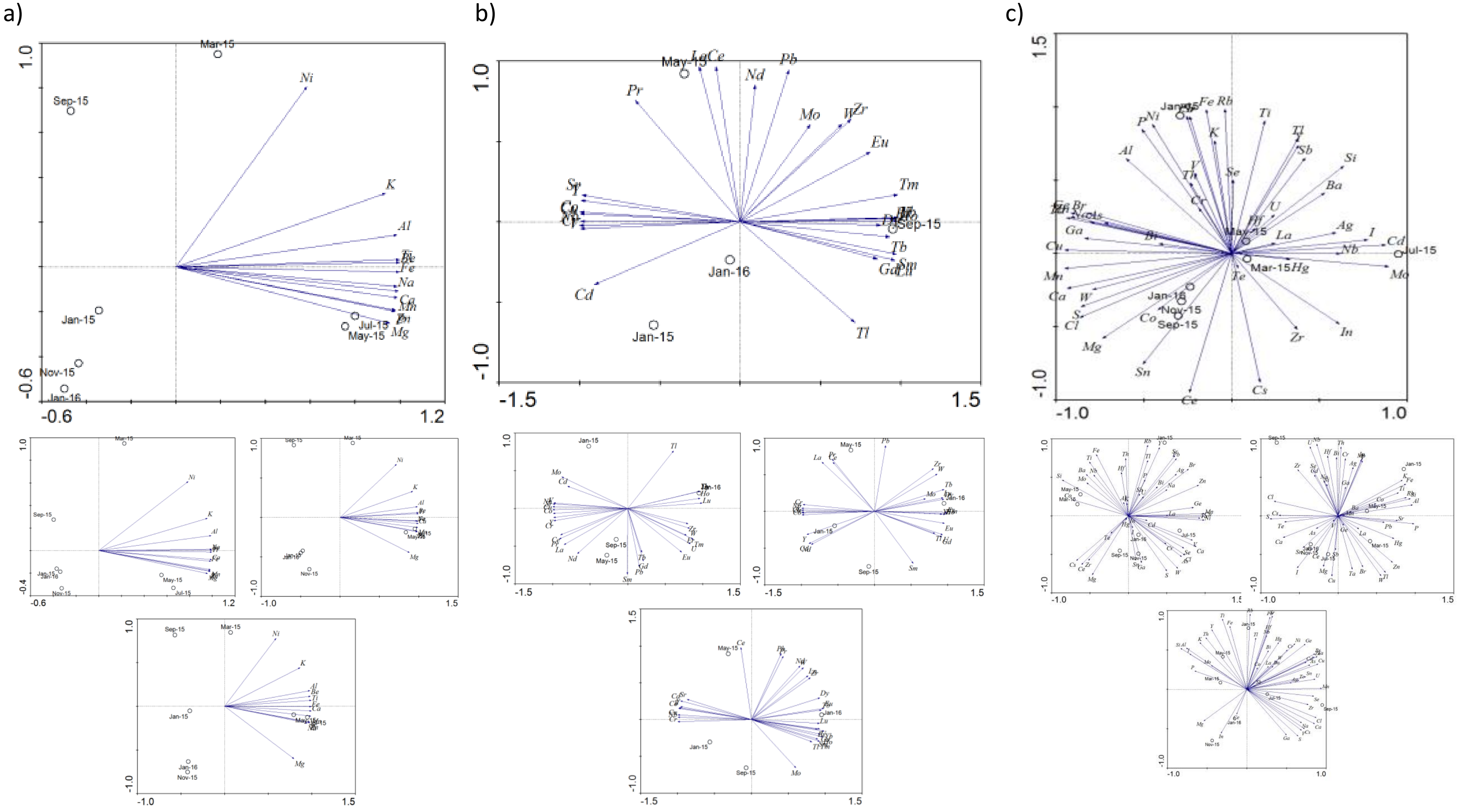


Figure 4.8: PCA output for temporal variation in garden soil/sediment samples when stored dry at room temperature a)ICPAES b)ICPMS and c) XRF (Left to right: Bag 1, Bag 2, Bag 3 and Bag 4: axis 1 - horizontal, axis 2 - vertical).

Table 4.7: PCA eigenvalues and cumulative percentage of variance between park soil/sediment samples stored in different bags

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Jan-15	1	0.673	67.3	1.000
		2	0.285	95.7	
		3	0.043	100.0	
	Mar-15	1	0.656	65.6	1.000
		2	0.233	88.9	
		3	0.111	100.0	
	May-15	1	0.474	47.4	1.000
		2	0.347	82.1	
		3	0.179	100.0	
	Jul-15	1	0.592	59.2	1.000
		2	0.262	85.4	
		3	0.146	100.0	
	Sep-15	1	0.568	56.8	1.000
		2	0.346	91.3	
		3	0.087	100.0	
	Nov-15	1	0.699	69.9	1.000
		2	0.255	95.4	
		3	0.046	100.0	
	Jan-16	1	0.814	81.4	1.000
		2	0.175	98.9	
		3	0.011	100.0	
ICP-MS	Jan-15	1	0.697	69.7	1.000
		2	0.195	89.2	
		3	0.108	100.0	
	May-15	1	0.967	96.7	1.000
		2	0.020	98.7	
		3	0.013	100.0	
	Sep-15	1	0.674	67.4	1.000
		2	0.227	90.1	
		3	0.099	100.0	
	Jan-16	1	0.771	77.1	1.000
		2	0.137	90.8	
		3	0.092	100.0	

XRF	Jan-15	1	0.453	45.3	1.000
		2	0.361	81.4	
		3	0.186	100.0	
	Mar-15	1	0.560	56.0	1.000
		2	0.232	79.2	
		3	0.208	100.0	
	May-15	1	0.564	56.4	1.000
		2	0.239	80.3	
		3	0.197	100.0	
	Jul-15	1	0.472	47.2	1.000
		2	0.296	76.8	
		3	0.232	100.0	
	Sep-15	1	0.473	47.3	1.000
		2	0.319	79.2	
		3	0.208	100.0	
	Nov-15	1	0.483	48.3	1.000
		2	0.268	75.1	
		3	0.249	100.0	
	Jan-16	1	0.404	40.4	1.000
		2	0.358	76.2	
		3	0.238	100.0	
IRMS	Jul-15	1	0.866	86.6	1.000
		2	0.134	100.0	
	Jan-16	1	1.000	100.0	1.000
		2		100.0	

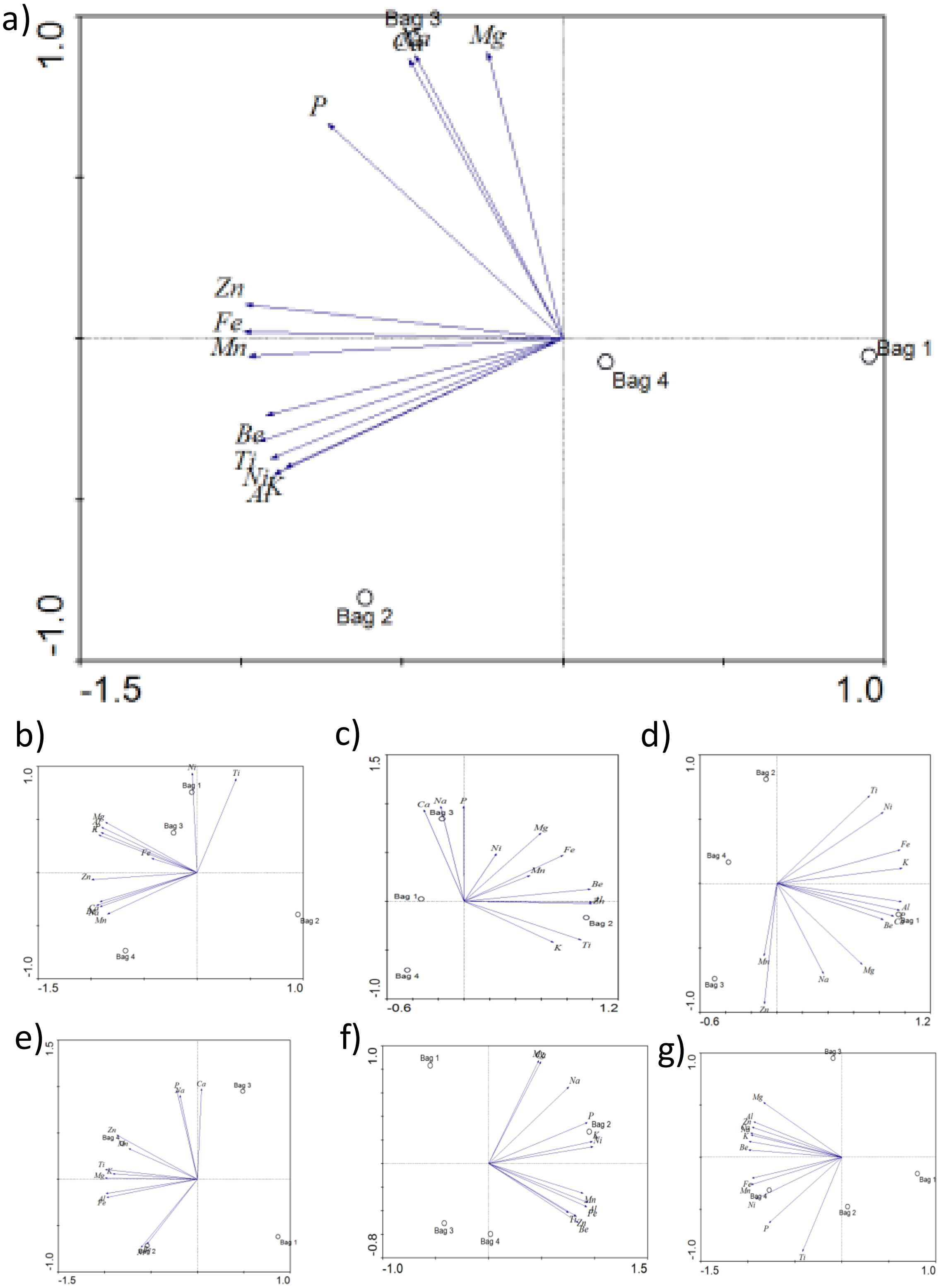


Figure 4.9: PCA output for ICP-AES data of park soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

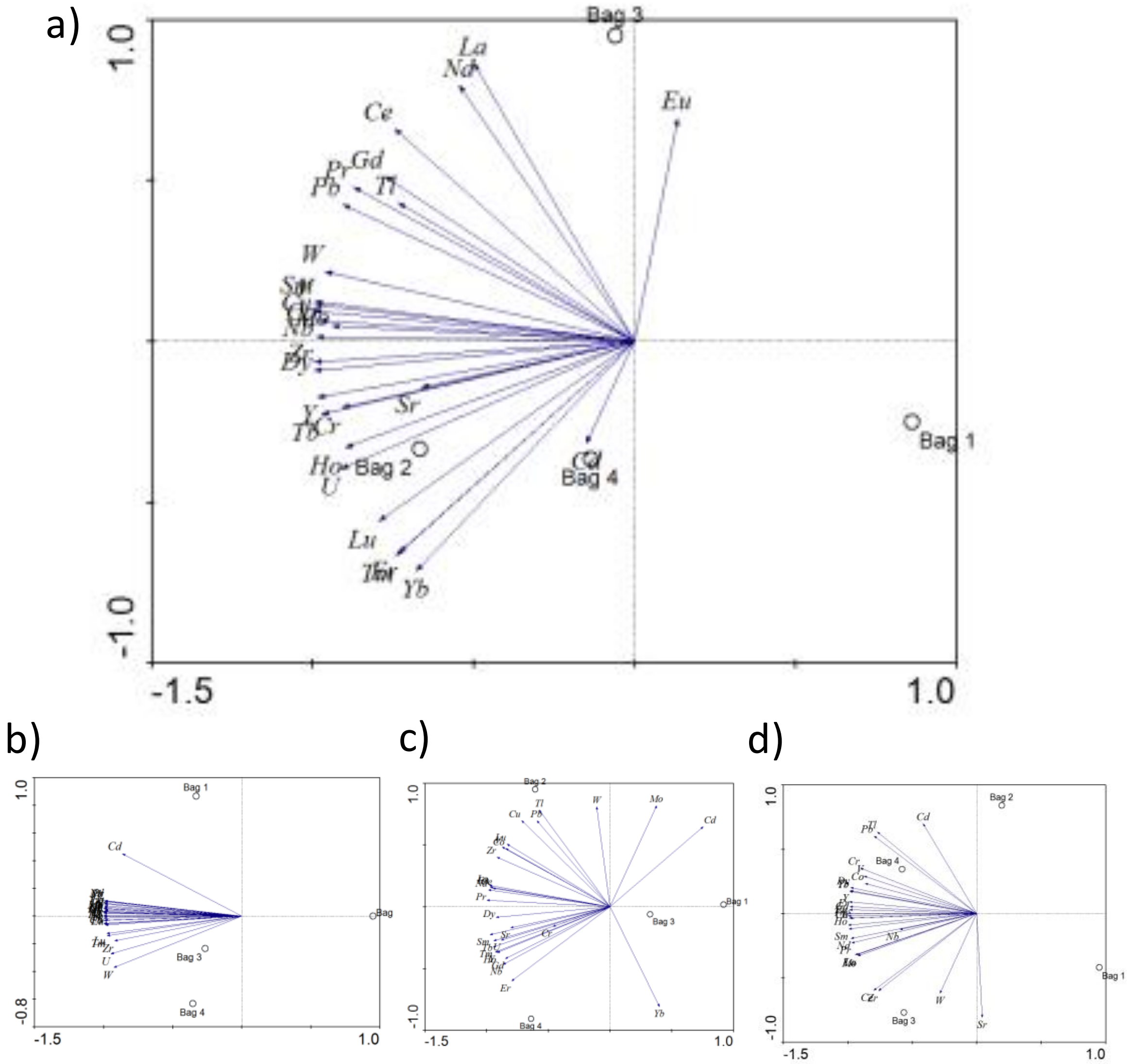


Figure 4.10: PCA output for ICP-MS data of park soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

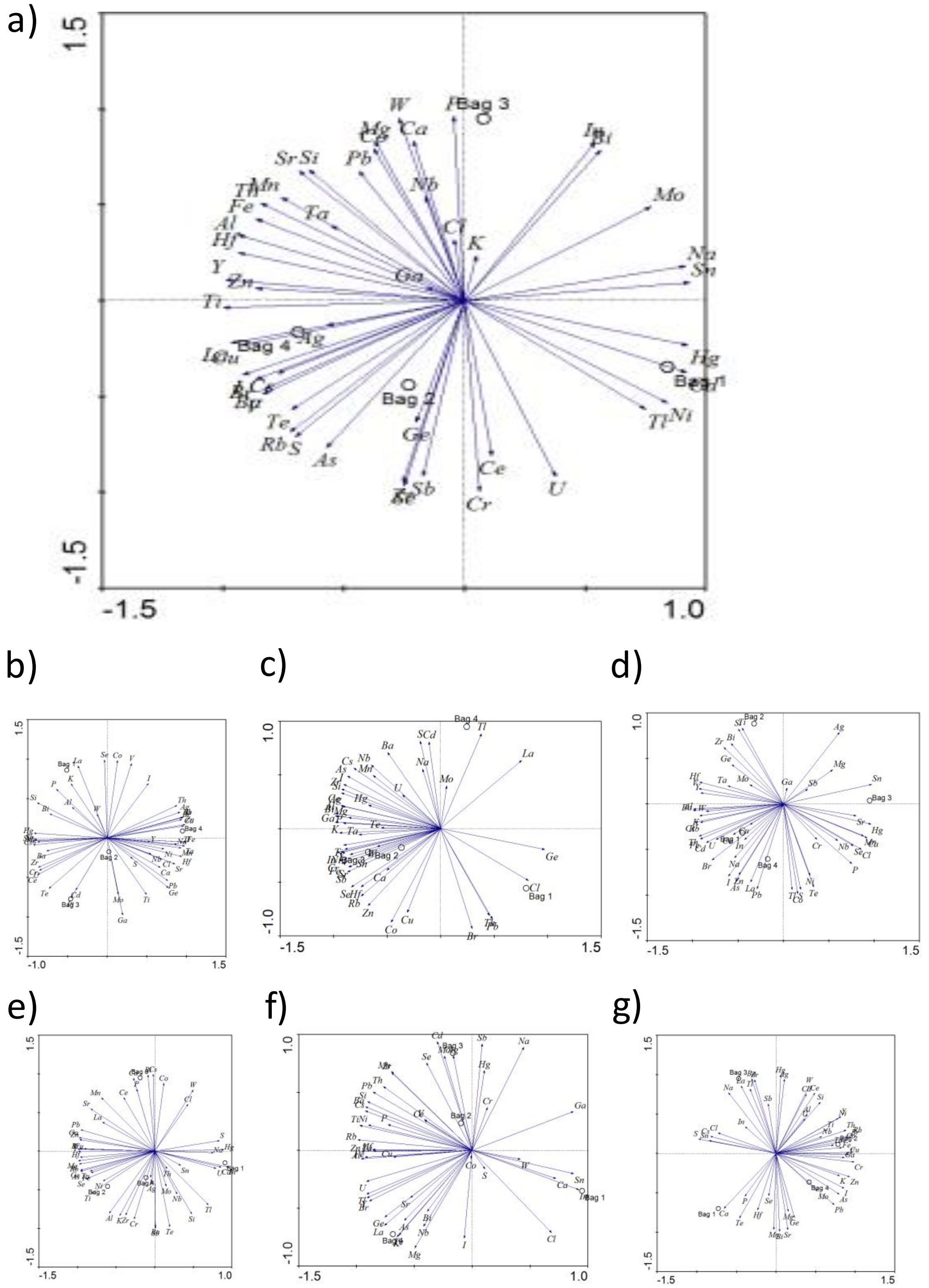


Figure 4.11: PCA output for XRF data of park soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

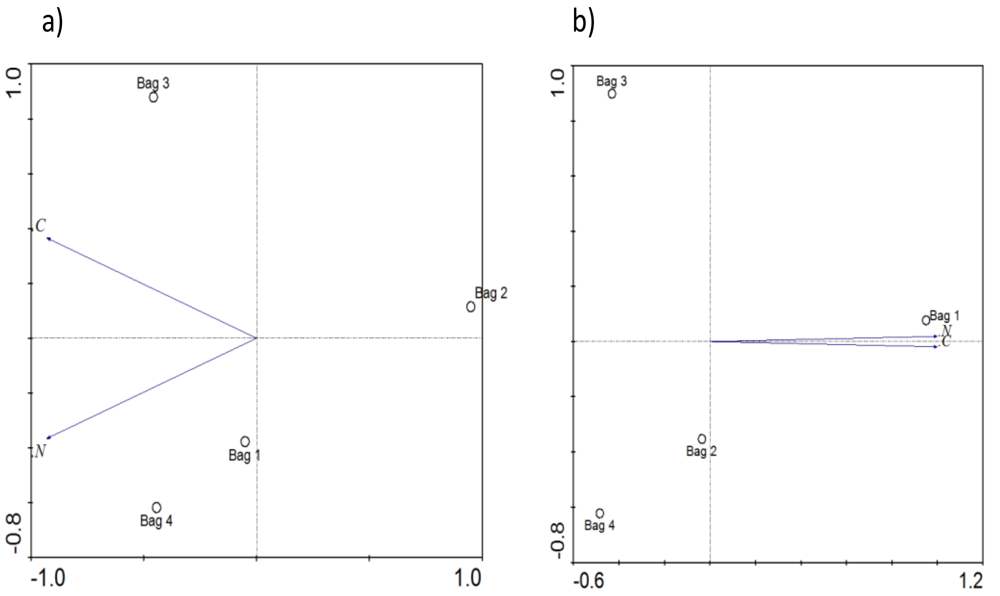


Figure 4.12: PCA output for IRMS data of park soil/sediment samples retained in different manufactured packaging (axis 1 - horizontal, axis 2 - vertical).

Table 4.8: PCA eigenvalues and cumulative percentage of variance between park soil/sediment samples stored wet at 0-4 ^oC

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Bag 1	1	0.805	80.5	1.000
		2	0.127	93.2	
		3	0.050	98.1	
		4	0.012	99.3	
	Bag 2	1	0.828	82.8	1.000
		2	0.101	92.8	
		3	0.047	97.5	
		4	0.016	99.1	
	Bag 3	1	0.806	80.6	1.000
		2	0.132	93.8	
		3	0.032	97.0	
		4	0.020	99.0	
	Bag 4	1	0.706	70.6	1.000
		2	0.172	87.7	
		3	0.075	95.3	
		4	0.027	98.0	
ICP-MS	Bag 1	1	0.763	76.3	1.000
		2	0.143	90.7	
		3	0.077	98.3	
		4	0.017	100.0	
	Bag 2	1	0.898	89.8	1.000
		2	0.060	95.8	
		3	0.032	99.0	
		4	0.010	100.0	
	Bag 3	1	0.760	76.0	1.000
		2	0.112	87.2	
		3	0.074	94.6	
		4	0.054	100.0	
	Bag 4	1	0.673	67.3	1.000
		2	0.158	83.1	
		3	0.107	93.8	
		4	0.062	100.0	
XRF	Bag 1	1	0.327	32.7	1.000
		2	0.225	55.3	
		3	0.157	71.0	
		4	0.133	84.2	
	Bag 2	1	0.326	32.6	1.000
		2	0.257	58.3	
		3	0.140	72.3	
		4	0.113	83.6	
	Bag 3	1	0.348	34.8	1.000
		2	0.224	57.2	
		3	0.166	73.8	

		4	0.106	84.4	
	Bag 4	1	0.418	41.8	1.000
		2	0.174	59.3	
		3	0.158	75.1	
		4	0.106	85.8	
IRMS	All bags	1	0.911	91.1	1.000
		2	0.089	100.0	

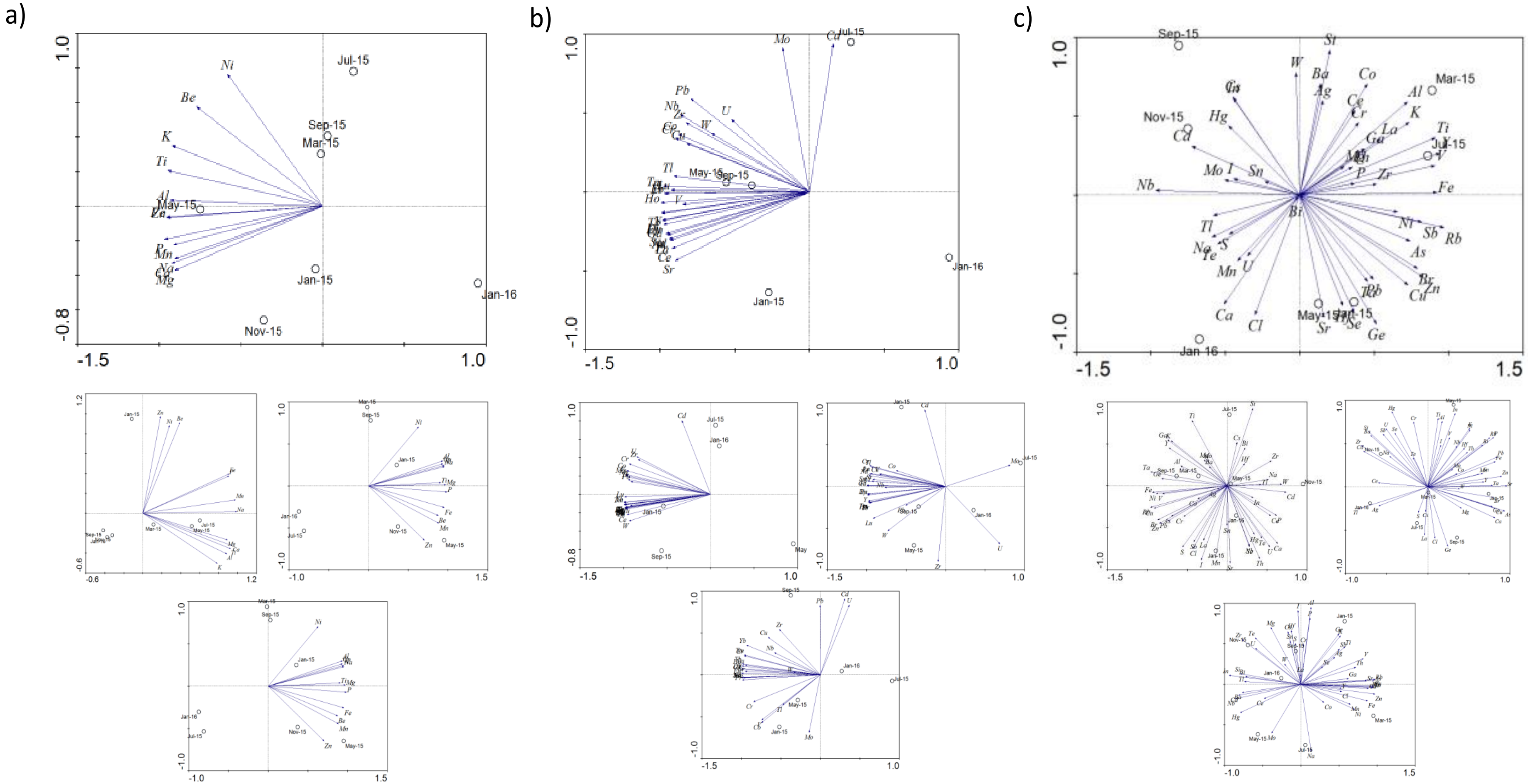


Figure 4.13: PCA output for temporal variation in park soil/sediment samples when stored wet at 0-4 ^{o}C a) ICPAES, b) ICPMS and c) XRF (Left to right: Bag 1, Bag 2, Bag 3 and Bag 4: axis 1 - horizontal, axis 2 - vertical).

Table 4.9: PCA eigenvalues and cumulative percentage of variance between park soil/sediment samples stored dry at room temperature

Method	Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
ICP-AES	Bag 1	1	0.729	72.9	1.000
		2	0.228	95.7	
		3	0.040	99.8	
		4	0.002	99.9	
	Bag 2	1	0.652	65.2	1.000
		2	0.301	95.3	
		3	0.041	99.4	
		4	0.005	99.9	
	Bag 3	1	0.681	68.1	1.000
		2	0.238	92.0	
		3	0.068	98.8	
		4	0.009	99.7	
	Bag 4	1	0.654	65.4	1.000
		2	0.258	91.2	
		3	0.081	99.3	
		4	0.006	99.9	
ICP-MS	Bag 1	1	0.647	64.7	1.000
		2	0.230	87.7	
		3	0.123	100.0	
	Bag 2	1	0.684	68.4	1.000
		2	0.223	90.7	
		3	0.093	100.0	
	Bag 3	1	0.710	71.0	1.000
		2	0.200	91.0	
		3	0.090	100.0	
	Bag 4	1	0.603	60.3	1.000
		2	0.267	87.0	
		3	0.130	100.0	
XRF	Bag 1	1	0.275	27.5	1.000
		2	0.249	52.4	
		3	0.180	70.4	
		4	0.139	84.4	
	Bag 2	1	0.376	37.6	1.000
		2	0.221	59.7	
		3	0.202	79.9	
		4	0.114	91.3	
	Bag 3	1	0.453	45.3	1.000
		2	0.178	63.1	
		3	0.122	75.3	

		4	0.108	86.1	
	Bag 4	1	0.353	35.3	1.000
		2	0.184	53.7	
		3	0.167	70.4	
		4	0.136	83.9	
IRMS	All Bags	1	0.840	84.0	1.000
		2	0.160	100.0	

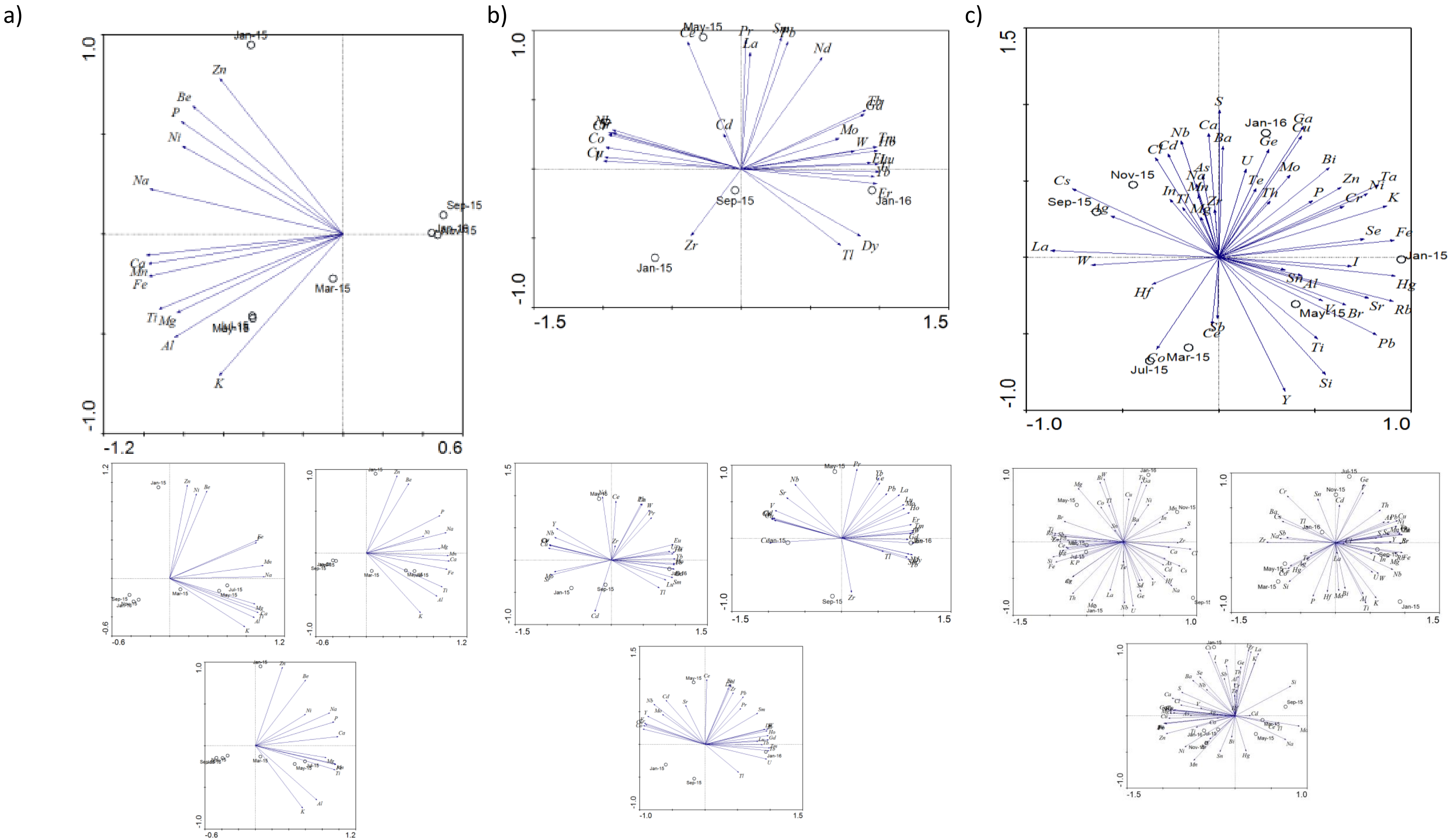


Figure 4.14: PCA output for temporal variation in park soil/sediment sample when stored dry at room temperature a) ICPAES, b) ICPMS and c) XRF (Left to right: Bag 1, Bag 2, Bag 3 and Bag 4: axis 1 - horizontal, axis 2 - vertical).

4.4 Discussion

The plots of the raw data (appendices 4.2 - 4.4 and 4.6 - 4.8 for XRF; 4.17 - 4.19 and 4.21 - 4.23 for ICP-AES; 4.32 - 4.34 and 4.36 - 4.38 for ICP-MS; 4.47 - 4.49 and 4.51 - 4.53 for IRMS) indicate that minimal differences are present in the elemental concentrations of the soil samples in the various packaging and storage conditions assessed. Further to this, the paired t-tests performed on this data (table 4.2) identify that any variance observed as being non-significant with p-values in the range of 0.059 - 0.917 for packaging types, p= 0.051 - 0.996 for samples stored dry at room temperature; p= 0.050 - 0.998 for samples stored wet at 0 - 4^{o}C and p= 0.051 - 0.949 between wet and dry samples (full details in appendices 4.9 - 4.15 for XRF; 4.24 - 4.30 for ICP-AES; 4.39 - 4.45 for ICP-MS; 4.54 - 4.56 for IRMS). Through the monitoring of procedural blanks and reference material, confidence in the data was provided as it could be confirmed that no contaminants were introduced during the analyses and that the data demonstrates good precision (appendices 4.57 - 4.60). This data provides empirical evidence in support of assertions made in the literature regarding the inorganic components of the soil being inert and therefore display no significant variance over time (Pye, 2007). This finding is promising, as it indicates the differences in packaging suppliers and storage facility conditions between different forensic laboratories should have no impact upon the interpretation of the evidence. Additionally a significant difference is not identified between samples that have been freeze dried and stored at room temperature and those that have been stored wet and refrigerated at 0 - 4 ^{o}C. Previously it has been asserted that the immediate freezing and subsequent freeze drying of sample material is most effective when organic or microbial assessment are to be performed as it prevents continued microbial activity and degradation (Mildenhall *et al.*, 2006; Dawson and Hillier, 2010) Furthermore, Fitzpatrick (2009) suggests that is preferable for freeze dried samples to be subsequently stored at room temperature. However, these studies to do not present data to rationalise these claims, and therefore, the suggested procedure is purely speculative. Nevertheless, data obtained in this study supports such an approach for samples being subjected to inorganic chemical assessment. Therefore, should findings for biological and physical assessments be in agreement, it would be recommended to freeze-dry and store samples at room temperature. This would facilitate an increased range of available assessments for sample characterisation, and therefore allow for a holistic approach to be taken.

However, the PCA biplots appear contradictory to the findings of the paired t-tests, as PCA highlights the subtle differences between samples making the differences appear much more apparent. PCA identified that for each parameter tested i.e. different sample bags (figures 4.3 - 4.6 and 4.9 - 4.12), samples stored wet and refrigerated (figures 4.7 and 4.13), and samples stored dry at room temperatures (figures 4.8 and 4.14), appear to be distinguishable from one another for each technique used to assess the samples at each analysis time across the year period of the study. While these differences are observed in the PCA biplots (figures 4.3 to 4.14), they are statistically non-significant, which is more clearly conveyed using more basic statistical methods, such as, the paired t-tests, used to initially assess the data in this study.

4.5 Conclusion

This study provides empirical evidence that can offer a foundation for decisions regarding the most appropriate manner in which to package and store geological evidence. It has identified that there is minimal change in the elemental composition of samples stored in different manufactured plastic sample bags, and in different storage conditions, over time. This is beneficial, as differences in these factors between laboratories or police forensic services will have no significant impact upon the composition of the samples, and therefore allow for comparisons between samples analysed at different times, or stored in different packaging types, to be made. Previous studies have been more focused on sample preservation for the purposes of biological or organic assessment. Combining these assertions with the findings of this study, the most appropriate state and conditions to store the sample would be freeze dried, as soon as possible after collection, and stored at room temperature, to ensure that multiple independent analyses remain available and consequently a more universal approach to characterising the evidence can be adopted.

Chapter 5 Site Discrimination: Forensic Discrimination of Mixed and Single Source Soil/Sediment Samples of a Discrete Location by Elemental Analysis

5.1 Introduction

Geochemical analysis allows for the determination of the elemental composition of geological materials, such as soils, sediments and rock (White, 2013). This information can be used in a forensic investigation to infer a potential provenance of a sample of interest, and/or to compare samples taken recovered from a suspect(s), victim(s), artefact(s), and/or crime scene to assess whether it is then possible to exclude samples from having been derived from the same provenance or not (Morgan and Bull, 2007a). Samples of interest are typically recovered from shoes, tyre treads, wheel arches, car foot wells, carpets and clothes (Pye and Blott, 2009), and is therefore usually composed of material from multiple locations (Morgan and Bull, 2007a). These locations may have been frequented by the suspect(s) or victim(s) pre-, syn- and post-forensic event, and are likely of a close proximity to one another, as crime events tend to occur in areas with which an offender is familiar (Felson, 2008). Discriminating between each of the sources within these mixtures is incredibly complex, due to the minimal amount of material available, and as *a priori* knowledge of the single source sites involved is often absent. Therefore, the interpretations should be approached with care (Morgan and Bull, 2006).

Physical assessment is considered to be the most effective means of discriminating between samples of different provenance. However, this form of assessment is dependent upon the knowledge and experience of the analyst, and can be time consuming (Murray, 2011). Chemical assessment (e.g. XRF, ICP-MS or ICP-AES) poses the advantage that it is faster than physical assessment methods, such as binocular microscopy, as the majority of the analysis is computer operated, has the ability to be automated, and allows for simultaneous qualitative and quantitative assessment of major and trace elements from minimal amounts of material (Pye *et al.*, 2006b). Previous studies (e.g. Croft and Pye, 2004; Pye *et al.*, 2006b; Pye *et al.*, 2007; Pye and Blott, 2009) have explored the potential of elemental techniques to distinguish between single source soil/sediment samples. However, for these forms of analysis to be applied in a forensic investigation, their feasibility in discriminating between close proximity sites needs to be empirically established.

The interpretation of geochemical profiles derived from mixed source samples is highly complex, and there is also a lack of empirical data in this area. Interpretative complications arise due to the pre-treatments that samples are required to undergo prior to elemental analysis. For instance, homogenisation is necessary to evenly distribute the elemental composition throughout the sample for a variety of these different analytical techniques. This makes the distinction between pre-, syn- and post-forensic event material highly complex (Morgan and Bull, 2006) as well, as the comparison and interpretation of these mixed source samples to single source samples (Morgan and Bull, 2007a).

There are a number of issues raised when interpreting geochemical data for samples of this nature. For instance, how to correctly determine if a sample is mixed provenance without *a priori* knowledge; how many contributors there are to that mixture; how to correctly assign the provenances within that mixture, particularly when there is insufficient or unreliable information regarding the scenes of interest to allow for the appropriate comparison samples to be collected; how to identify when the material transferred to the exhibit, i.e. pre-, syn- or post-forensic event; how significant the difference in elemental signatures between the mixed source sample and the single source samples they are composed of is, particularly in geographically similar locations and does this difference allow for samples to be robustly excluded from an investigation. These are issues that must be addressed to enable reliable and robust evidence to be provided to aid in a forensic investigation and for presentation in court (Morgan and Bull, 2006).

Aims and Objectives

The research in this chapter aimed to identify the feasibility of using elemental analysis to assess soil/sediment material in forensic investigation. The ability of elemental analysis techniques to discriminate between close proximity single source sites and multiple source samples of known locations will therefore be tested. This study will also aim to identify any potential temporal or spatial influences upon the elemental data. It will use Loss-on-Ignition (LOI), X-ray Fluorescence Spectroscopy (XRF), Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) on soil/sediment samples from known locations. LOI is not a method adopted for forensic investigation due to the amount of sample material it requires. However, it is commonly used in traditional geosciences as a starting point to determine basic sediment properties. XRF, ICP-MS and ICP-AES are commonly used within forensic investigation both on geological material and other forms of trace evidence and require a minimal amount of material.

In order to address this aim, the following objectives were identified:

1. To establish the chemical properties of known single source samples through LOI, XRF, ICP-MS and ICP-AES.
2. To establish the chemical properties of known mixed source samples through LOI, XRF, ICP-MS and ICP-AES.
3. To establish the feasibility of elemental analysis to discriminate between known single and mixed source samples.

5.2 Method

Samples collected from the London and Nottingham sites, as described in section 3.1, were subjected to the preparatory treatments (sections 3.5 and 3.6), before conducting organic assessment (section 3.7) and elemental analysis (section 3.8).

5.3 Results

5.3.1 Organic Analysis

The following section presents the data for the organic assessment of the soil/sediment samples taken from the Nottingham and London sample locations (see table 5.2 and figures 5.4 to 5.7). Statistical assessments of these data sets to ascertain the level of discrimination between each of the sample sites within the Nottingham location and London location are presented in tables 5.3 to 5.4 and the artificial mixtures to the single source control site in tables 5.5 to 5.6.

Table 5.1: Mean and standard deviation of sample organic content percentage

Nottingham Sample Collection								
Sample	October		January		April		July	
	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation
A1	12.0	1.2	10.0	3.0	9.7	3.4	5.2	2.5
A2	18.3	2.9	9.1	1.9	9.9	0.2	12.1	5.9
A3	12.1	0.3	10.6	0.9	9.9	0.7	6.7	0.5
A4	10.5	0.7	8.0	0.6	11.8	1.3	10.0	1.1
A5	10.3	0.4	10.3	1.7	11.1	0.0	8.9	1.0
B1	14.0	0.8	11.7	0.3	21.3	0.7	15.3	0.4
B2	17.3	0.6	11.0	1.3	15.8	0.5	13.9	0.8
B3	11.1	1.4	13.5	0.4	17.0	4.3	17.7	2.4
B4	13.3	0.2	13.8	0.7	20.7	3.7	15.8	0.5
B5	18.7	2.7	12.0	1.4	19.8	0.2	12.0	0.8
C1	13.1	3.0	9.8	0.4	12.2	0.4	11.0	1.1
C2	12.4	1.8	9.3	0.1	12.5	0.7	10.8	0.7
C3	11.3	0.2	9.0	0.1	11.7	0.1	12.8	0.3
C4	10.9	1.8	9.9	0.5	14.2	2.0	10.5	0.9
C5	12.7	0.3	9.2	0.1	12.2	0.2	10.3	1.1
AB	14.8	1.5	10.6	1.2	12.2	0.0	11.3	1.1
AC	13.1	0.8	10.0	0.1	10.9	0.8	9.4	0.8
BC	13.3	1.5	11.4	0.6	14.3	0.6	12.9	0.5
ABC	14.8	1.3	9.2	0.5	13.1	1.9	12.0	0.6
London Sample Collection								
Sample	October		January		April		July	
	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation	Mean (n=3)	Standard Deviation
A1	19.3	0.4	21.3	0.7	14.4	2.8	25.9	4.0
A2	21.8	0.8	17.2	0.9	18.8	1.2	40.4	0.6
A3	19.8	2.1	17.2	0.7	14.7	2.6	36.3	6.0
A4	18.1	0.3	19.4	0.9	20.5	2.2	32.6	3.4
A5	20.1	0.1	17.4	0.4	16.1	1.8	27.6	4.0
B1	9.6	0.4	8.4	1.3	19.5	2.6	16.6	1.0
B2	8.6	0.5	10.9	0.1	13.4	0.2	15.8	2.4
B3	9.6	0.8	13.7	0.1	15.8	0.5	16.4	0.9
B4	14.0	0.3	11.0	0.8	16.6	3.5	6.5	2.3
B5	12.9	0.0	12.8	0.3	13.5	0.4	19.2	4.0
C1	12.3	0.4	13.5	0.6	19.2	2.1	12.6	0.7
C2	10.5	0.2	11.5	0.2	16.0	2.1	20.5	1.1
C3	13.7	0.1	11.4	0.5	15.4	0.6	13.4	1.7
C4	12.7	0.2	12.9	0.3	16.4	0.8	13.3	1.3
C5	11.5	0.5	12.6	0.0	13.3	0.4	17.1	3.1
AB	9.6	0.5	14.4	0.4	16.6	1.4	18.9	4.1
AC	16.2	1.0	16.9	0.7	15.7	0.9	21.2	0.3
BC	14.4	2.0	22.9	19.3	16.7	6.0	16.3	2.0
ABC	13.4	0.3	13.2	1.1	14.9	1.2	20.7	3.0

*SDs significantly higher than the rest of the data set highlighted.

The Nottingham sample sites were found to contain a similar organic content with a range of 8.0 to 21.3 % (table 5.1), which is to be expected as each of the sites within this region were observed to contain similar plant matter.

Plots of these raw data (figure 5.1) indicated some slight differences in organic content between collection times, in general a lower organic content is observed in January and higher readings in April. ANOVA was used to assess whether a statistically significant difference could be identified between the organic contents for each site. From this statistical output (table 5.2), a significant difference was identified between the samples sites at the 95% significance level for each collection, except for the samples collected in October. For the London sample, collection site A has a higher organic content than sites B and C, with the exception of the April collection, for which all sites have a similar organic content. This is further supported by the ANOVA assessment of the data (Table 5.3), where no significant difference was identified between sites for the April collection only ($p = 0.391 > 0.05$), but a significant difference was identified between all sites for all other collections ($p = 0.000 < 0.05$).

The standard deviation of the data indicates, for the most part. that the data values for each analysis are consistent. with the exception of artificial mixture BC collected from London during the January collection. where the standard deviation is 19.3. This difference can more clearly be seen in figure 5.4, where the organic content for BC is much higher than the other collections.

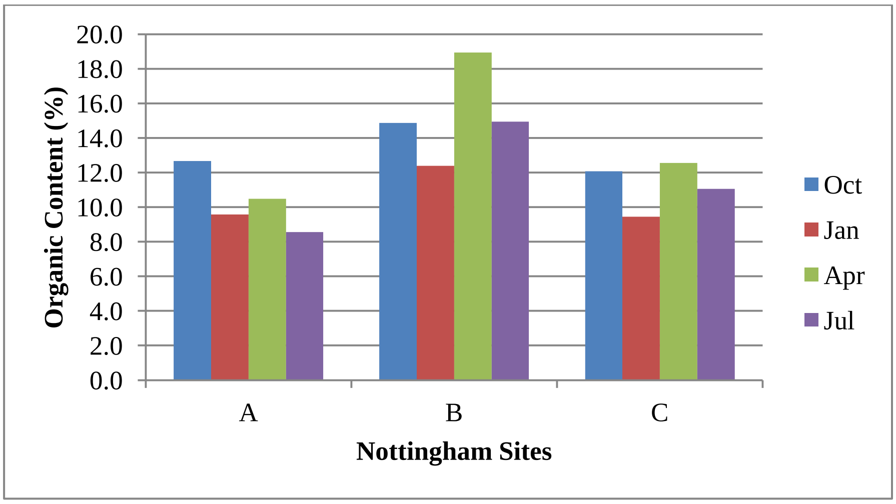


Figure 5.1: Mean organic content for Nottingham sites A, B, and C.

Figure 5.2: Mean organic content for London sites A, B and C.

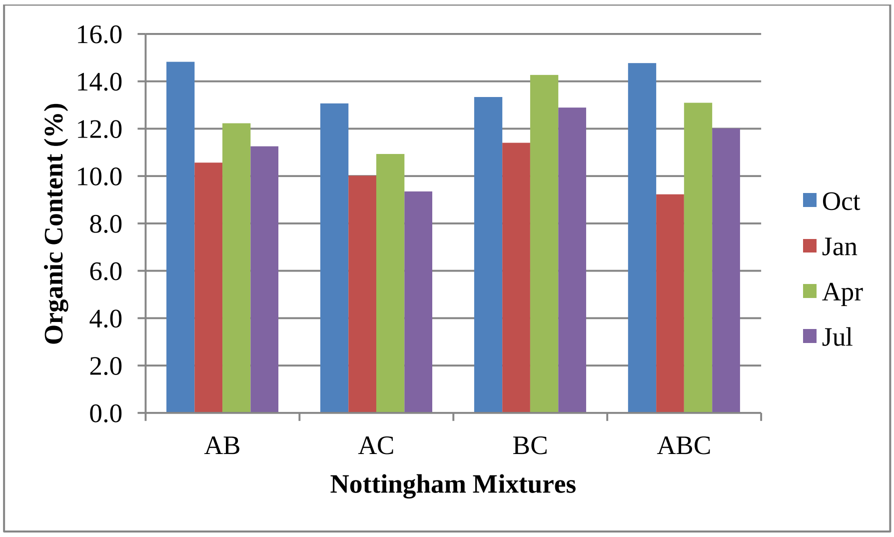


Figure 5.3: Organic content for Nottingham artificial mixtures.

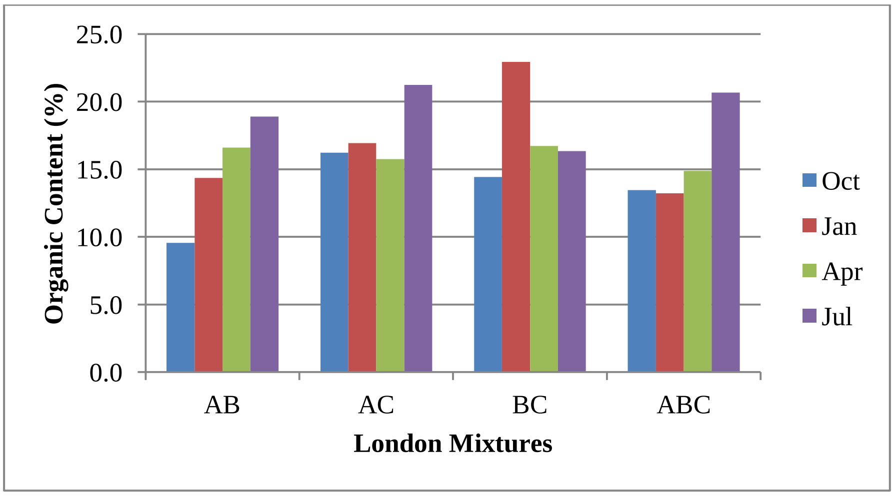


Figure 5.4: Organic content for London artificial mixtures.

Table 5.2: ANOVA statistics for Nottingham LOI data

Collection		Sum of Squares	df	Mean Square	F	Sig.
October	Between Groups	21.641	2	10.821	1.544	.253
	Within Groups	84.117	12	7.010		
	Total	105.758	14			
January	Between Groups	27.768	2	13.884	15.857	.000
	Within Groups	10.507	12	0.876		
	Total	38.276	14			
April	Between Groups	194.366	2	97.183	38.149	.000
	Within Groups	30.570	12	2.547		
	Total	224.936	14			
July	Between Groups	102.947	2	51.474	11.875	.001
	Within Groups	52.014	12	4.335		
	Total	154.962	14			

Table 5.3: ANOVA statistics for London LOI data

Collection		Sum of Squares	df	Mean Square	F	Sig.
October	Between Groups	231.899	2	115.949	39.585	.000
	Within Groups	35.149	12	2.929		
	Total	267.048	14			
January	Between Groups	150.460	2	75.230	27.218	.000
	Within Groups	33.168	12	2.764		
	Total	183.628	14			
April	Between Groups	26.924	2	13.462	1.018	.391
	Within Groups	158.736	12	13.228		
	Total	185.659	14			
July	Between Groups	1009.293	2	504.647	21.267	.000
	Within Groups	284.756	12	23.730		
	Total	1294.049	14			

Tables 5.4 and 5.5 present the paired t-test statistical output for the organic content of the artificial mixtures in comparison to their control groups for both Nottingham and London collections respectively. With the exception of Nottingham mixture AB compared to control site B, there is no significant difference in the organic content between any of the artificial mixtures and their corresponding control sites at the 95% significance level.

Table 5.4: Paired t-test statistics for Nottingham LOI data

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	-1.048	1	.485
	A - AC	-1.051	1	.484
	A - BC	-1.345	1	.407
	A - ABC	-1.079	1	.476
	B - AB	13.000	1	.049
	B - AC	1.129	1	.461
	B - BC	1.026	1	.492
	B - ABC	2.333	1	.258
	C - AB	-1.000	1	.500
	C - AC	-.922	1	.526
	C - BC	-1.083	1	.475
	C - ABC	-1.023	1	.493
January	A - AB	-1.085	1	.474
	A - AC	-1.048	1	.485
	A - BC	-1.045	1	.486
	A - ABC	.944	1	.518
	B - AB	1.022	1	.493
	B - BC	1.043	1	.487
	B - BC	1.041	1	.487
	B - ABC	1.032	1	.490
	C - AB	-1.075	1	.477
	C - AC	-1.036	1	.489
	C - BC	-1.042	1	.487
	C - ABC	.913	1	.529
April	A - AB	-1.035	1	.489
	A - AC	-1.044	1	.486
	A - BC	-1.049	1	.485
	A - ABC	-1.039	1	.488
	B - AB	1.043	1	.487
	B - AC	1.041	1	.487
	B - BC	1.035	1	.489
	B - ABC	1.042	1	.487
	C - AB	1.063	1	.481
	C - AC	1.038	1	.488
	C - BC	-1.060	1	.481
	C - ABC	-1.038	1	.488
July	A - AB	-1.038	1	.488
	A - AC	-1.026	1	.492
	A - BC	-1.047	1	.485
	A - ABC	-1.047	1	.485
	B - AB	1.039	1	.488
	B - AC	1.040	1	.487
	B - BC	1.020	1	.494
	B - ABC	1.028	1	.491
	C - AB	-1.000	1	.500
	C - AC	1.048	1	.485
	C - BC	-1.056	1	.483
	C - ABC	-1.066	1	.480

*statistically significant values highlighted

Table 5.5: Paired t-test statistics for London LOI data

Collection	Pair	t	df	Sig. (2-tailed)
October	A - AB	1.044	1	.486
	A - AC	1.040	1	.488
	A - AB	1.042	1	.487
	A - ABC	1.042	1	.487
	B - AB	1.044	1	.486
	B - AC	-1.047	1	.486
	B - BC	-1.047	1	.485
	B - ABC	-1.049	1	.485
	C - AB	1.048	1	.485
	C - AC	-1.045	1	.486
	C - BC	-1.044	1	.486
	C - ABC	-1.047	1	.486
January	A - AB	1.049	1	.485
	A - AC	1.051	1	.484
	A - BC	-1.046	1	.486
	A - ABC	1.046	1	.486
	B - AB	-1.034	1	.489
	B - AC	-1.040	1	.487
	B - BC	-1.044	1	.486
	B - ABC	-1.033	1	.490
	C - AB	-1.031	1	.490
	C - AC	-1.040	1	.487
	C - BC	-1.045	1	.486
	C - ABC	-1.024	1	.492
April	A - AB	1.063	1	.481
	A - AC	1.052	1	.484
	A - BC	1.105	1	.468
	A - ABC	1.030	1	.491
	B - AB	-1.049	1	.485
	B - AC	1.000	1	.500
	B - BC	-1.042	1	.487
	B - ABC	1.000	1	.500
	C - AB	-1.000	1	.500
	C - AC	1.138	1	.459
	C - BC	-1.000	1	.500
	C - ABC	1.034	1	.489
July	A - AB	1.039	1	.488
	A - AC	1.038	1	.488
	A - AB	1.042	1	.487
	A - ABC	1.041	1	.487
	B - AB	-1.046	1	.486
	B - AC	-1.045	1	.486
	B - BC	-1.028	1	.491
	B - ABC	-1.039	1	.488
	C - AB	-1.047	1	.486
	C - AC	-1.045	1	.486
	C - BC	-1.021	1	.493
	C - ABC	-1.039	1	.488

5.3.2 Elemental Analysis

The following section presents the data obtained for the elemental analysis performed on the soil/sediment samples collected from the Nottingham sample location and London sample location through XRF (section 5.3.2.1), ICP-MS (section 5.3.2.2) and ICP-AES (section 5.3.2.3).

It has been demonstrated, through the monitoring of blank controls samples and reference material (table 5.6), that no contamination has been introduced during sample digestion or analysis. It is also identified that the concentrations determined for each element were consistent throughout the analyses, with the exception of the lighter elements and those prone to spectral interferences for the XRF analyses previously discussed (section 3.8.1). It should also be noted that CRM mean values for XRF are based on fewer readings than that of ICP-AES and ICP-MS (8 versus 120). Additionally, preparations of samples undergoing ICP-AES and ICP-MS were more involved than those for XRF and could contribute to variations in sample readings in addition to potential spectral interferences. Extra sample preparation included a sample digestion, which dilutes the samples (see table 5.6 footnote), and for ICP-MS a further dilution (by a factor of 100), was necessary due to the sensitivity of the instrument. like with XRF, ICP-AES also encountered issues with Na measurements (percentage error 89.6 %), as well as Be (percentage error 100 %) and Ni (percentage error 140.6 %). For ICP-MS issues are encountered with measurements for V (percentage error -73.9 %), Cd (percentage error 100 %), Tl (percentage error -400 %) and Ce (percentage error -593). Therefore, these elements were not included in the data interpretation as the error rates reflect that the differences observed in these elements between samples of interest cannot be relied up on.

Table 5.6: Mean and standard deviation of element concentrations for certified reference material and procedural blanks

XRF											
Sample		Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti
CRM 1	ppm	280.0	11650.0	65090.0	251300.0	1110.0	3558.0	214.7	23000.0	27540.0	4504.0
	Mean*	232.01	9833.12	53284.34	215846.62	902.90	3215.06	40.10	19117.36	18990.28	3671.51
	SD	111.97	5475.14	30074.66	105929.33	433.04	1526.42	31.64	9218.80	12999.35	1781.46
	Error %	17.1	15.6	18.1	14.1	18.7	9.6	81.3	16.9	31.0	18.5
		V	**Cr**	**Mn**	**Fe**	**Co**	**Ni**	**Cu**	**Zn**	**Ga**	**Ge**
	ppm	70.0	121.9	544.0	41090.0	13.6	42.9	89.8	408	14.5	1.2
	Mean*	75.63	114.52	541.38	41391.05	25.87	41.23	88.12	396.61	14.67	1.40
	SD	33.57	52.55	7.12	439.87	8.97	1.81	2.26	12.46	0.83	0.43
	Error %	-8.0	6.1	0.5	-0.7	-90.22	3.9	1.9	2.8	-1.2	-16.7
		As	**Se**	**Br**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Mo**	**Ag**
	ppm	14.7	0.5	5.4	95.7	122.6	35.6	312.7	16.6	2.2	0.9
	Mean*	14.66	0.83	5.44	97.13	124.87	36.37	311.25	14.46	6.89	0.98
	SD	1.28	0.25	0.47	1.98	1.96	0.87	6.68	2.92	2.05	0.70
	Error %	0.3	-66.0	-0.7	-1.5	-1.9	-2.2	0.5	12.9	-213.2	-8.9
		Cd	**In**	**Sn**	**Sb**	**Te**	**I**	**Cs**	**Ba**	**La**	**Ce**
	ppm	2.94	0.8	11.4	3.1	1.0	1.8	3.3	384.2	26.9	38.7
	Mean*	5.11	0.63	10.95	2.46	0.87	1.71	3.09	340.28	25.90	38.51
	SD	0.68	0.07	1.14	0.90	0.13	0.09	0.20	9.19	5.93	6.64
	Error %	-73.8	21.3	4.0	20.7	13.0	5.0	6.4	11.4	3.7	0.5
		Hf	**Ta**	**W**	**Hg**	**Tl**	**Pb**	**Bi**	**Th**	**U**	
	ppm	5.7	5.8	4.1	0.7	1.6	147.6	0.8	10.7	7.0	
	Mean*	6.56	4.54	3.47	0.65	1.53	148.54	0.59	9.51	5.53	
	SD	2.54	0.22	0.60	0.19	0.15	3.44	0.12	0.83	0.54	
	Error %	-15.1	21.7	15.4	7.1	4.4	-0.6	26.3	11.1	21.0	

ICP-MS***															
Sample		**V**	**Cr**	**Co**	**Cu**	**Sr**	**Y**	**Zr**	**Ng**	**Mo**	**Cd**	**La**	**Ce**	**Pr**	**Nd**
CRM 2	ppm	89.7	75.3	15.6	30.9	274	-	200	-	-	0.29	40	7.5	-	-
	+/-	8.7	3.2	1.2	1.9	10	-	-	-	-	0.06	-	-	-	-
	Mean**	3.12	1.83	0.37	0.21	4.62	0.29	4.81	0.30	0.00	0.00	0.50	1.04	0.12	0.43
	SD	0.25	0.17	0.03	0.01	1.95	0.16	1.88	0.04	0.01	0.00	0.26	0.48	0.06	0.22
		Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
	ppm	5	1	7	1	4	-	-	-	2	0.5	2	<0.2	41.3	4
	+/-	-	-	-	-	-	-	-	-	-	-	-	-	4.4	2
	Mean**	0.08	0.02	0.08	0.01	0.06	0.01	0.03	0.01	0.03	0.01	0.06	0.02	0.73	0.09
	SD	0.05	0.01	0.04	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.02	0.00	0.07	0.01
Blank		**V**	**Cr**	**Co**	**Cu**	**Sr**	**Y**	**Zr**	**Ng**	**Mo**	**Cd**	**La**	**Ce**	**Pr**	**Nd**

	Mean**	0.15	0.00	0.00	0.02	0.02	-0.01	0.14	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	SD	0.04	0.05	0.01	0.00	0.01	0.01	0.15	0.00	0.01	0.00	0.00	0.01	0.00	0.00
		Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
	Mean**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	SD	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01

ICP-AES***													
Sample		**K**	**Al**	**Be**	**Ca**	**Fe**	**Mg**	**Mn**	**Na**	**Ni**	**P**	**Ti**	**Zn**
CRM 2	ppm	26300	74800	2	63400	37300	11900	734	4500	37.4	1400	3800	119
	+/-	2300	5500	1	2500	1900	1700	34	-	3.3	-	-	7
	Mean**	58.77	155.00	0.00	40.88	82.59	25.03	1.54	0.94	0.18	3.26	13.26	0.03
	SD	0.80	2.65	0.00	1.59	1.84	0.47	0.05	0.06	0.01	0.03	0.15	0.00
	Error %	-11.3	-3.61	100.0	67.7	-10.7	-5.2	-4.9	89.6	-140.6	-16.4	-74.4	87.4
Blank	Mean**	0.01	0.14	0.00	0.12	0.02	0.04	0.01	0.01	0.00	0.04	0.07	0.00
	SD	0.04	0.13	0.00	0.10	0.07	0.05	0.01	0.03	0.01	0.04	0.05	0.00

*n = 24 based on 3 replicates of 8 plates containing 1 reference material

**n = 120 based on 5 replicate measures of each reference material (n=24)/procedural blank (n=24)

*** ICP-MS in ppb; samples diluted for ICP-MS twice (0.1 ml in 10 ml (100x) of a 0.1 g in 50 ml digest (500x)) and ICP-AES once (10 ml of 0.1g in 50 ml digest (500x))

5.3.2.1 XRF

Statistical analyses outlined in section 3.11.1 were performed on the raw XRF data (appendix 5.4 - 5.9) to ascertain intra- and inter-site variability (tables 5.7 to 5.15 and figures 5.5 to 5.6), and single- mixed source sample (tables 5.16 to 5.19 and figures 5.7 to 5.10). Three replicate measures were taken of each sample analysed by XRF and five replicate measures were taken per sample for ICP-MS and ICP-AES.

Table 5.7: Statistically significant and non-significant elements determined through XRF for both Nottingham and London sample collections.

Location	Collection	Significant	Non-significant
Nottingham	October	Mg, Al, S, Cl, K, Si, P, Ca, Ti, V, Fe, Co, Ni, Cu, Zn, Ga, As, Br, Mo, Rb, Sr, Y, Nb, Cd, Sn, Ba, Ce, Pb. (Total: 28/50, 56 %)	Na, V, Cr, Mn, Ge, Se, Zr, Ag, In, Sb, I, Cs, La, Ta, Te, Hf, Hg, W, Tl, Bi, Th, U. (Total: 22/50, 44 %)
	January	Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, Mn, Fe, Mo, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Sn, Ba, Hf, Ta, Pb, Th, Hg, U. (Total: 31/50, 62 %)	Na, V, Co, Ge, Br, As, Se, Cd, Ag, Sb, I, Cs, La, In, Ce, Te, W, Tl, Bi. (Total: 19/50, 38 %)
	April	Mg, Al, Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Ni, Cu, Zn, Ga, Br, Rb, Sr, Y, Zr, Sn, Ba, Ta, La, Pb, Th, W (Total: 29/50, 58 %)	Na, V, Co, Cr, Ge, As, Nb, Mo, Ag, In, Se, Sb, Cs, Ce, Te, I, Hg, Hf, Tl, Bi, U (Total: 21/50, 42 %)
	July	Mg, Al, Si, P, S, K, Ca, Ri, Mn, Fe, Mo, Zn, Ga, Ge, Br, Rb, Sr, Y, Zr, Nb, Sn, Ba, La, Ce, W, Pb, Th. (Total: 28/50, 56 %)	Na, V, Cl, Cr, Co, Ni, Cu, As, Se, Ag, Cd, Sb, In, Te, I, Cs, Hf, Hg, Ta, Bi, Tl, U. (Total: 22/50, 44 %)
London	October	Mg, Al, Si, P, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Ga, Se, Rb, Sr, Y, Zr, Nb, Ag, Cd, In, Sn, Sb, I, Cs, Ba, La, Ce, Ta, W, Tl, Pb, Th, Bi. (Total: 37/50, 74 %)	Na, S, Cl, K, Zn, Ge, As, Br, Mo, Te, Hf, Hg, U. (Total: 13/50, 26 %)
	January	Mg, Al, Si, P, S, Cl, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Y, Zr, Nb, Ag, Sn, Sb, I, Cs, Ba, La, Ce, Hf, Ta, W, Tl, Pb, Th. (Total: 39/50, 78 %)	Na, K, Ge, Br, Mo, Cd, In, Te, Hg, Bi, U. (Total: 11/50, 22 %)
	April	Mg, Al, K, Ca, Fe, Co, Ni, Cu, Zn, Ga, Ge, Se, Br, Rb, Sr, Y, Zr, Cd, Cs, Ba, Ce, Hf, Ta, Pb, Th. (Total: 26/50, 52 %)	Na, Si, P, S, Cl, Ti, V, Cr, Mn, As, Nb, Mo, Ag, In, Sn, Sb, Te, I, La, W, Hg, Tl, Bi, U. (Total: 24/50, 48 %)
	July	Mg, Al, Si, P, Cl, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Y, Zr, Nb, Ag, Cd, Sn, Sb, Te, I, Cs, Ba, La, Ce, Hf, Ta, Tl, Pb, Bi, Th. (Total: 39/50, 78 %)	Na, S, K, V, Ge, Br, Mo, In, W, Hg, U. (Total: 11/50, 22 %)

ANOVA statistical analysis (table 5.7) identified which elements were significantly different at the 95 % significance level between sites, and therefore, responsible for site discrimination. A greater proportion of elements were found to be significantly different statistically at the 95 % significance level. However, this difference is marginal with a percentage range of 56 to 62 % for the Nottingham sample collection, and 52 % for the London April collection. The difference is more distinct for the October, January and July sample collections in London, with a percentage range of 74 to 78 %. For CDFA, each of the sites at Nottingham and London were 100% correctly classified (table 5.10). CDFA confirmed that it was possible to discriminate between the Nottingham samples sites at the 99 % significance level (p = 0.000; table 5.9), through function 1 and 2 elements (table 5.11), with function 1 accounting for the majority of the variance (table 5.8). For the October collection, function 1 explains 89.8% of the variance, and function 2 accounts for 10.2 % of the variance between the groups; for January, 94.4% of the variance comes from function 1 and 5.6% from function 2; April, 99.2% from function 1 and 0.8% from function 2; and July, 62.5% of the variance is explained by function 1 and 37.5% by function 2 at the 99 % significance level. This discrimination between sites A to C for each collection is more clearly observed in the CDFA graphical output (figure 5.5), with the exception of sites A and C for the April collection.

Table 5.8: CDFA eigenvalues for the Nottingham sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	328.263	89.8	89.8	.998
	2	37.099	10.2	100.0	.987
January	1	344.057	94.4	94.4	.999
	2	20.503	5.6	100.0	.976
April	1	1626.024	99.2	99.2	1.000
	2	13.902	.8	100.0	.966
July	1	170.340	62.5	62.5	.997
	2	102.413	37.5	100.0	.995

Table 5.9: Wilks' Lambda values for the Nottingham sample collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
October	1 through 2	.000	61.341	24	.000
	2	.026	23.661	11	.014
January	1 through 2	.000	57.927	24	.000
	2	.047	19.943	11	.046
April	1 through 2	.000	65.624	24	.000
	2	.067	17.560	11	.067
July	1 through 2	.000	63.586	24	.000
	2	.010	30.152	11	.001

Table 5.10: CDFA classification results for the Nottingham sample collections

Collection	Site	Predicted Group Membership			Total
		A	B	C	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.11: CDFA structure matrix for the Nottingham sample collections

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Te	-531	.260	W	-678	.037	Hf	-.583	.252	Sb	-.533	.020
Co	.518	.035	Ce	-572	.188	I	.549	-.182	Cs	-.433	.090
Ag	.468	-.268	Sb	.514	.376	As	.428	.292	La	-.411	-.184
Hf	-457	.077	Mo	-.478	-.191	Nb	-.374	.009	Nb	.399	-.098
Sr	-441	-.205	Co	-.435	-.079	Cu	-.345	.120	Cd	.282	-.160
Fe	-415	-.073	Ba	-.426	-.073	Sr	-.250	-.190	U	.239	-.064
Nb	-.386	-.044	Cu	-.400	.048	Te	-.239	.139	Ni	-.223	.100
Mn	-365	.308	Mn	-.387	.133	Zr	-.186	.130	S	.168	-.113
Sb	-317	.314	Tl	-.369	-.086	Hg	-.186	.032	Se	.164	-.033
Cd	-.305	-.056	Hg	.332	.188	Sb	.182	.037	Rb	-.152	.147
Bi	.296	.101	Cs	.303	-.011	Ni	-.173	-.117	Mo	.149	-.045
U	-293	-.058	Ga	-.277	.048	Cd	.142	.091	Zr	.130	.060
Cs	-.284	-.049	Nb	-.124	-.023	Sn	-.142	-.031	Fe	-.121	.113
Y	-269	-.052	Zn	-.100	-.096	Ta	-.107	.004	K	-.108	.093
Rb	-223	-.070	Se	-.056	-.601	K	-.087	.029	Te	.104	.074
Cu	-216	.161	Cd	-.046	-.523	Rb	.062	-.022	Ce	-.104	-.015
W	-211	-.075	Si	-.149	.519	Pb	.032	-.021	Si	-.086	.077
Ba	-197	.029	Ti	-.100	.512	Cs	.561	-.645	Th	.082	.031
Ni	-184	-.139	As	-.338	.479	W	.453	.593	Cr	-.032	-.012
Ga	-177	-.024	Al	-.030	.436	La	-.166	-.459	In	.024	-.021
I	-168	.074	K	-.076	.429	Tl	.239	.434	Zn	.317	-.570
Al	-129	-.061	I	.259	-.425	Br	.113	.420	Tl	-.214	.527
Mg	-126	.097	Ag	-.018	.401	Se	-.214	.394	Pb	.171	-.526
Zr	.109	-.003	In	.033	.387	Ge	-.204	.376	Mn	-.052	.513
La	.108	.003	U	-.004	-.380	Ce	-.103	-.372	Hf	.041	-.471
K	-092	-.018	Rb	-.088	.352	Th	.358	-.372	Hg	-.261	-.470
In	.081	.059	Sr	-.228	.345	Mo	.126	.355	W	.397	.464
P	.076	.027	Mg	.020	.345	Ba	-.118	-.351	Co	.185	.314
Ti	-071	-.003	Fe	-.082	.315	S	.105	.332	Cu	.256	-.310
Si	-051	-.016	Y	-.300	.303	U	-.190	.321	Ta	-.195	.287
Ta	-.092	-580	Cl	.022	-277	In	.222	-.312	Ag	.059	-.245
As	.098	.577	Th	.136	.248	Ca	.016	-.308	Ge	-.056	-.221
Sn	.049	.447	Zr	-.016	-242	Si	-.085	-.283	Br	-.126	.205
Se	-.235	-433	Sn	.108	-233	Mn	-.215	-.262	I	-.099	-.192
Hg	.130	.342	Ge	.087	-228	Co	.097	.250	As	-.039	.165
Ce	.125	.250	Bi	.103	-224	Ag	.092	.213	P	.072	-.151
Ge	-.096	-247	Ni	-.168	.202	Mg	-.079	.191	Sn	.075	-.146
Mo	-.107	.234	S	-.064	-190	Ga	.139	.181	Mg	-.077	.123
Zn	-.077	-226	Br	-.016	-182	Na	-.013	-.138	Y	-.089	-.123
Ca	.035	.218	Cr	-.048	.176	Zn	-.040	.133	Al	-.089	.121
Br	-.028	-214	Pb	-.162	-171	V	-.015	-.132	Ti	-.098	.117
Pb	.085	.182	Te	-.043	.154	Bi	-.090	-.130	Ca	-.045	-.113
Tl	-.068	.102	Ca	-.046	.143	Fe	-.009	.120	Ba	.011	.104
S	.095	-100	P	-.098	-129	Ti	-.101	-.105	Sr	-.001	-.087
Cl	.035	.088	Hf	.033	.127	Al	-.091	.092	Ga	.024	-.076
Th	-.021	-049	Na	.025	.100	Cl	.029	.078	Bi	.058	-.064
Cr	.003	-035	V	-.014	.087	Cr	-.001	-.066	Cl	-.016	-.040
V	-.025	-027	Ta	.079	.083	P	.057	-.065	Na	.008	.038
Na	-.010	-011	La	.003	-051	Y	-.031	-.052	V	-.003	.014

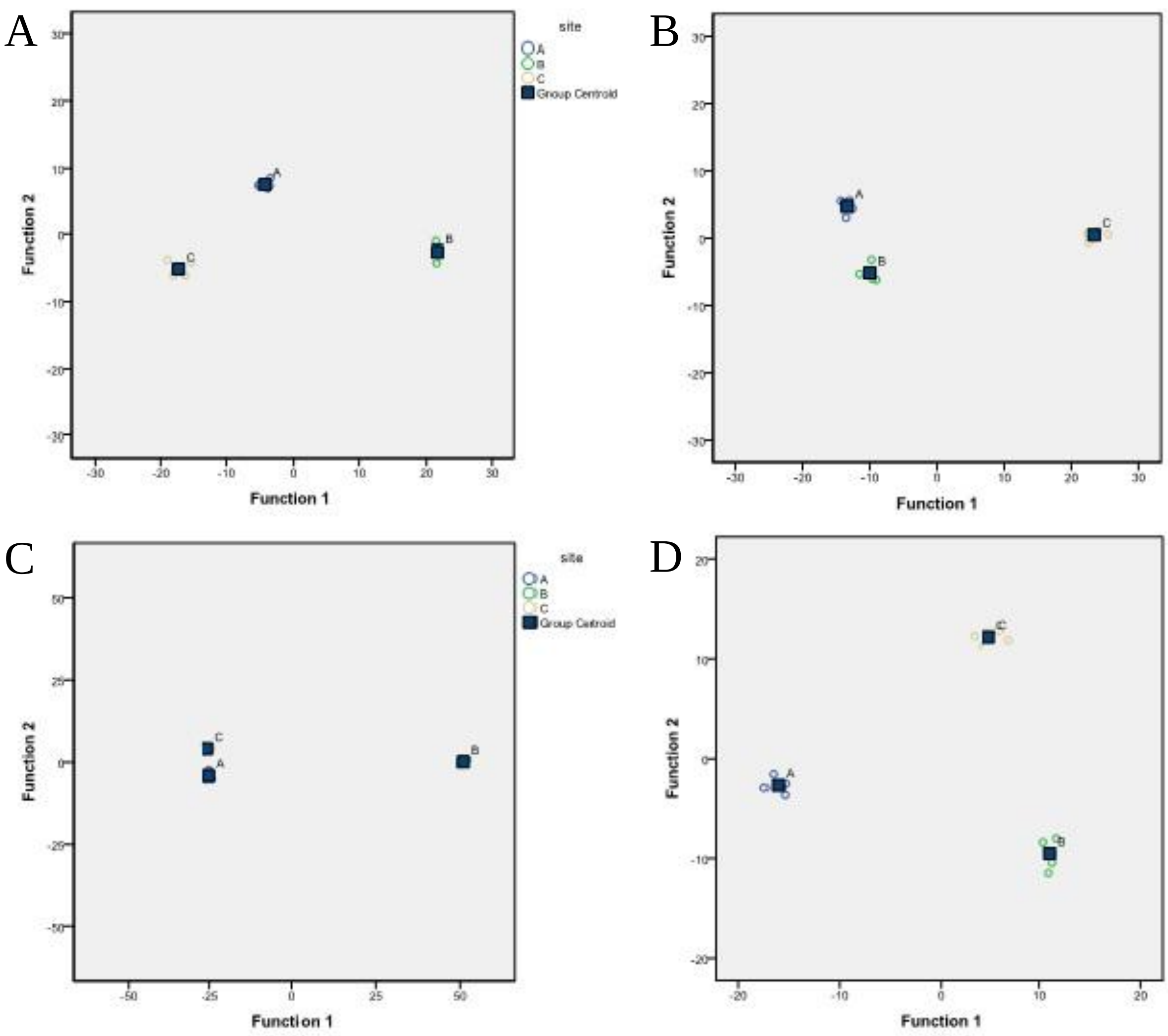


Figure 5.5: CDFA charts for the XRF data for the Nottingham sample collections (A - October, B - January, C - April and D - July)

For the London collections, 100 % of the sites were correctly classified (table 5.14). It was possible to distinguish between all sites at the 99 % significance level, where p = 0.000 (table 5.13), with function 1 elements (table 5.15) responsible for the majority of the variation between sites (table 5.12). However, for the April collection, no significant difference was identified between the sites (p = 0.071 > 0.05). For the October collection, 97.5 % of the variance was contributed from function 1 elements and 2.5 % from function 2; for January, 92.7 % and 7.3 %; April, 96.4% and 3.6%; and July, 99.5% and 0.5 % from function 1 and function 2 elements respectively. This distinction between London sample sites is visible in the CDFA graphical output (figure 5.6); minimal within-site variation can also be observed, with the exception of sites B and C for the April sample collection, where the data is much more disperse.

Table 5.12: CDFA eigenvalues for the London sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	10161.839	97.5	97.5	1.000
	2	259.865	2.5	100.0	.998
January	1	1935.726	92.7	92.7	1.000
	2	151.542	7.3	100.0	.997
April	1	61.608	96.4	96.4	.992
	2	2.302	3.6	100.0	.835
July	1	6485.934	99.5	99.5	1.000
	2	31.421	0.5	100.0	.984

Table 5.13: Wilks' Lambda values for the London collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
October	1 through 2	.000	96.138	24	.000
	2	.004	36.166	11	.000
January	1 through 2	.000	81.875	24	.000
	2	.007	32.678	11	.001
April	1 through 2	.005	34.654	24	.074
	2	.303	7.764	11	.734
July	1 through 2	.000	79.666	24	.000
	2	.031	22.612	11	.020

Table 5.14: CDFA classification results for the London sample collections

Collection	**Site**	**Predicted Group Membership**			**Total**
		A	**B**	**C**	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.15: CDFA structure matrix for the London sample collections (elements contributing most to each function in descending order)

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Te	-.666	-.266	W	-.583	.315	Hg	.472	-.038	Ag	-.513	.022
Cs	-.379	.131	Hg	-.519	-.213	Ta	-.317	-.115	Sn	-.426	-.060
In	-.359	.176	In	-.504	.036	Co	.272	.051	Cd	-.394	-.244
Tl	.275	.066	Ag	-.391	-.205	Ba	-.217	.019	Fe	.355	.100
As	.254	-.139	Tl	-.317	-.106	Th	.212	-.154	Rb	.339	.315
Ni	.230	-.229	Nb	.257	.234	Rb	.174	-.136	Hg	.247	-.085
Mn	.220	-.158	Sn	-.239	.208	Sn	-.171	.016	Mo	.247	-.001
Co	.208	-.109	Hf	.229	.193	Cs	.155	.123	Sb	.204	-.044
Sr	.185	.064	U	-.207	.076	Nb	.153	-.132	Se	.160	-.031
Cu	.153	-.149	Ga	-.168	.096	Te	-.151	-.026	Ta	.123	.033
Hf	.135	.026	Zn	-.161	.106	Ca	-.143	.142	Ge	.062	.024
U	-.100	.005	Cd	-.094	-.070	Zr	.110	-.044	Zn	.059	.027
Se	.091	-.005	Mg	-.062	-.023	V	-.084	-.052	Cu	.048	.018
W	-.084	.001	Zr	.054	-.002	Fe	-.071	.029	Br	-.011	.009
Ce	-.066	-.026	Na	.009	-.009	Sb	-.047	-.041	Ca	.090	-.696
Mg	.026	.021	I	-.129	.546	P	-.021	.004	Te	.069	.460
Mo	-.206	.473	Bi	-.025	.448	In	-.154	-.485	La	.205	.449
Cd	.197	-.365	Pb	.017	.446	W	-.274	-.436	Bi	.164	.414
Hg	-.065	.347	Sb	.056	.430	Mg	-.098	.385	U	-.306	-.389
La	.161	-.321	Ge	.317	.378	Br	-.195	-.375	Cl	-.011	-.337
Ga	-.068	.297	Ce	-.034	.335	Mo	.077	.364	In	-.308	-.331
Fe	.248	-.270	Te	-.044	.329	Se	-.190	-.347	Si	.006	.324
Sn	.207	-.245	As	-.113	.318	Bi	.295	.321	Y	.064	.323
Zn	-.214	-.235	Th	-.110	.303	Hf	-.039	-.314	Ti	-.003	.307
Ta	-.127	-.221	Fe	-.165	.303	Al	-.194	.313	Ce	-.081	.303
Al	.047	-.201	Ta	.051	.302	Tl	-.113	-.311	I	-.019	-.289
Ba	.040	-.197	La	.118	.296	Ge	-.208	-.287	Sr	-.029	-.255
I	.024	-.193	Co	.114	.263	K	.093	.280	Zr	-.090	.245
Bi	.133	.188	Cu	.015	.260	Cr	.176	-.272	Mn	.094	-.237
Y	.110	-.185	Ca	-.175	-.247	Sr	-.208	.270	Cr	.000	.218
Pb	.117	-.181	Ti	.010	.247	I	.043	-.268	Nb	-.142	.214
Ge	-.038	-.178	Ni	-.121	.245	Cd	-.192	.261	P	.009	-.198
Sb	.107	-.173	Br	.052	.242	As	-.096	-.261	Ni	.065	.192
Ag	.125	-.153	Y	-.086	.228	Y	-.135	-.258	Co	-.073	.173
Cr	.006	-.150	Ba	.114	.223	Ni	-.221	-.252	Pb	.080	.148
Ca	.049	.150	Se	-.068	-.210	Pb	-.036	-.243	As	.098	.137
Nb	-.123	-.148	Cr	-.007	.204	Zn	-.168	-.229	S	-.003	-.134
Th	.024	-.143	Sr	-.058	-.177	Ga	-.171	.226	Mg	.020	-.133
Rb	-.037	-.135	Al	-.056	.163	Ag	-.067	-.213	Ba	.052	.109
Ti	-.005	-.129	Cs	-.067	.161	S	-.079	-.192	Al	.034	.100
Zr	-.022	-.096	Rb	-.129	.132	Ce	.102	-.170	W	-.037	.099
V	.009	-.096	P	-.049	-.100	La	-.129	.169	Cs	-.039	.094
Br	.041	-.089	Si	.010	.100	Cu	-.151	-.162	Hf	.036	.092
Si	.001	-.085	Mo	.067	.100	U	-.081	.153	Tl	.068	-.089
P	.018	.064	Mn	-.026	-.095	Cl	-.021	-.149	Th	-.031	.084
S	.004	.042	Cl	.007	-.086	Na	.001	-.141	Ga	-.002	-.070
Cl	.000	.032	V	-.009	.081	Si	.073	.124	Na	.001	.069
Na	-.004	-.027	S	-.020	-.076	Ti	.069	-.112	K	.007	-.067
K	.004	.017	K	.007	-.023	Mn	-.041	-.070	V	.007	.048

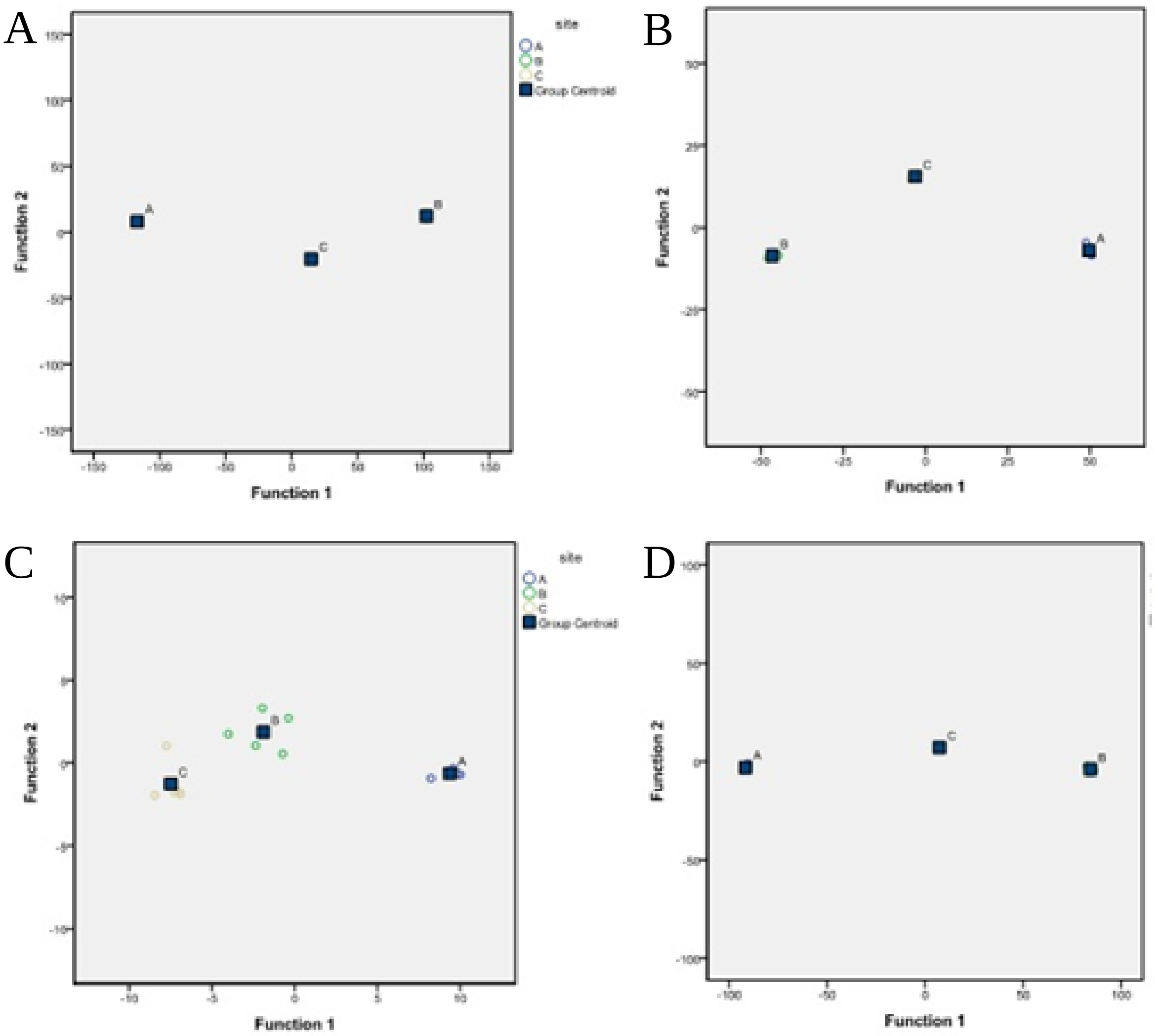


Figure 5.6: CDFA charts for the XRF data for the London sample collections (A - October, B - January, C - April and D - July)

Table 5.16: Paired t-test statistics for elemental data obtained through XRF for the Nottingham sample collections

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	2.361	48	.022
	A - AC	-.807	48	.423
	A - BC	1.168	48	.096
	A - ABC	1.732	48	.090
	B - AB	-1.261	48	.214
	B - AC	-1.754	48	.086
	B - BC	-1.429	48	.160
	B - ABC	-.128	48	.898
	C - AB	1.543	48	.129
	C - AC	-.297	48	.768
	C - BC	1.506	48	.139
	C - ABC	1.386	48	.172
January	A - AB	1.677	48	.100
	A - AC	1.542	48	.130
	A - BC	1.560	48	.125
	A - ABC	1.600	48	.116
	B - AB	1.510	48	.138
	B - AC	.838	48	.406
	B - BC	1.213	48	.231
	B - ABC	1.190	48	.240
	C - AB	1.064	48	.293
	C - AC	1.006	48	.320
	C - BC	1.983	48	.053
	C - ABC	1.798	48	.078
April	A - AB	1.785	48	.081
	A - AC	.503	48	.617
	A - BC	1.648	48	.106
	A - ABC	1.460	48	.151
	B - AB	-1.519	48	.135
	B - AC	1.472	48	.147
	B - BC	-1.521	48	.135
	B - ABC	-1.582	48	.120
	C - AB	.772	48	.444
	C - AC	-.887	48	.379
	C - BC	1.415	48	.164
	C - ABC	.148	48	.883
July	A - AB	2.140	48	.037
	A - AC	.667	48	.508
	A - BC	1.993	48	.052
	A - ABC	2.214	48	.032
	B - AB	-1.420	48	.162
	B - AC	-1.432	48	.159
	B - BC	-1.318	48	.194
	B - ABC	-1.361	48	.180
	C - AB	.702	48	.486
	C - AC	-1.176	48	.246
	C - BC	1.404	48	.167
	C - ABC	.626	48	.535

*statistically significant values highlighted

Table 5.17: Paired t-test statistics for elemental data obtained through XRF for the London sample collections

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	-2.090	48	.042
	A - AC	-1.493	48	.142
	A - BC	1.955	48	.056
	A - ABC	-1.934	48	.059
	B - AB	-.551	48	.584
	B - AC	-.105	48	.917
	B - BC	1.400	48	.168
	B - ABC	-.189	48	.851
	C - AB	-.204	48	.839
	C - AC	1.801	48	.078
	C - BC	.741	48	.462
	C - ABC	.252	48	.802
January	A - AB	.284	48	.778
	A - AC	-1.645	48	.107
	A - BC	-1.928	48	.060
	A - ABC	-1.970	48	.055
	B - AB	1.790	48	.080
	B - AC	.075	48	.941
	B - BC	-.338	48	.737
	B - ABC	.058	48	.954
	C - AB	.885	48	.381
	C - AC	1.367	48	.178
	C - BC	.500	48	.620
	C - ABC	.941	48	.351
April	A - AB	-1.535	48	.131
	A - AC	-1.435	48	.158
	A - BC	-1.526	48	.134
	A - ABC	-1.478	48	.146
	B - AB	.214	48	.831
	B - AC	.138	48	.891
	B - BC	.107	48	.915
	B - ABC	-.129	48	.898
	C - AB	-.270	48	.788
	C - AC	-.357	48	.723
	C - BC	-.337	48	.737
	C - ABC	-.453	48	.653
July	A - AB	-2.201	48	.033
	A - AC	-1.269	48	.211
	A - BC	-1.965	48	.055
	A - ABC	-1.871	48	.067
	B - AB	1.799	48	.078
	B - AC	.892	48	.377
	B - BC	-.431	48	.668
	B - ABC	1.027	48	.310
	C - AB	.658	48	.514
	C - AC	1.287	48	.204
	C - BC	-.296	48	.768
	C - ABC	.712	48	.480

*statistically significant values highlighted

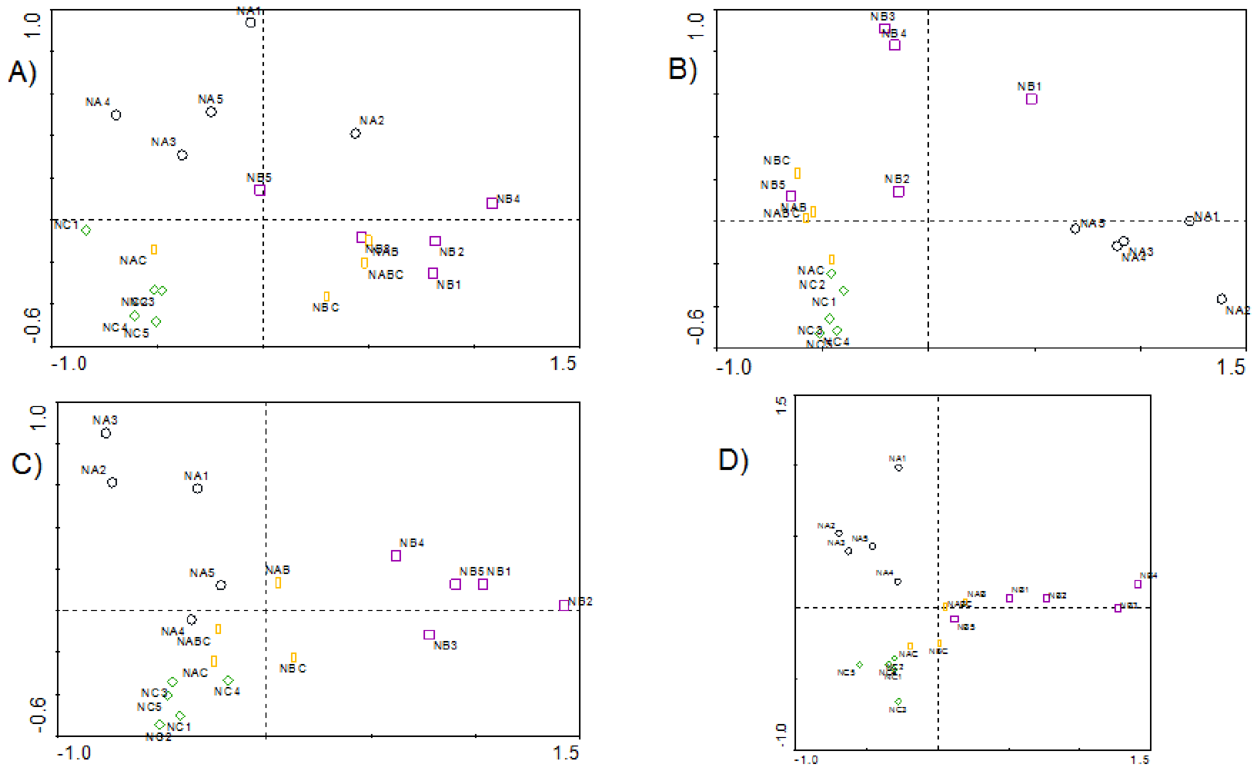


Figure 5.7: PCA biplot for single source and mixed source sample data determined by XRF for the Nottingham sample collections (A - October, B - January, C - April, D - July: axis 1 - horizontal, axis 2 - vertical).

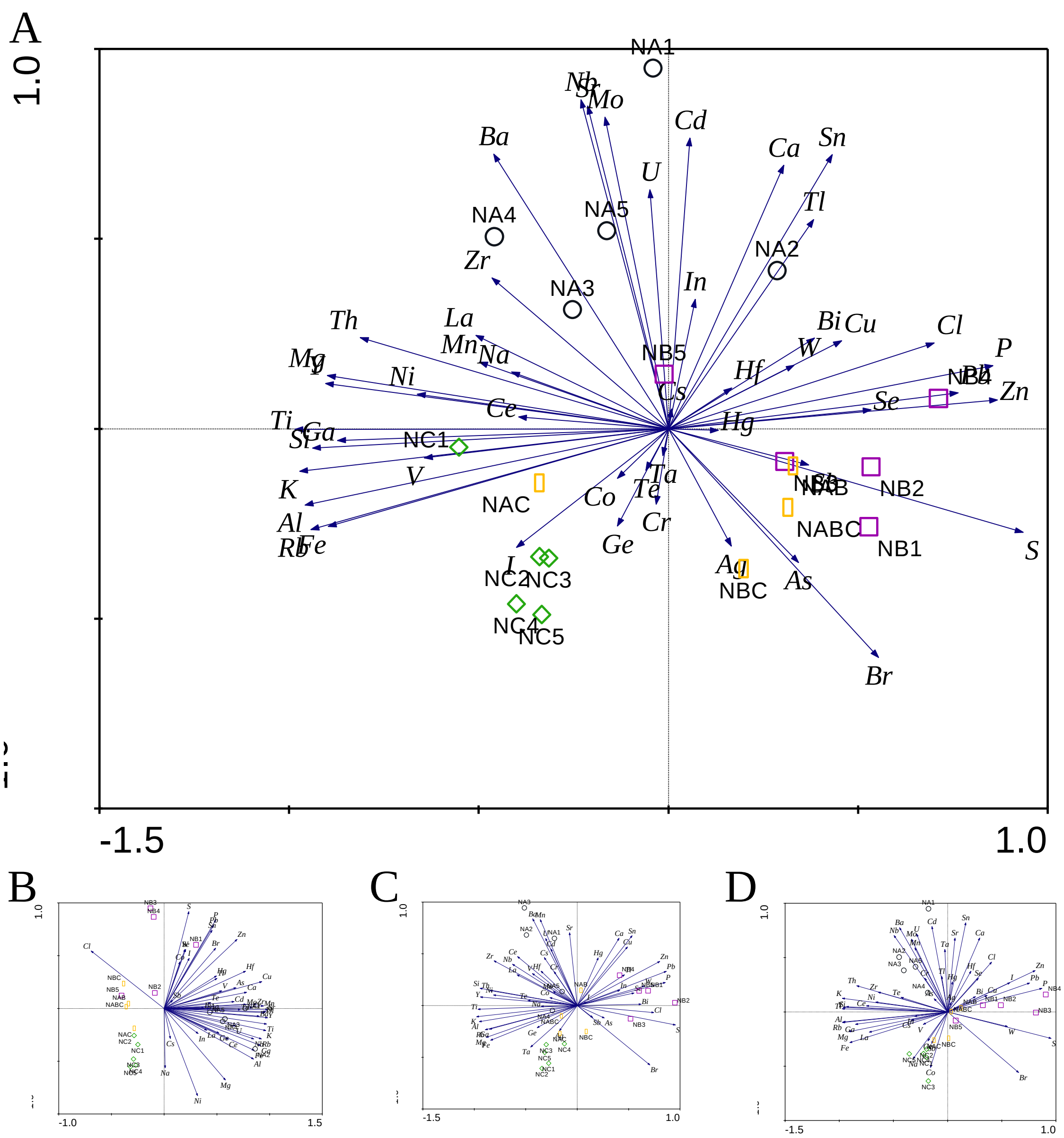


Figure 5.8: Elements responsible for variation between sites and mixtures for the XRF data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.18: PCA eigenvalues and cumulative percentage of variance for Nottingham sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.329	32.9	1.000
	2	0.139	46.8	
	3	0.082	55.0	
	4	0.077	62.8	
January	1	0.449	44.9	1.000
	2	0.161	61	
	3	0.071	68.1	
	4	0.060	74.1	
April	1	0.387	38.7	1.000
	2	0.139	52.6	
	3	0.076	60.2	
	4	0.060	66.2	
July	1	0.339	33.9	1.000
	2	0.152	49.1	
	3	0.089	58.0	
	4	0.074	65.4	

With the exception of October pair A-AB ($p = 0.022 < 0.05$), July pairs A-AB ($p = 0.037 < 0.05$), and A-ABC ($p = 0.032 < 0.05$) for the Nottingham collection; and October pair A-AB ($p = 0.042 < 0.05$) for the London collection, the paired t-test revealed no statistical significant difference between the artificial mixtures and the corresponding control site (table 5.16 and 5.17). Additionally no significant difference could be established between mixtures and single source samples that did not contribute to the mixture (e.g. A with mixture BC), with p-values in the range of 0.052 to 0.486 for Nottingham samples and 0.056 to 0.941 for London samples.

From PCA (tables 5.18 and 5.19) it is observed generally (figures 5.7 and 5.9), that the mixture data points are distributed between the control sites. However, in some cases, mixtures tend to associate more with one control site than the other, despite being composed of equal proportions of the control site material. Given that the artificial mixtures were created using equal proportions of material from the control sites, it might be expected that mixture data points would be equidistant from the sites responsible for the mixture (e.g. figure 5.9D, where mixture AB is between site A and B, and mixture AC between sites A and C). However, this is not observed in the majority of cases, which is likely due to elements not being mutually exclusive at each location.

Figures 5.8 and 5.10 illustrate the elements responsible for the variance between the sites and mixtures. The more pronounced the arrowed lines, the more significant the contribution of that element to the variation. For example, for the October collection in Nottingham for site A, Nb is the most significant element, followed by Br, Mo, Ba, Cd, U and Zr. For site B, the most significant element was S, followed by Zn, P, Cl and Se. For site C, the most significant element is I, followed by Ge, Cr, Co, Te and Ta. For the October collection in London, elements Bi and Tl are the most significant for site A. For site B, Sn is the most significant element followed by Sb, P, As, In and Br. For site C, Ti, Cr, Zr and Si are the most significant elements, followed by Se, Nb, I and Hf.

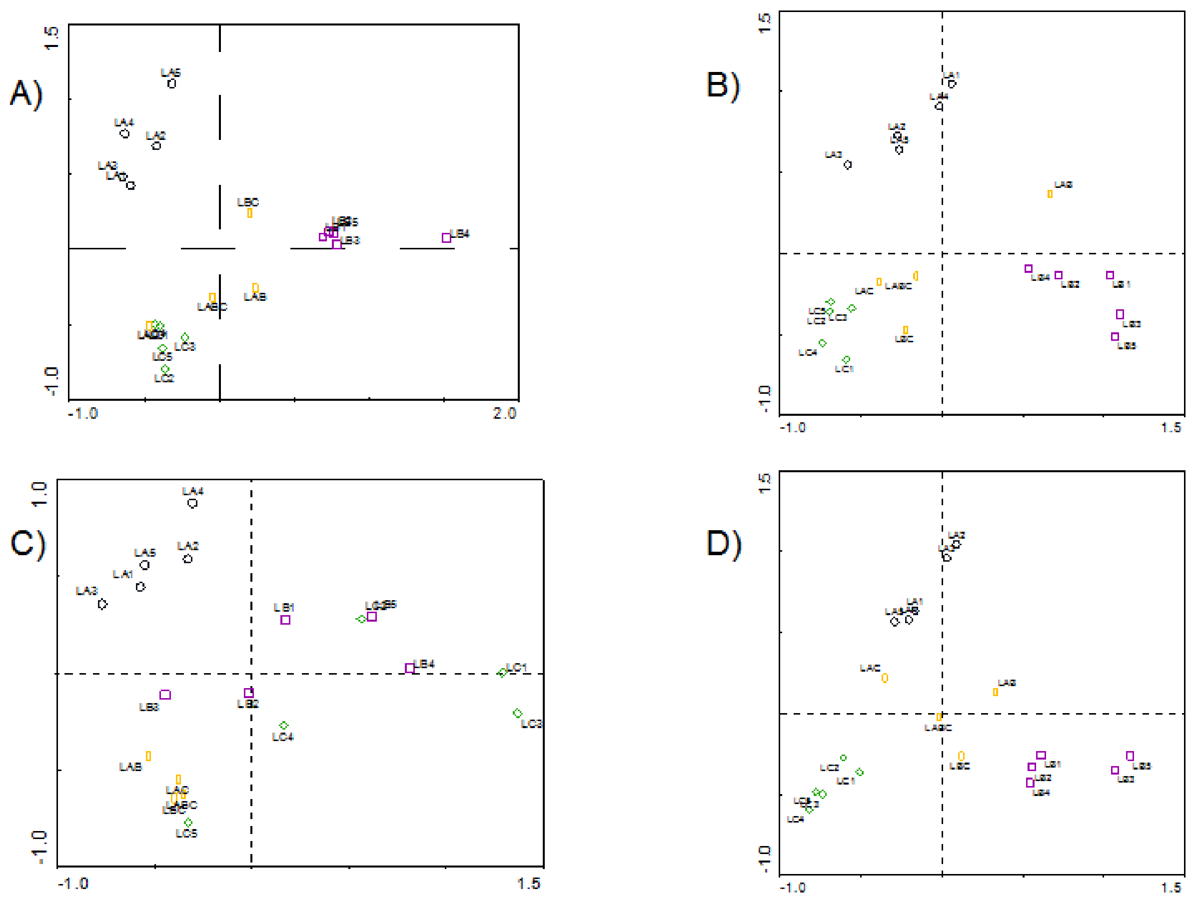


Figure 5.9: PCA biplot for single source and mixed source sample data determined by XRF for the London sample collections (A - October, B - January, C - April, D - July: (axis 1 - horizontal, axis 2 - vertical).

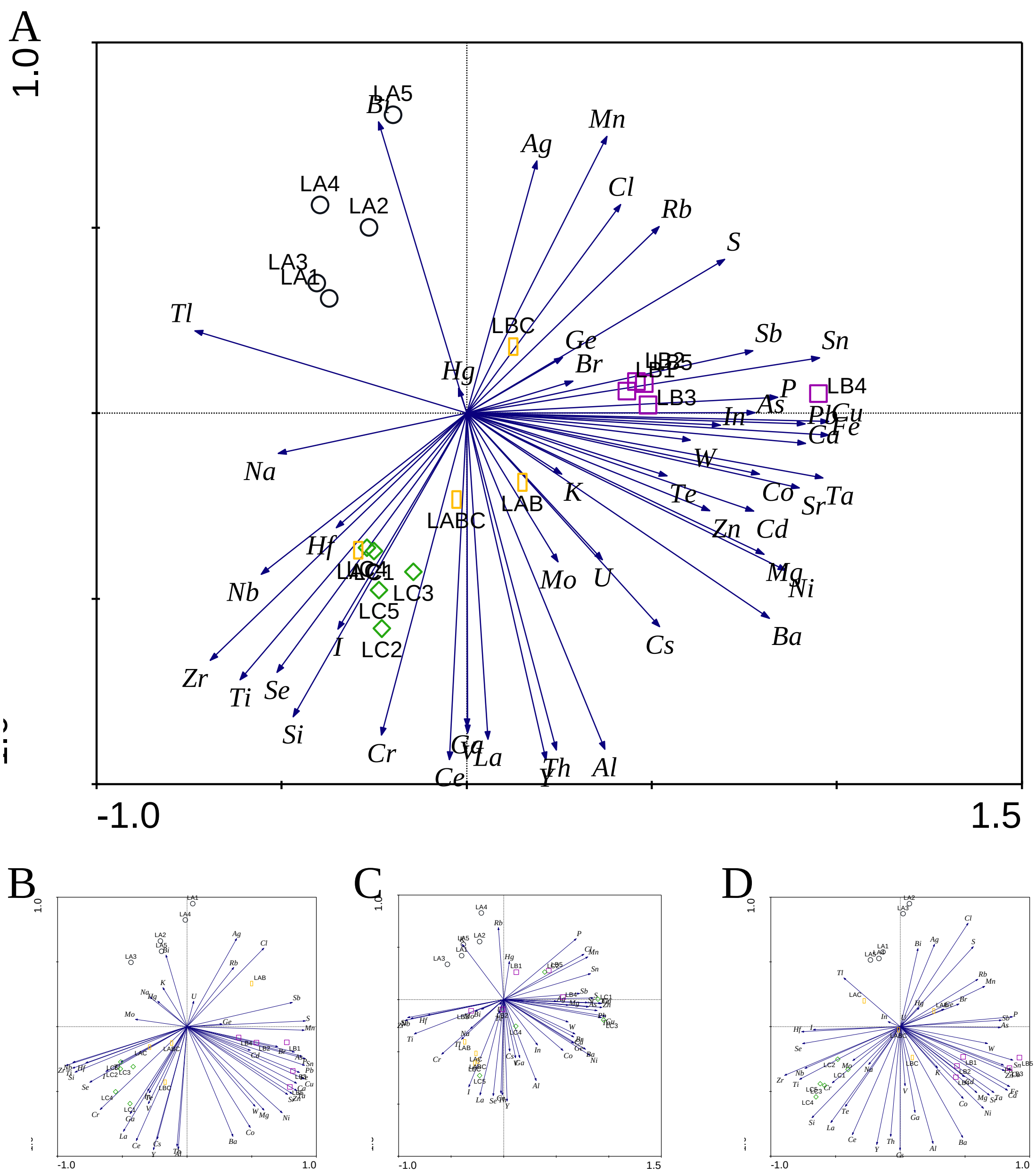


Figure 5.10: Elements responsible for variation between sites and mixtures for the XRF data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.19: PCA eigenvalues and cumulative percentage of variance for London sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.364	36.4	1.000
	2	0.270	63.4	
	3	0.129	76.3	
	4	0.054	81.7	
January	1	0.399	39.9	1.000
	2	0.268	66.7	
	3	0.085	75.2	
	4	0.063	81.5	
April	1	0.391	39.1	1.000
	2	0.211	60.2	
	3	0.120	72.1	
	4	0.050	77.1	
July	1	0.334	33.4	1.000
	2	0.253	58.8	
	3	0.163	75.1	
	4	0.057	80.8	

5.3.2.3 ICP-MS

ANOVA statistical assessment (table 5.20) identified which elements were significantly different between sites at the 95 % significance level. The majority of elements were found to have statistically significant differences between sites, with a percentage range of 57.1 to 78.6 % for the Nottingham samples and 67.9 to 100 % for the London collection.

Table 5.20: Statistically significant and non-significant elements determined through ICP-MS for both Nottingham and London sample collections

Location	Collection	Significant	Non-significant
Nottingham	October	V, Co, Sr, Y, Nb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Pb, U. (Total: 21/28, 75 %)	Cr, Cu, Zr, Mo, Cd, W, Tl (Total: 7/28, 25 %)
	January	V, Mo, Pr, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Tl, Pb, U. (Total: 16/28, 57.1 %)	Cr, Co, Cu, Sr, Y, Zr, Nb, Cd, La, Ce, Nd, W. (Total: 12/28, 42.9 %)
	April	Co, Y, Zr, Nb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U. (Total: 19/28, 67.9 %)	V, Cr, Cu, Sr, Mo, Cd, W, Tl, Pb. (Total: 9/28, 32.1 %)
	July	V, Co, Cu, Y, Nb, Mo, Cd, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Tl, Pb, U. (Total: 22/28, 78.6 %)	Cr, Sr, Zr, Yb, Lu, W. (Total: 6/28, 21.4 %)
London	October	V, Co, Cu, Sr, Y, Nb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Pb, U. (Total: 19/28, 67.9 %)	Cr, Zr, Mo, Cd, Tm, Yb, Lu, W, Tl. (Total: 9/28, 32.1 %)
	January	V, Cr, Co, Cu, Sr, Y, Zr, Nb, Mo, Cd, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb,	-

		Lu, W, Tl, Pb, U. (Total: 28/28, 100 %)	
	April	V, Cr, Co, Cu, Sr, Y, Zr, Nb, Cd, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Yb, Pb, U. (Total: 23/28, 82.1 %)	Mo, Tm, Lu, W, Tl (Total: 5/28, 17.9 %)
	July	V, Cr, Co, Cu, Sr, Y, Zr, Nb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Tl, U. (Total: 24/28, 85.7 %)	Mo, Cd, Lu, W. (Total: 4/28, 14.3 %)

For CDFA, each of the Nottingham sites were 100 % correctly classified (table 5.23), and it was possible to discriminate between these sites (table 5.22) at the 99 % significance level (p = 0.000), with function 1 elements (table 5.24) accounting for the majority of the variance observed (table 5.21). For the October collection, function 1 elements contribute 99.4 % of the variance; for the January collection, function 1 contributes 66.5 % of the variance; for the April collection, function 1 contributes 87.7 % of the variance; and for the July collection, function 1 contributes 87.9 % of the variance. This distinction between sites A to C for each collection is pronounced, as evidenced by the CDFA graphical output (figure 5.11). It should also be noted that within site variation is minimal with the exception of sites B and C (figure 5.11B).

Table 5.21: CDFA eigenvalues for the Nottingham sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	1034.239	99.4	99.4	1.000
	2	6.285	.6	100.0	.929
January	1	66.336	66.5	66.5	.993
	2	33.359	33.5	100.0	.985
April	1	481.980	87.7	87.7	.999
	2	67.679	12.3	100.0	.993
July	1	305.608	87.9	87.9	.998
	2	41.986	12.1	100.0	.988

Table 5.22: Wilks' Lambda values for the Nottingham sample collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
October	1 through 2	.000	58.034	24	.000
	2	.137	12.908	11	.299
January	1 through 2	.000	50.353	24	.001
	2	.029	22.990	11	.018

April	1 through 2	.000	67.661	24	.000
	2	.015	27.491	11	.004
July	1 through 2	.000	61.662	24	.000
	2	.023	24.446	11	.011

Table 5.23: CDFA classification results for the Nottingham sample collections

Collection	Site	Predicted Group Membership			Total
		A	B	C	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	4	4
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.24: CDFA structure matrix for the Nottingham sample collections (elements contributing most to each function in descending order)

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Pb	-.078	.063	Pb	-.369	.156	Eu	-.256	-.246	Sm	.116	.063
La	.017	-.552	W	.274	.129	Dy	-.207	-.141	Tl	.100	.053
Ce	.006	-.551	Er	.211	.031	Er	-.191	-.054	Eu	-.072	.031
Pr	-.044	-.508	Lu	.211	.118	U	-.175	.114	Yb	.070	-.052
Y	.000	-.507	Dy	.211	.030	Pb	.165	-.028	Dy	.065	.029
Nd	-.030	-.461	Gd	.203	.020	V	-.029	-.027	Pb	.072	-.568
Nb	.014	-.385	Mo	.196	-.021	Cu	.011	-.010	Pr	.075	.429
Co	-.025	-.315	Tb	.178	.124	Yb	-.256	-.492	La	.015	.345
Sr	-.037	-.301	Tm	.174	.143	Lu	-.250	-.475	Nd	-.052	.333
Ho	.000	-.267	Eu	.162	.089	Tm	-.319	-.353	Nb	.013	.309
Cr	-.002	-.210	Yb	.159	-.034	Sm	-.210	-.275	Gd	-.005	.290
Dy	-.027	-.188	U	.137	.025	Ho	-.177	-.263	U	.072	.290
Er	-.062	-.144	Tl	.135	.066	Pr	-.152	-.250	Ce	.024	.288
Gd	.007	-.137	Ho	.112	.110	Nd	-.106	-.246	Y	.046	.238
Mo	-.006	.132	Ce	.095	.071	Y	-.056	-.208	Cd	-.031	-.161
W	-.022	.131	Co	.092	.052	Nb	-.085	-.193	Cu	.048	-.159
Eu	.060	-.127	Y	.045	.013	Ce	-.046	-.182	W	.073	-.139
V	.072	-.123	V	-.142	.165	La	-.071	-.167	Mo	.047	-.124
Tb	.038	-.123	Sm	.111	.161	Zr	-.068	-.164	V	-.059	.111
U	.042	.121	Nd	.057	.131	Co	.011	-.159	Ho	.056	.097
Sm	.045	-.114	Pr	.054	.118	Gd	-.017	-.144	Er	-.081	.093
Cd	.004	.090	Cd	-.024	-.116	Tb	-.069	-.125	Co	.053	.076
Tm	.000	-.080	Cr	.029	.115	Tl	-.049	-.107	Tm	.056	-.072
Yb	-.052	-.069	Zr	-.011	.107	Sr	.010	-.094	Sr	.019	-.053
Tl	.038	.064	La	.022	.104	Cr	-.020	-.072	Zr	.010	.048
Lu	-.026	-.060	Sr	.052	.101	Mo	.009	-.064	Lu	-.024	-.046
Cu	-.012	.051	Nb	.024	.091	W	.000	-.050	Cr	.008	-.030
Zr	.011	.039	Cu	.011	-.042	Cd	-.010	-.031	Tb	-.003	.012

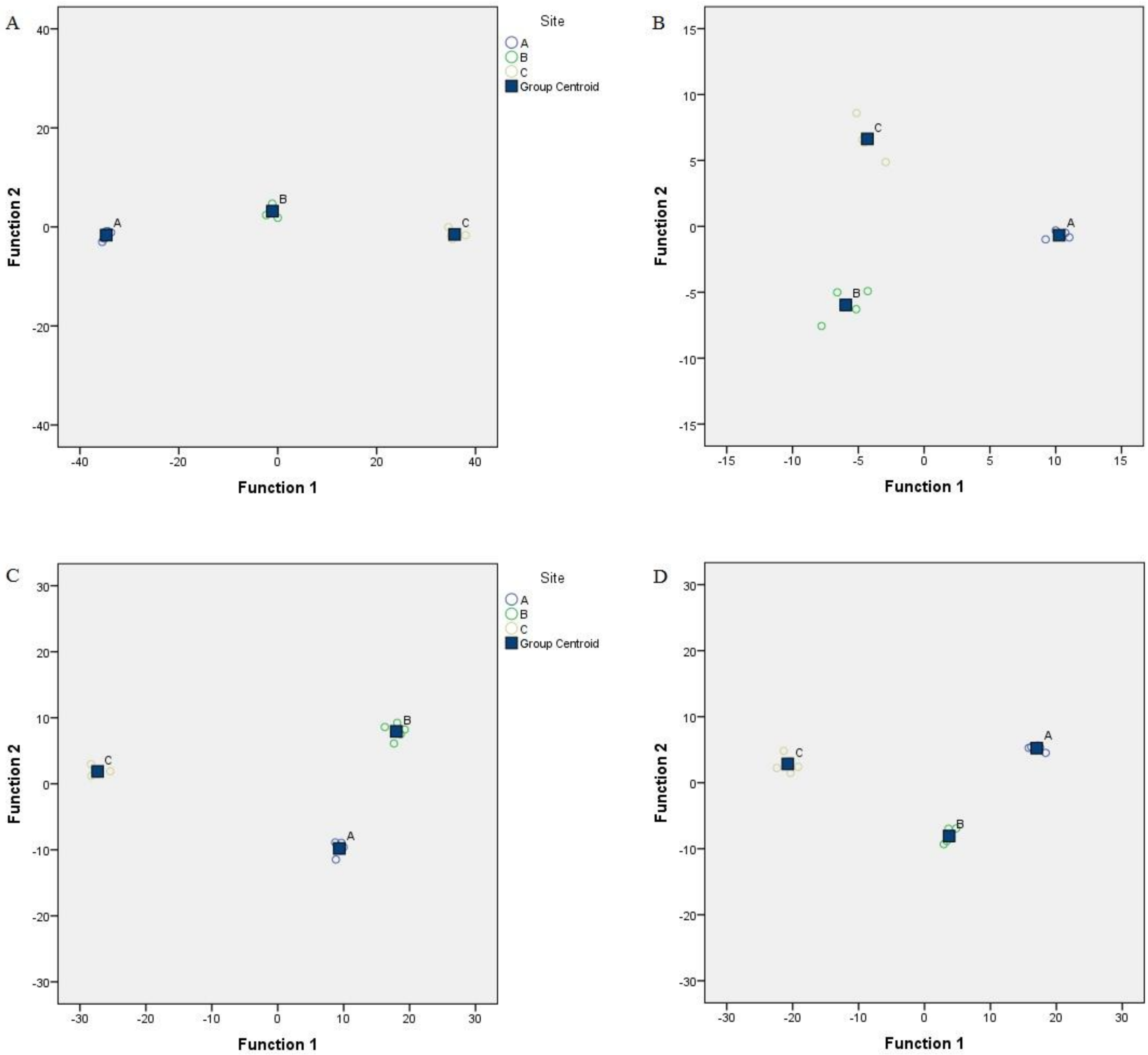


Figure 5.11: CDFA charts for the ICP-MS data for the Nottingham sample collections (A - October, B - January, C - April and D - July)

Table 5.25: CDFA eigenvalues for the London sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	745.718	82.5	82.5	.999
	2	158.369	17.5	100.0	.997
January	1	2106.593	96.4	96.4	1.000
	2	77.723	3.6	100.0	.994
April	1	278.472	62.8	62.8	.998
	2	165.112	37.2	100.0	.997
July	1	5216.419	97.6	97.6	1.000
	2	127.769	2.4	100.0	.996

Table 5.26: Wilks' Lambda values for the London sample collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
October	1 through 2	.000	75.965	24	.000
	2	.006	32.963	11	.001
January	1 through 2	.000	78.125	24	.000
	2	.013	28.379	11	.003
April	1 through 2	.000	69.846	24	.000
	2	.006	33.232	11	.000
July	1 through 2	.000	87.216	24	.000
	2	.008	31.577	11	.001

Table 5.27: CDFA classification results for the London sample collections

Collection	Site	Predicted Group Membership			Total
		A	**B**	**C**	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	4	4
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.28: CDFA structure matrix for the London sample collections (elements contributing most to each function in descending order)

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Pb	-.144	.110	Cd	.410	.098	Sr	-.186	.045	Tm	-.149	.003
Cr	-.021	.018	Pb	.199	.002	Dy	-.143	-.064	Eu	-.111	.104
Cd	-.013	-.001	Sr	.118	-.086	Co	-.121	-.047	Gd	-.081	-.028
Mo	-.011	-.009	Cu	.054	.000	V	-.096	-.042	Co	.056	-.041
Lu	.196	.331	Mo	.032	.027	Cu	-.094	.013	Tl	-.038	.031
Eu	.093	.317	Ho	.074	-.360	Zr	.092	-.089	Yb	-.036	-.009
Sr	.002	.291	W	.163	-.331	Eu	-.085	-.003	Tb	.035	.016
Gd	.120	.244	Dy	.017	-.320	Pb	-.053	-.043	V	.033	-.023
Co	-.043	.232	Tm	-.053	-.307	Cd	-.049	-.019	Er	-.088	-.195
Tm	.152	.226	Lu	.040	-.302	Tl	-.030	-.027	Ho	.003	-.180
Ho	-.052	.209	Tb	.057	-.296	Mo	-.025	.003	Y	.033	-.160
Tb	.052	.202	Y	.031	-.294	Lu	-.067	-.165	Cr	.016	-.144
Yb	.117	.191	Eu	.058	-.289	Y	-.063	-.103	Nb	-.003	-.116
Er	.116	.189	Tl	.097	-.281	Ho	.003	-.100	Lu	-.083	.108
Cu	.008	.182	Yb	.040	-.274	Gd	-.054	-.097	La	.019	-.107
Dy	.009	.175	Gd	.025	-.258	Er	-.052	-.093	Nd	.025	-.106
V	-.042	.158	Sm	.047	-.255	U	-.030	-.093	U	-.053	-.106
Sm	.045	.154	Nd	-.009	-.222	Nb	.075	-.079	Ce	.042	-.091
Y	-.079	.127	Pr	.011	-.216	Nd	-.059	-.079	Pr	.030	-.089
U	-.027	-.119	Co	.077	-.210	W	.026	-.077	Pb	-.082	.083
Nd	-.023	.110	Er	.057	-.201	Yb	-.071	-.077	Zr	-.006	-.072
Ce	-.092	.093	La	.017	-.195	Pr	-.036	-.072	Sr	.032	.059
Pr	-.057	.093	Ce	-.018	-.165	La	-.038	-.072	Dy	.029	-.057
La	-.065	.083	Cr	.018	-.161	Cr	-.012	-.066	Cu	.024	.052
Tl	.044	.070	Nb	-.017	-.133	Tm	-.045	-.066	Sm	.010	-.050
Nb	-.042	-.059	V	.031	-.119	Ce	-.045	-.062	W	.041	-.042
Zr	-.008	-.031	U	-.069	-.100	Sm	-.045	-.061	Cd	.006	-.034
W	-.011	-.016	Zr	-.012	-.089	Tb	-.023	-.061	Mo	.001	-.032

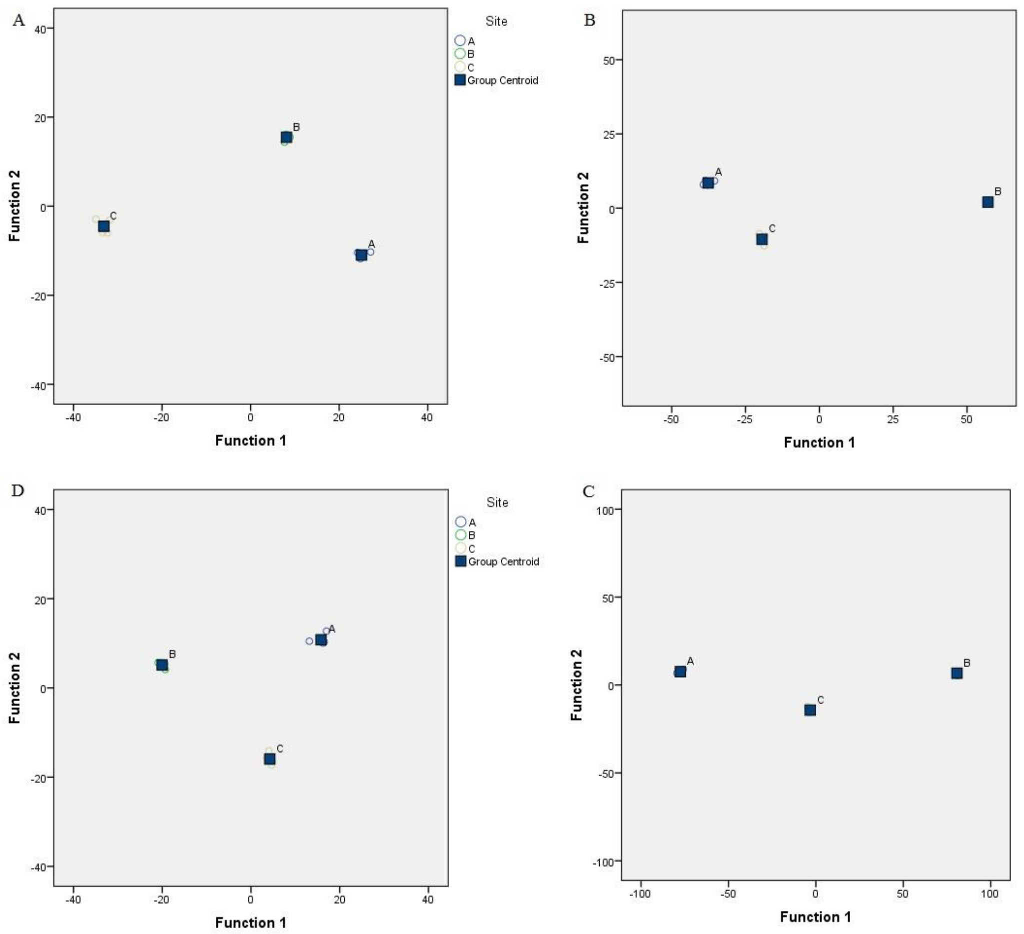


Figure 5.12: CDFA charts for the ICP-MS data for the London sample collections (A - October, B - January, C - April and D - July)

For the London sample collections, 100 % of the sites were correctly classified (Table 5.27). CDFA determined that sites were able to be distinguished, with a p-value of 0.000 for each collection at the 99 % significance level (table 5.26), and with function 1 elements (table 5.28) accounting for the majority of the variation (table 5.25). For the October collection, function 1 elements contribute 82.5 % of the variance, and function 2 contributes 17.5 %; for the January collection, function 1 elements contribute 96.4 % of the variance and function 2 contributes 3.6 %; for the April collection, function 1 elements contribute 62.8 % of the variance and function 2 contributes 37.2 %; and for the July collection, function 1 elements contribute 97.6 % of the variance and function 2 elements contribute 2.4 %. A clear distinction between sites A to C, with minimal variation within sites, can be observed in the CDFA graphical output (figure 5.12).

Table 5.29: Paired t-test statistics for elemental data obtained through ICP-MS for the Nottingham sample collections

Collection	Pair	T	Df	Sig. (2-tailed)
October	A - AB	1.394	27	.175
	A - AC	2.423	27	.022
	A - BC	.440	27	.663
	A - ABC	2.313	27	.029
	B - AB	1.598	27	.122
	B - AC	.911	27	.370
	B - BC	.853	27	.401
	B - ABC	1.158	27	.257
	C - AB	1.767	27	.089
	C - AC	3.450	27	.002
	C - BC	1.255	27	.220
	C - ABC	2.364	27	.026
January	A - AB	.896	27	.378
	A - AC	1.775	27	.087
	A - BC	-3.199	27	.004
	A - ABC	3.238	27	.003
	B - AB	.670	27	.508
	B - AC	.455	27	.660
	B - BC	-3.247	27	.003
	B - ABC	1.651	27	.110
	C - AB	.152	27	.880
	C - AC	1.273	27	.214
	C - BC	-3.222	27	.003
	C - ABC	1.689	27	.103
April	A - AB	-.047	27	.963
	A - AC	-.040	27	.969
	A - BC	3.117	27	.004
	A - ABC	.435	27	.667
	B - AB	.288	27	.775
	B - AC	-.229	27	.820
	B - BC	2.459	27	.021
	B - ABC	-.051	27	.960
	C - AB	-.959	27	.346
	C - AC	-1.743	27	.093
	C - BC	2.705	27	.012
	C - ABC	-1.117	27	.274
July	A - AB	.988	27	.332
	A - AC	1.273	27	.214
	A - BC	1.135	27	.267
	A - ABC	.600	27	.554
	B - AB	.168	27	.868
	B - AC	.677	27	.504
	B - BC	.418	27	.679
	B - ABC	-.973	27	.339
	C - AB	-1.728	27	.095
	C - AC	-2.100	27	.045
	C - BC	-2.018	27	.054
	C - ABC	-1.977	27	.058

*statistically significant values highlighted

Table 5.30: Paired t-test statistics for elemental data obtained through ICP-MS for the London sample collections

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	-.019	27	.985
	A - AC	.284	27	.779
	A - BC	.182	27	.857
	A - ABC	-.645	27	.525
	B - AB	.143	27	.887
	B - AC	.474	27	.639
	B - BC	1.031	27	.312
	B - ABC	-.481	27	.635
	C - AB	-.486	27	.631
	C - AC	2.623	27	.014
	C - BC	.082	27	.936
	C - ABC	-1.481	27	.150
January	A - AB	-1.811	27	.081
	A - AC	-3.402	27	.002
	A - BC	-2.760	27	.010
	A - ABC	-3.078	27	.005
	B - AB	1.727	27	.096
	B - AC	1.512	27	.142
	B - BC	.147	27	.884
	B - ABC	1.310	27	.201
	C - AB	.386	27	.703
	C - AC	3.206	27	.003
	C - BC	-1.233	27	.228
	C - ABC	-.137	27	.892
April	A - AB	-1.704	27	.100
	A - AC	-1.953	27	.061
	A - BC	-1.926	27	.065
	A - ABC	-1.798	27	.083
	B - AB	-.816	27	.421
	B - AC	.063	27	.950
	B - BC	.253	27	.802
	B - ABC	.667	27	.510
	C - AB	-.252	27	.803
	C - AC	2.367	27	.025
	C - BC	.972	27	.340
	C - ABC	1.328	27	.195
July	A - AB	-.280	27	.782
	A - AC	-.119	27	.906
	A - BC	-1.139	27	.179
	A - ABC	-.983	27	.334
	B - AB	1.647	27	.111
	B - AC	-1.389	27	.298
	B - BC	.073	27	.943
	B - ABC	.857	27	.399
	C - AB	.018	27	.986
	C - AC	.646	27	.524
	C - BC	-1.465	27	.155
	C - ABC	-.362	27	.721

*statistically significant values highlighted

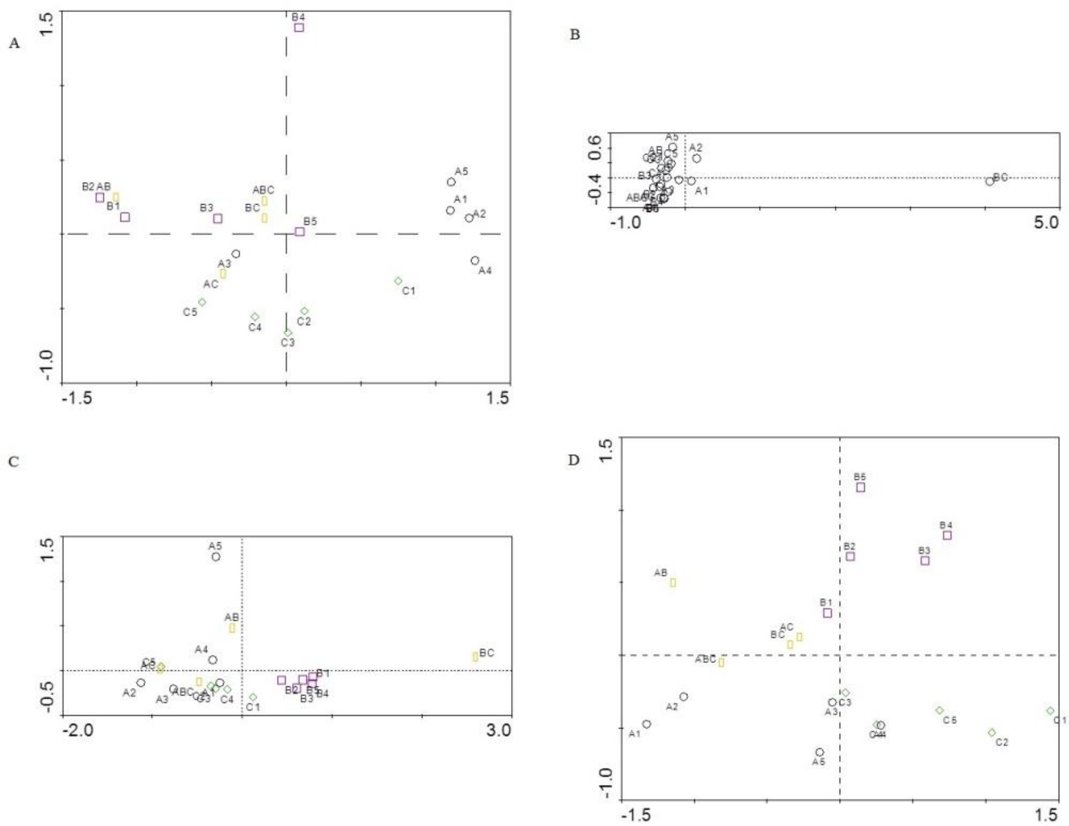


Figure 5.13: PCA biplot for single source and mixed source sample data determined by ICP-MS for the Nottingham sample collections (A - October, B - January, C - April and D - July: (axis 1 - horizontal, axis 2 - vertical).

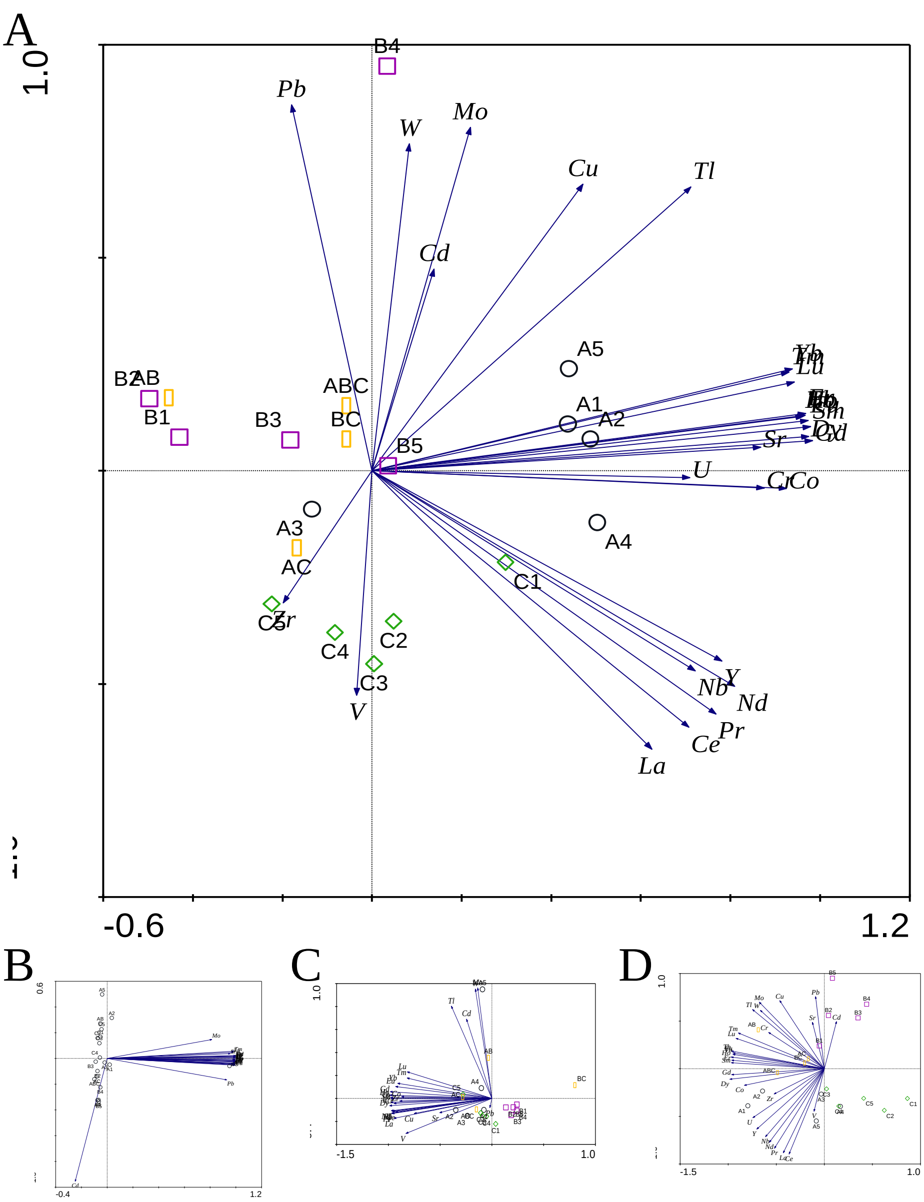


Figure 5.14: Elements responsible for the variation between sites and mixtures for the ICP-MS data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.31: PCA eigenvalues and cumulative percentage of variance for the Nottingham sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.582	58.2	1.000
	2	0.197	77.8	
	3	0.100	87.8	
	4	0.037	91.6	
January	1	0.936	93.6	1.000
	2	0.035	97.1	
	3	0.020	99.1	
	4	0.005	99.5	
April	1	0.695	69.5	1.000
	2	0.119	81.4	
	3	0.072	88.6	
	4	0.034	92.1	
July	1	0.516	51.6	1.000
	2	0.275	79.1	
	3	0.058	84.8	
	4	0.052	90.1	

In the majority of cases, paired t-tests (tables 5.29 and 5.30) revealed no significant difference between the mixed-source and single-source control samples at the 95 % significance level. Exceptions include October pairs A-AC ($p = 0.022$), A-ABC ($p = 0.029$), C-AC ($p = 0.002$) and C-ABC ($p = 0.026$); January pairs A-BC ($p = 0.004$), A-ABC, B-BC and C-BC ($p = 0.003$); April pairs A-BC ($p = 0.004$), B-BC ($p = 0.021$) and C-BC ($p = 0.012$); and July pair C-AC ($p = 0.045$), for the Nottingham collection. For the London collection, exceptions include October pair C-AC ($p = 0.014$); January pairs A-AC ($p = 0.002$), A - BC ($p = 0.010$), A-ABC ($p = 0.005$) and C-AC ($p = 0.003$); and April pair C-AC ($p = 0.025$). Though this is seemingly a high number of exceptions, when related back to the entire number of pairs tested more were still found to be statistically non-significant (25 % significant and 75 % non-significant for Nottingham and 12.5 % significant and 87.5 % non-sifnificant for London).

PCA of the data (tables 5.31 and 5.32), is in agreement with the findings derived from the paired t-tests. Data points for each of the control sites are seen to cluster together (figures 5.13 and 5.15), and the mixtures' data points are between the control site clusters. The only exception to this is the January collection in Nottingham, where no clear distinction can be made between sites (figure 5.13B). For the London sample collection, the clustering of the control sites is clearer than for the Nottingham sites. However, once again, it can be observed that mixtures appear to be associating more with one of the control sites that they are composed of than the other. For instance, mixture AC associates with site A more than site C in the April collection (figure 5.15C) but with site C more in the October and January collections (figure 5.15A and 5.15B).

The elements responsible for the variation between the control sites and mixtures are observed in figures 5.14 (Nottingham) and 5.16 (London). For the October collection in Nottingham (figure 5.14A) it can be seen that the most significant elements for site A are the rare earth elements and Co; for site B the most significant element is Pb; and for site C the most significant elements are V and Zr, however due to the error rate associated with V (section 5.3.2, table 5.6) its use in application to site discrimination should be approached with caution. For the October collection in London (figure 5.16A), there are no distinctive elements for site A to distinguish it from the other sites; for site B, the most significant elements are Cu, Pb, Sr, Tm, Lu, Eu and Yb; and for site C, the most significant element is Nb, followed by Zr, W and Mo.

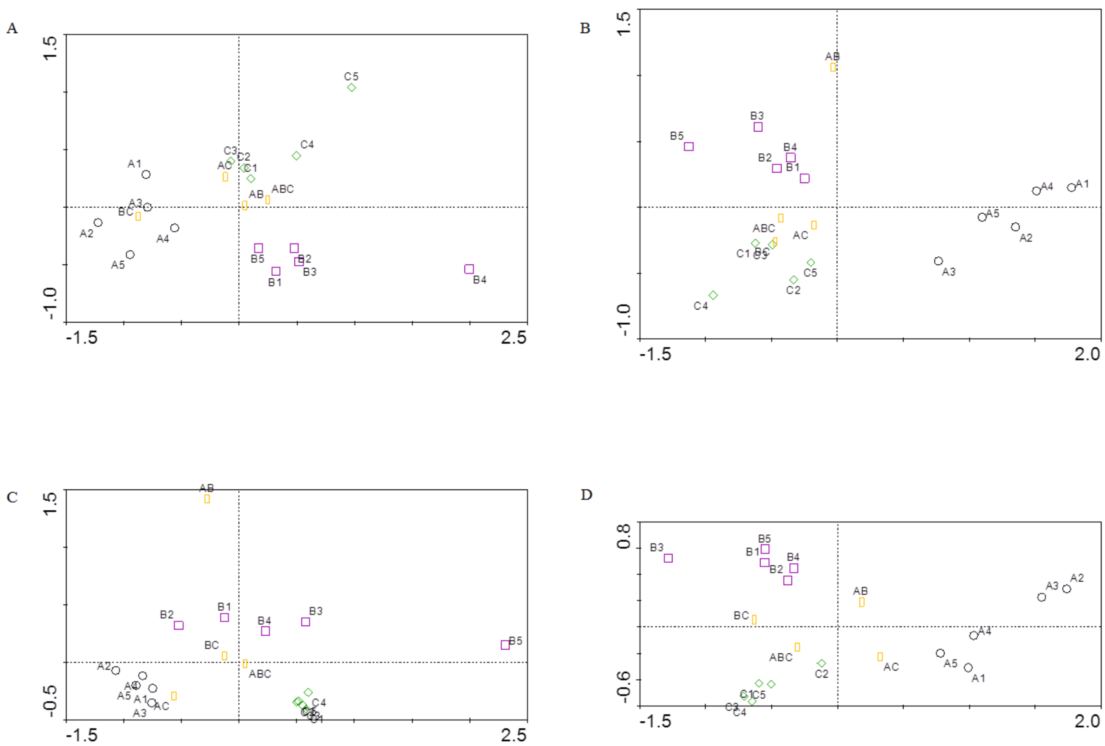


Figure 5.15: PCA biplot for single source and mixed source sample data determined by ICP-MS for the London sample collections (A - October, B - January, C - April and D - July: (axis 1 - horizontal, axis 2 - vertical).

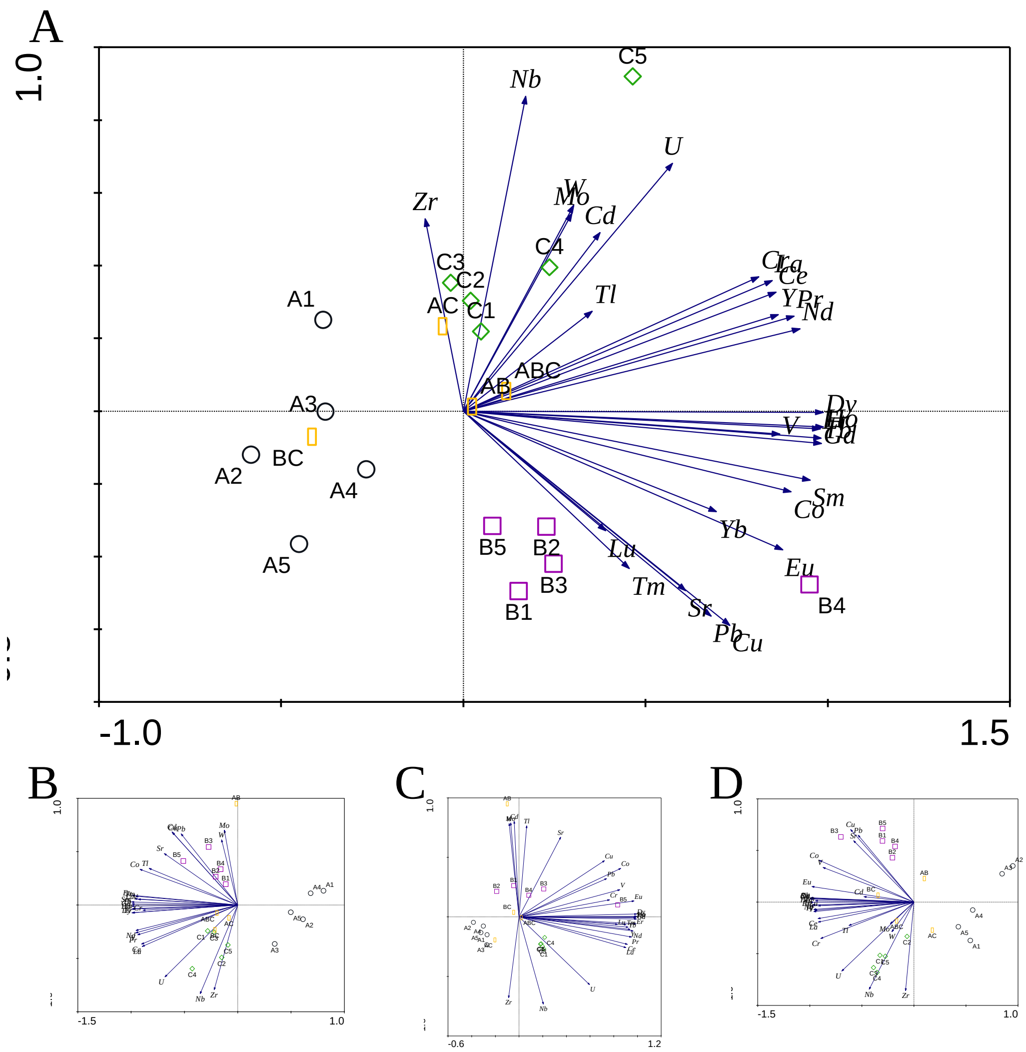


Figure 5.16: Elements responsible for the variation between sites and mixtures for the ICP-MS data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.32: PCA eigenvalues and cumulative percentage of variance for the London sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.559	55.9	1.000
	2	0.161	72.0	
	3	0.154	87.4	
	4	0.070	94.5	
January	1	0.693	69.3	1.000
	2	0.179	87.2	
	3	0.075	94.6	
	4	0.017	96.3	
April	1	0.615	61.5	1.000
	2	0.179	79.4	
	3	0.135	92.9	
	4	0.039	96.8	
July	1	0.670	67.0	1.000
	2	0.138	80.8	
	3	0.120	92.8	
	4	0.030	95.9	

5.3.3.4 ICP-AES

ANOVA statistical analysis (table 5.33) revealed that the majority of the elements tested were found to be significantly different between sites at the 95 % significance level, with the January collection at the Nottingham site being the lowest at 8 out of the 12 elements tested revealed as significantly different.

Table 5.33: Statistically significant and non-significant elements determined through ICP-AES for both Nottingham and London sample collections

Location	Collection	Significant	Non-significant
Nottingham	October	Al, Be, Ca, Fe, K, Mg, Ni, P, Ti. (9/12, 75%)	Mn (p = 0.111), Na (p = 0.195) and Zn (p = 0.613) (3/12, 25%)
	January	Al, Be, Fe, K, Mn, Ni, P, Ti. (8/12, 66.7%)	Ca (p = 0.207), Mg (p = 0.113), Na (p = 0.532) and Zn (p = 0.053) (4/12, 33.3%)
	April	Al, Be, Ca, Fe, K, Mg, Mn, Na, Ni, P, Ti and Zn. (12/12, 100%)	- (0/12, 0%)
	July	Al, Be, Ca, Fe, K, Mg, Mn, Na, Ni, P, Ti and Zn. (12/12, 100%)	- (0/12, 0%)
London	October	Al, Be, Ca, Fe, K, Mg, Mn, Na, Ni, P, Ti and Zn. (12/12, 100%)	- (0/12, 0%)
	January	Al, Be, Ca, Fe, Mg, Mn, Ni, P, Ti and Zn. (10/12, 83.3%)	K (p = 0.738) and Na (p = 0.144) (2/12, 16.7%)
	April	Al, Be, Ca, Fe, Mg, Mn, Ni, P, Ti and Zn. (10/12, 83.3%)	K (p = 0.583) and Na (p = 0.125) (2/12, 16.7%)
	July	Al, Be, Fe, K, Mg, Mn, Na, Ni, P, Ti and Zn. (11/12, 91.7%)	Ca (p = 0.082) (1/12, 8.3%)

For CDFA, the Nottingham sample sites were 100 % correctly classified (table 5.36), and able to be discriminated with a p-value of 0.000 for each collection at the 99 % significance level (table 5.35). Function 1 elements (table 5.37) account for the majority of the percentage variance observed (table 5.34). For the October collection, function 1 elements contribute 89.3 % of the variance, and function 2 elements 10.7 %; for the January collection, function 1 elements contribute 98.5 % of the variance, and function 2 1.5 %; for the April collection, function 1 elements contribute 97.9 % of the variance, and function 2 2.1%; and for the July collection, function 1 elements contribute 95.4 % of the variance, and function 2 4.6 %. Figure 5.20 illustrates the graphical output from the CDFA, in which each of the Nottingham sites are distinguishable from one another and within site variation is minimal.

Table 5.34: CDFA eigenvalues for the Nottingham sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	349.854	89.3	89.3	.999
	2	41.856	10.7	100.0	.988
January	1	3707.305	98.5	98.5	1.000
	2	54.861	1.5	100.0	.991
April	1	415.512	97.9	97.9	.999
	2	9.1916	2.1	100.0	.950
July	1	1428.624	95.4	95.4	1.000
	2	68.744	4.6	100.0	.993

Table 5.35: Wilks' Lambda values for the Nottingham sample collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
October	1 through 2	.000	67.328	22	.000
	2	.023	26.305	10	.003
January	1 through 2	.000	85.688	18	.000
	2	.018	28.160	8	.000
April	1 through 2	.000	54.363	24	.000
	2	.098	15.093	11	.178
July	1 through 2	.000	74.815	24	.000
	2	.014	27.591	11	.004

Table 5.36: CDFA classification results for the Nottingham sample collections

Collection	Site	Predicted Group Membership			Total
		A	B	C	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	4	4
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.37: CDFA structure matrix for the Nottingham sample collections (elements contributing most to each function in descending order)

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Zn	-.287	-.216	Ni	.289	.088	P	-.127	.043	K	-.064	-.055
Ca	-.063	.024	P	-.154	.149	Mg	.125	.094	Zn	.032	.283
Mg	-.030	.378	Fe	.062	-.040	Fe	.074	-.008	P	.045	.247
Fe	.119	.185	Be	.027	.017	Mn	.012	.330	Ca	-.007	.168
P	-.049	-.176	Mn	-.002	-.146	Na	.034	.329	Fe	-.039	-.148
Al	.099	.155	K	.027	-.118	Ca	-.034	.318	Mg	-.072	-.111
Ni	-.016	.135	Ti	-.004	-.110	Ti	.092	.276	Be	-.025	-.099
K	.082	.116	Al	.040	-.092	K	.112	.247	Ti	-.064	-.092
Ti	.085	.100	Ca	-.002	-.066	Zn	-.038	.189	Ni	-.034	-.091
Mn	.008	.100	Mg	-.016	-.060	Al	.085	.152	Al	-.055	-.086
Na	.018	.070	Zn	-.011	-.041	Be	.039	.098	Mn	-.026	.068
Be	.045	.054	Na	-.009	-.032	Ni	.039	.072	Na	-.053	-.057

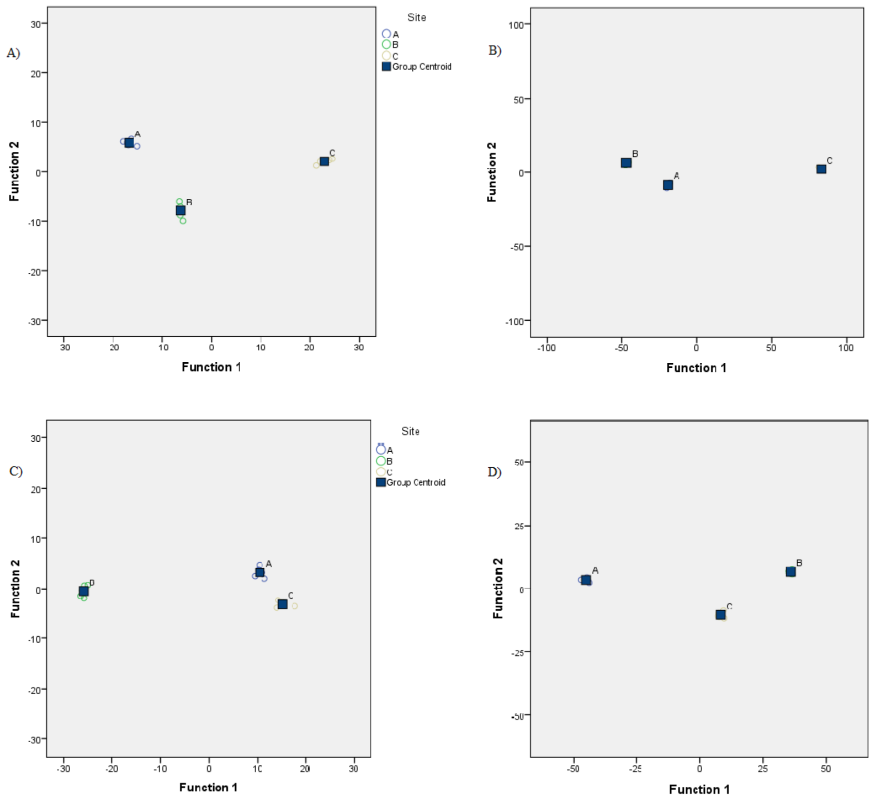


Figure 5.17: CDFA charts for the ICP-AES data for the Nottingham sample collections (A - October, B, January, C - April and D - July)

Table 5.38: CDFA eigenvalues for the London sample collections

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	1462.330	85.5	85.5	1.000
	2	248.890	14.5	100.0	.998
January	1	9428.245	88.5	88.5	1.000
	2	121.331	11.5	100.0	1.000
April	1	1146.039	92.9	92.9	1.000
	2	87.238	7.1	100.0	.994
July	1	829.791	82.5	82.5	.999
	2	176.267	17.5	100.0	.997

Table 5.39: Wilks' Lambda values for the London sample collections

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
October	1 through 2	.000	83.262	24	.000
	2	.004	35.887	11	.000
January	1 through 2	.000	113.809	22	.000
	2	.001	49.748	10	.000
April	1 through 2	.000	80.675	22	.000
	2	.011	31.360	10	.001
July	1 through 2	.000	89.250	20	.000
	2	.006	38.832	9	.000

Table 5.40: CDFA classification results for the London sample collections

Collection	Site	Predicted Group Membership			Total
		A	B	C	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
January	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
April	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100
July	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 5.41: CDFA structure matrix for the London sample collections (elements contributing most to each function in descending order)

E	October Functions		E	January Functions		E	April Functions		E	July Functions	
	1	2		1	2		1	2		1	2
Ti	-.055	-.001	P	.487	.304	Fe	.092	-.057	Fe	.167	.005
Mn	.025	-.018	Ca	.163	-.030	Ni	.073	.030	Ni	.066	.031
Al	-.034	.227	Fe	.030	-.001	Mg	.042	-.010	Mg	.062	.008
Mg	.035	.204	Ni	.025	-.008	Ca	.037	-.014	P	.057	-.030
Fe	.045	.167	Mn	.020	.010	Na	.019	-.012	K	.034	.017
Ni	.014	.131	Zn	.018	-.013	Ti	-.051	.123	Na	.032	.003
Be	-.015	.106	Al	.010	-.059	Be	.050	.097	Ca	.025	.003
P	.047	.093	Be	.026	-.054	P	.066	-.090	Ti	-.062	.124
Zn	.018	.066	Mg	.028	-.031	Al	.043	.088	Zn	-.099	.106
Ca	.018	.061	Ti	-.012	-.025	Mn	.034	-.084	Al	.070	.096
K	.001	.054	Na	.005	-.012	Zn	-.037	.054	Be	.057	.085
Na	.004	.052	K	.000	-.007	K	.006	-.025	Mn	.025	-.059

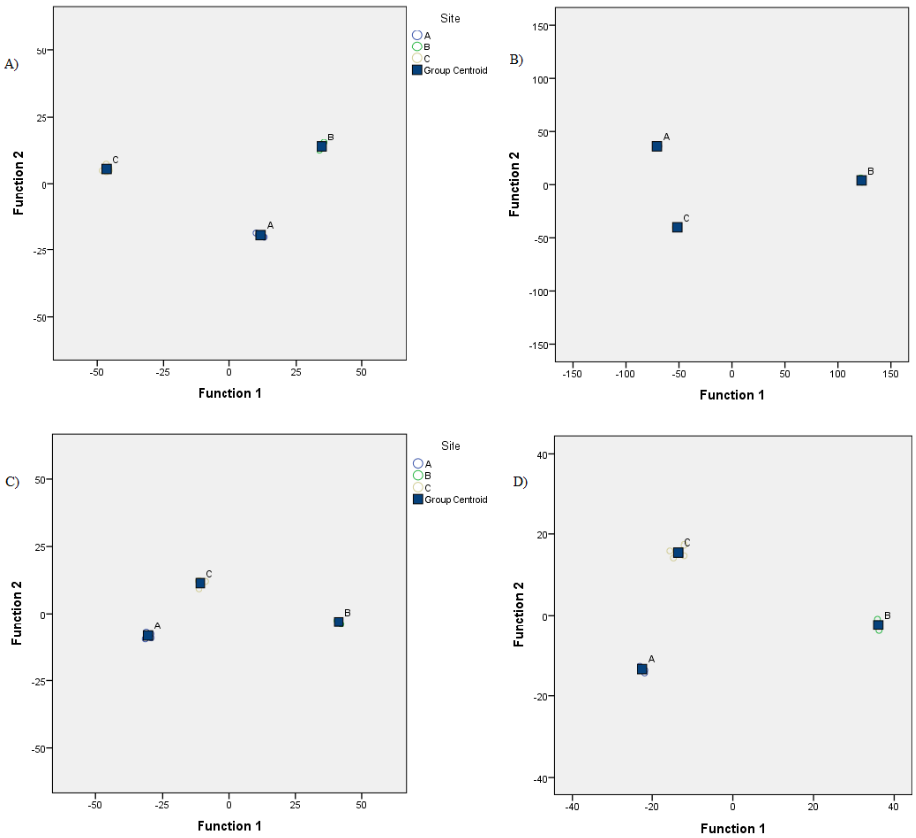


Figure 5.18: CDFA charts for the ICP-AES data for the London sample collections (A - October, B - January, C - April and D - July)

For the London collections, 100 % of the sites were correctly classified (table 5.40), and a significant difference was identified between each of the sites with p-values of 0.000 for each collection at the 99 % significance level (table 5.39). Function 1 elements (table 5.41) accounted for the majority of the variance observed (table 5.38). For the October collection, function 1 elements contribute 85.5 % of the variance, and function 2 contributed14.5 %; for the January, collection function 1 elements contribute 88.5 % of the variance and function 2 contributed 11.5 %; for the April collection, function 1 elements contribute 92.9 % of the variance, and function 2 contributed 7.1 %; and for the July collection, function 1 elements contribute 82.5 % of the variance, and function 2 elements contribute 17.5 %. This site distinction is further clarified with the graphical output generated from CDFA (figure 5.18), where minimal variation is observed within sites.

Table 5.42: Paired t-test statistics for elemental data obtained through ICP-AES for the Nottingham sample collections

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	2.292	11	.043
	A - AC	-.198	11	.847
	A - BC	.758	11	.464
	A - ABC	1.618	11	.134
	B - AB	.871	11	.402
	B - AC	-1.382	11	.194
	B - BC	-.953	11	.361
	B - ABC	-1.239	11	.241
	C - AB	1.228	11	.245
	C - AC	.649	11	.530
	C - BC	1.285	11	.225
	C - ABC	1.087	11	.300
January	A - AB	1.623	11	.133
	A - AC	-1.294	11	.222
	A - BC	-1.262	11	.233
	A - ABC	-.640	11	.535
	B - AB	-2.349	11	.039
	B - AC	-2.068	11	.063
	B - BC	-2.151	11	.055
	B - ABC	-2.120	11	.058
	C - AB	1.754	11	.107
	C - AC	1.523	11	.156
	C - BC	1.547	11	.150
	C - ABC	1.859	11	.090
April	A - AB	2.390	11	.036
	A - AC	2.451	11	.032
	A - BC	2.620	11	.024
	A - ABC	2.563	11	.026
	B - AB	-.401	11	.696
	B - AC	-.331	11	.747
	B - BC	-.762	11	.462
	B - ABC	-.736	11	.477
	C - AB	.909	11	.383
	C - AC	1.661	11	.125
	C - BC	.837	11	.420
	C - ABC	.912	11	.381
July	A - AB	2.501	11	.029
	A - AC	2.537	11	.028
	A - BC	2.578	11	.026
	A - ABC	2.545	11	.027
	B - AB	.015	11	.989
	B - AC	-.060	11	.954
	B - BC	.346	11	.736
	B - ABC	-.109	11	.915
	C - AB	.956	11	.405
	C - AC	1.410	11	.186
	C - BC	1.326	11	.212
	C - ABC	.960	11	.358

*statistically significant values highlighted

Table 5.43: Paired t-test statistics for elemental data obtained through ICP-AES for the London sample collections

Collection	Pair	t	Df	Sig. (2-tailed)
October	A - AB	-2.059	11	.064
	A - AC	-1.542	11	.151
	A - BC	-2.045	11	.066
	A - ABC	-2.076	11	.062
	B - AB	1.099	11	.295
	B - AC	1.562	11	.147
	B - BC	1.745	11	.109
	B - ABC	1.322	11	.213
	C - AB	-1.449	11	.175
	C - AC	2.002	11	.071
	C - BC	-.744	11	.473
	C - ABC	-1.269	11	.231
January	A - AB	-1.701	11	.117
	A - AC	-1.484	11	.166
	A - BC	-1.887	11	.086
	A - ABC	-1.836	11	.094
	B - AB	1.811	11	.097
	B - AC	1.571	11	.145
	B - BC	1.297	11	.221
	B - ABC	1.525	11	.156
	C - AB	-.111	11	.913
	C - AC	1.796	11	.100
	C - BC	-.757	11	.465
	C - ABC	.524	11	.610
April	A - AB	-2.172	11	.053
	A - AC	-1.459	11	.173
	A - BC	-2.009	11	.070
	A - ABC	-2.013	11	.069
	B - AB	1.385	11	.193
	B - AC	1.786	11	.120
	B - BC	.925	11	.375
	B - ABC	1.479	11	.167
	C - AB	-2.026	11	.068
	C - AC	1.393	11	.191
	C - BC	-2.184	11	.051
	C - ABC	-2.101	11	.059
July	A - AB	-2.261	11	.045
	A - AC	-1.772	11	.104
	A - BC	-2.189	11	.051
	A - ABC	-2.199	11	.050
	B - AB	1.897	11	.084
	B - AC	2.013	11	.069
	B - BC	1.406	11	.187
	B - ABC	1.930	11	.080
	C - AB	-1.657	11	.126
	C - AC	1.454	11	.174
	C - BC	-2.087	11	.061
	C - ABC	-1.353	11	.203

*statistically significant values highlighted

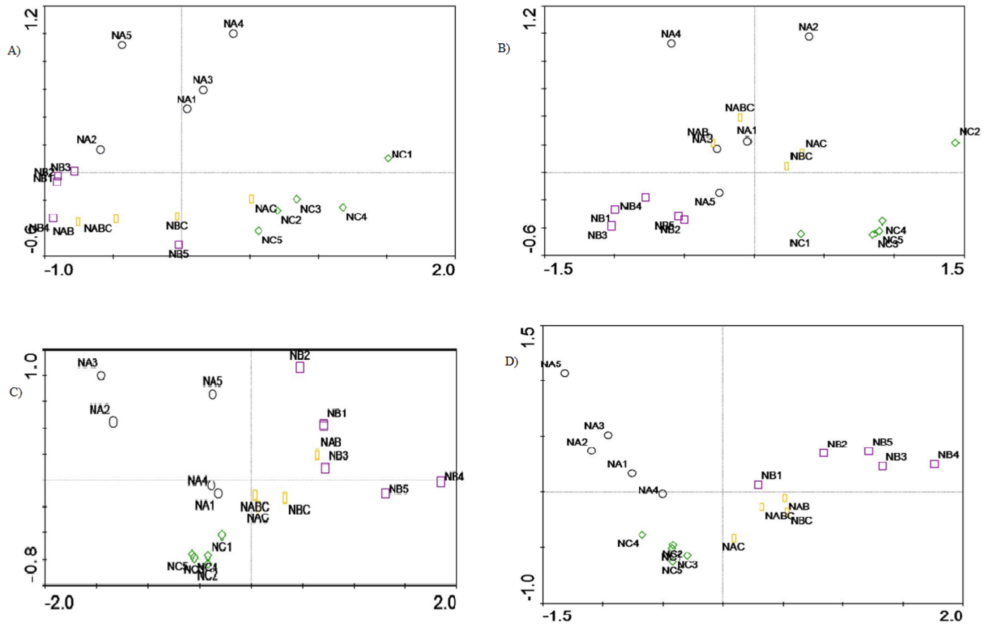


Figure 5.19: PCA biplot for single source and mixed source sample data determined by ICP-AES for the Nottingham sample collections (A - October, B - January, C - April, D - July: (axis 1 - horizontal, axis 2 - vertical).

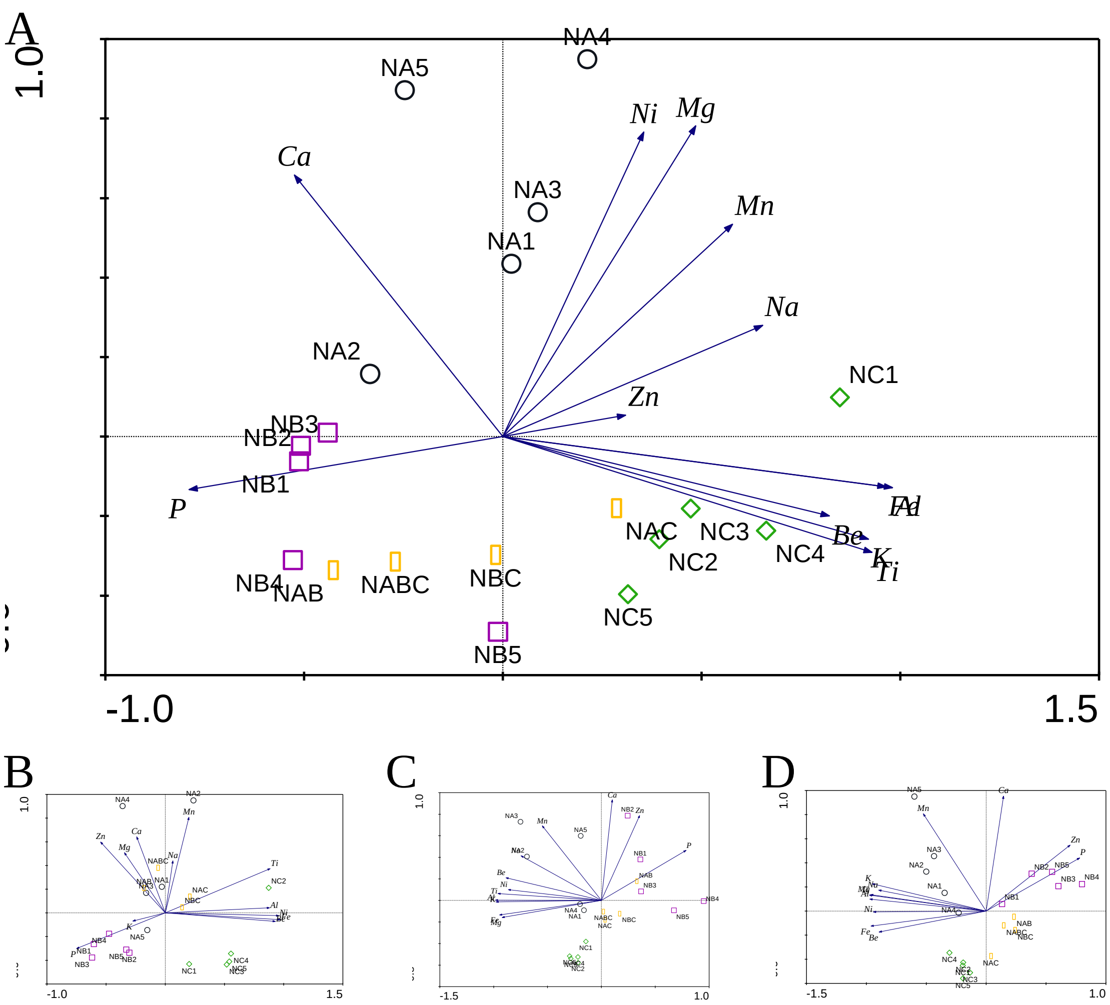


Figure 5.20: Elements responsible for variation between sites and mixtures for the ICP-AES data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.44: PCA eigenvalues and cumulative percentage of variance for the Nottingham sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.533	53.3	1.000
	2	0.187	71.9	
	3	0.130	82.2	
	4	0.066	88.9	
January	1	0.454	45.4	1.000
	2	0.177	63.1	
	3	0.159	79.0	
	4	0.087	87.7	
April	1	0.644	64.4	1.000
	2	0.205	84.9	
	3	0.045	89.4	
	4	0.037	93.2	
July	1	0.712	71.2	1.000
	2	0.186	89.8	
	3	0.046	94.4	
	4	0.021	96.5	

In the majority of the cases, paired t-tests (table 5.42 and 5.43) revealed no significant difference between the mixed source samples and the single source control sites at the 95 % significance level, including those sites that are not responsible for the mixtures where p-values range from 0.063 to 0.954 for Nottingham and 0.051 to 0.913 for London. Exceptions include October pair A-AB ($p = 0.043$), January pair B-AB ($p = 0.039$), April pairs A-AB ($p = 0.036$), A-AC ($p = 0.032$), A-BC ($p = 0.024$), and A-ABC ($p = 0.026$); and July pairs A-AB ($p = 0.029$), A-AC ($p = 0.028$), A-BC ($p = 0.026$), and A-ABC ($p = 0.027$) for the Nottingham collection; and July pair A-AB ($p = 0.045$) for the London collection.

From PCA (tables 5.44 and 5.45) it is generally observed that, control site data points cluster together and the mixture data points are between the control site clusters (figures 5.19 and 5.21). However, for the London sample collection, control sites A and C cluster close to one another for the April and July collection (figure 5.21C and 5.21D). While data points for the artificial mixtures located between the control sites have a tendency to associate with one site more than another out of the control sites from which they have been composed. For instance, in figure 5.19A, mixtures AB and ABC appear to associate more with control site B than A or C.

For the October collection in Nottingham (figure 5.20A), the most significant elements identified for site A are Ca, Ni and Mg; for site B the most significant element is P; and for site C the most significant elements are Ti, K, Be and Fe. For the October collection in London (figure 5.22A), the most significant element for site A is Mn; for site B, the most significant elements are P, Zn, Ca and Fe; and for site C, the most significant element is Ti.

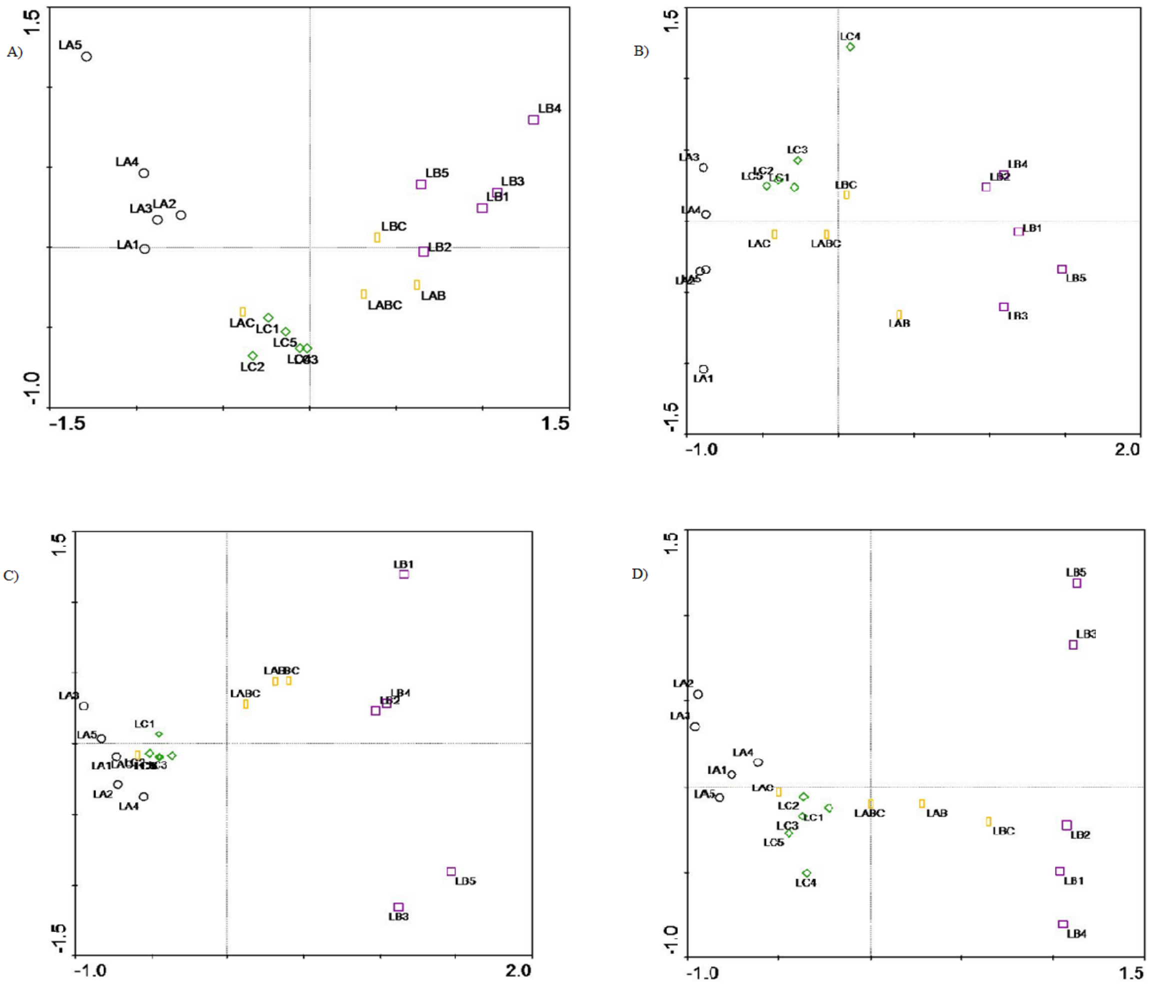


Figure 5.21: PCA biplot for single source and mixed source sample data determined by ICP-AES for the London sample collections (A - October, B - January, C - April, D - July: axis 1 - horizontal, axis 2 - vertical).

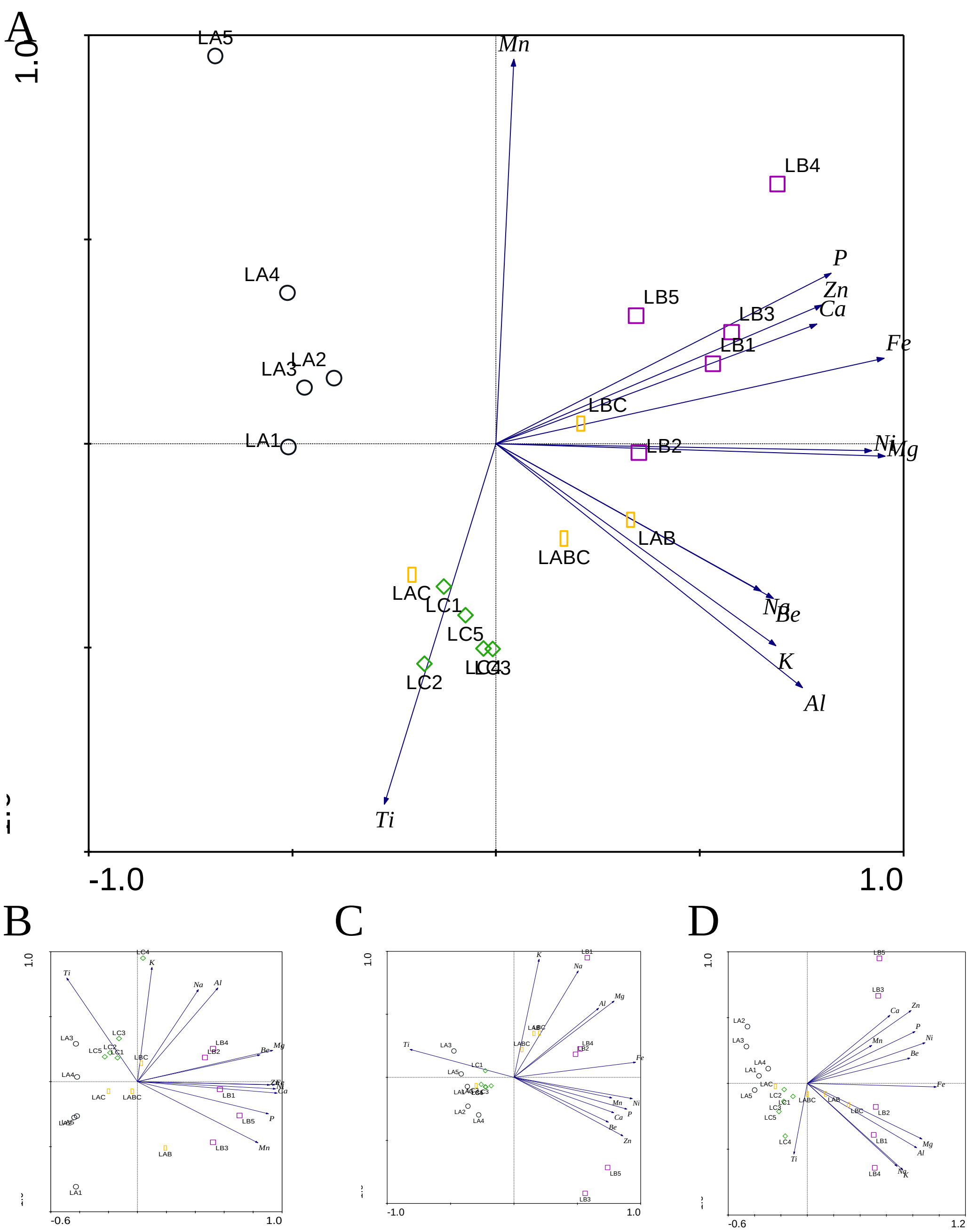


Figure 5.22: Elements responsible for variation between sites and mixtures for the ICP-AES data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA (axis 1 - horizontal, axis 2 - vertical).

Table 5.45: PCA eigenvalues and cumulative percentage of variance for London

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.551	55.1	1.000
	2	0.247	79.8	
	3	0.126	92.3	
	4	0.034	95.7	
January	1	0.620	62.0	1.000
	2	0.236	85.6	
	3	0.079	93.4	
	4	0.032	96.7	
April	1	0.595	59.5	1.000
	2	0.239	83.4	
	3	0.100	93.4	
	4	0.030	96.4	
July	1	0.560	56.0	1.000
	2	0.207	76.7	
	3	0.137	90.5	
	4	0.042	94.6	

5.3.4 Synopsis

Table 5.46 summarises the main findings of the organic and elemental techniques used to assess variation within and between sites, temporal variation over the annual collection period, and the comparison of the artificial mixtures to the corresponding control sites. XRF and LOI results are in agreement for the spatial assessment and the comparison of the mixtures and control samples. Temporal variation was observed in the LOI data which is to be expected due to the seasonal changes in plant matter.

Table 5.46: Variance identified between samples and collections by organic and elemental analysis

Method	Spatial (Within Site)	Spatial (Between Site)	Temporal	Single vs. Mixed Source
LOI	Non-significant	Significant	Significant	Non-significant
XRF	Non-significant	Significant	Non-significant	Non-significant
ICP-MS	Non-significant	Significant	Non-significant	Non-significant
ICP-AES	Non-significant	Significant	Non-significant	Non-significant

5.4 Discussion

5.4.1 Organic Analysis

The percentage organic content remains fairly consistent for each of the Nottingham sites with percentages between 8.0 to 21.3 % over the four collections, which is to be expected given that each of the sites were composed of very similar plant matter. Site B appears marginally higher for the April and July collections, in comparison to sites A and C, with percentage ranges of 15.8 to 21.3 % and 13.9 to 17.7 % respectively. ANOVA assessment of the data indicated that there were a significant differences for the January, April ($p = 0.000$) and July ($p = 0.001$) collections, but not for October ($p = 0.253$).

For the London sample collection the organic matter percentage is slightly more dispersed, with ranges from 6.5 to 40.4 %. As LOI does not identify the organic components contributing to this percentage it cannot be said what has given rise to the vast differences in the percentage values however some examples include plant material or animal matter. ANOVA assessment of the data indicated that there was a significant difference between the sites, with the exception of the April collection.

Paired t-tests applied to the data demonstrated no significant difference in the organic content between the artificial mixtures and the single source samples that they are composed of, at the 95% significance level. There was one exception to this that narrowly identified as being significant: Nottingham sample pair B - AB for the October collection, where $p = 0.049 < 0.050$. Should the same results be found in an investigation, it would be possible to state that the mixed source sample cannot be excluded from originating from the control site. However, the same is found for comparisons made between mixed source samples and sites that have not contributed to the mixture, further highlighting how complex interpreting samples of this nature can be. Correct inclusion or exclusion decisions are highly reliant upon having accurate information about the sites frequented pre-, syn- and post-forensic event, to allow for representative samples to be collected and compared to the mixtures, is crucial if correct decisions regarding inclusion or exclusion of evidence are to be made. This is reliant upon the accuracy of witness and/or suspect testimony (Walker and Hemmens, 2011), available CCTV coverage (Edelman and Bijhold, 2010), mobile phone (Schmidtz and Cooper, 2007) or social network data (Lin *et al.,* 2015). Even if accurate source information can be obtained from these mediums, that enable acquisition of representative single source samples for mixed source comparisons, false positives are still possible when material from close proximity sites are involved, and should be taken into account .

5.4.2 Elemental Analysis

Elemental analysis via XRF and ICP-AES identified a significant difference between each of the control sites A-C for both Nottingham and London sample locations. This is highly beneficial to forensic investigation, as crime events tend to take place over short distances that the offender is familiar with (Canter, 2003; Felson, 2008). Although XRF reveals more significantly different elements than non-significant, these are not huge differences. For instance, for Nottingham in the January collection, 31/50 elements were statistically significant, 29/50 for the April collection, and 28/50 for both October and January collections. For London, 39/50 elements tested for the January and July collections were significantly different, 37/50 for the October collection, and the April collection being the lowest at 26/50 elements being significant. Whereas for ICP-MS, the Nottingham January collection was the most marginal at 57.1 %, and then for October 75 %, April 67.9 % and July 78.6 % of the elements were significant. For the London collections, the October collection had the lowest percentage of significant elements at 67.9 % then for January 100 %, April 82.1 % and July 85.7 % of the elements were significant. For ICP-AES the Nottingham April and July collections, 100 % of the elements were significantly different between sites, October, 75 % were more significant and 66.7 % for the January collection. For the London sample location, for the October collection, 100 % of the elements were significantly different, July 91.7 % and 83.3 % for the January and April collections. The inconsistencies in elements identified as being significantly different between the three techniques are likely a result of the differing pre-requisite sample preparations, i.e. homogenisation only versus homogenisation and acid digestion. This further emphasises that interpreting geochemical data of geologically similar sites can be complex. Discriminating between soil/sediment samples from close proximity sites is dependent upon more than the analytical technique adopted, including, the type of soil or sediment, the past and current land-use of the site of interest and the parent material (Pye *et al.*, 2006a).

Minimal variation was found within each of the control sites A, B and C, for both Nottingham and London sample locations. This illustrated by the graphical output from the CDFA analysis (figures 5.5 and 5.6 for the XRF data, figures 5.11 and 5.12 for the ICP-MS data, and figures 5.17 and 5.18 for the ICP-AES data). These findings are in agreement with those presented by Pye *et al.* (2006a). This would suggest that discrimination between close proximity sites could be achieved in some cases with fewer control samples. However, in the XRF data illustrated in figure 5.6C, the five control samples for sites B and C are more dispersed than seen in other collections, and similarly, in the ICP-MS data for the January collection of site B (figure 5.11B). This highlights the need to obtain more than one sample where possible, to ensure that the material is fully representative of the site. Five control samples would be a preferable amount to collect to reduce interpretation issues should outliers be present, without becoming overwhelmed unnecessary excess data, which the study by Pye *et al.* (2006a) supports. However, as each crime scene is different, this amount could be altered if deemed necessary to meet the needs of the crime (Murray, 2004). For instance, in some cases the crime scene is identified prior to a suspect. Therefore, the scene may then be subjected to a number of changes, due to human activity in and around the area, and variances in the weather. In these cases, a larger sample set may be necessary to allow for accurate comparisons to be made when a suspect is identified (McKinley and Ruffell, 2007).

Paired t-tests found that generally, significant differences at the 95% significance level could not be identified between the artificial mixtures and the control sites from which they were composed. However, there were some exceptions identified, suggesting inconsistencies between the techniques. This may be a result of the particular elements examined or the amount of elements. For instance, XRF examined 49 elements, in comparison to 28 elements by ICP-MS, and 12 elements by ICP-AES. Exceptions to this, for the XRF data, include Nottingham control site A to mixture AB ($p = 0.022$) in the October collection, and to AB ($p = 0.037$) and ABC ($p = 0.032$) for the July collection; and for London control site A, to mixture AB ($p = 0.042$) for the October collection.

In the ICP-MS data, exceptions include:

- Nottingham control site A to mixtures AC ($p = 0.022$ - October) and ABC ($p = 0.029$ - October; $p = 0.003$ - January)
- Nottingham control sites B and C to mixture BC ($p = 0.003$ - January; $p = 0.021$ and 0.012 respectively - April).
- Nottingham control site C to mixtures AC ($p = 0.002$ - October; $p = 0.045$ - July) and ABC ($p = 0.026$ - October)
- London control site A to mixtures AC ($p = 0.002$ - January) and ABC ($p = 0.005$ - January).
- London control site C to mixture AC ($p = 0.014$ - October; $p = 0.025$ - April).

In the ICP-AES data exceptions include:

- Nottingham control site A to mixture AB ($p = 0.043$ - October; $p = 0.036$ - April; $p = 0.026$ - July), mixture AC ($p = 0.032$ - January; $p = 0.028$ - April) and mixture ABC ($p = 0.026$ - January; $p = 0.027$ - April)
- Nottingham control site B to AB ($p = 0.039$)
- London control site A to mixture AB ($p = 0.045$ - July)

PCA (tables 5.18, 5.19, 5.31, 5.32, 5.44 and 5.45) was also applied to the data in order to visualise the relationship between the mixed source samples and the control sites, as presented in figures 5.7 to 5.10 for XRF, figures 5.13 to 5.16 for ICP-MS, and figures 5.19 to 5.22. It is noted that for ICP-MS more of the variance is explained by axis 1 than experienced in the XRF analyses, this is likely due ICP-MS assessing fewer elements than XRF (28 compared to 49). As with CDFA (figures 5.5 to 5.6, 5.11 to 5.12 and 5.17 to 5.18), a clustering of the control sites can be observed in the PCA biplots with the mixtures falling between the sites, with the exception of the ICP-MS data for the January collection in Nottingham, where no discernible differences can be observed between the sites and mixtures AB, AC and ABC. It would be expected that the mixtures would fall equidistant between the sites that they were composed of, given the conditions in which the artificial mixtures were derived in the laboratory, as observed in figure 5.9D. However, for the rest of the collections this is not the case. For instance, in figure 5.7A, mixture AC associates more with site C than site A, and mixtures AB and ABC associate more with site B than the other sites that they are composed of. Similar observations can be made in the ICP-AES data; in figure 5.13A, mixtures AB and ABC associate more with control site B than the other control site(s) that they are derived from. Given the inconsistencies in the degree of association between two particular sites, the exact reason for this phenomenon at this stage is unknown. From the data obtained from the procedural blanks (table 5.6), it has been ruled out that contamination was introduced to samples while vessels are open (to allow HNO_3 and HF to evaporate during the digestion phase). In other studies (e.g. Reidy *et al.* 2013), a microwave digest method is adopted so that closed vessels may be used, in an effort to minimise the opportunity for contaminants to be introduced. Sample matrixing between the sample and the acids used in the digest for the ICP-AES and ICP-MS analyses (Pye *et al.* 2006b), or interferences from the carrier gases used to deliver the sample through the system (Bell, 2006), are other possibilities for the patterns observed. These are factors that are likely to have contributed to some of the discrepancies identified in some element readings such as V, Cd, Ce, Tl for ICP-MS and Na, BE and Ni for ICP-AES. The findings for single-mixed source sample comparisons are in agreement with those of the pilot study (Cheshire *et al.*, 2016), and further highlight the complexity of interpreting data of this nature. In this study, the samples are of known provenance and the identity and proportions of control sites used in the mixtures are known. However, in a real forensic investigation, this would not be the case, resulting in greater variability which complicates the interpretation. Without a geochemical database for the comparison of samples of interest, it cannot be definitively determined how commonly these geochemical profiles are found (Morgan and Bull, 2007a). Therefore, it may only be said that it cannot be excluded that the mixed source sample originated from the location(s) compared to.

5.4.3 Synopsis

Overall, there is a general agreement in the ability of each technique to distinguish between single source samples of close proximity sites and single-mixed source samples using each of the elemental techniques. The discrepancies present may have be due to inconsistencies in the homogenisation of the samples prior to the analysis, matrixing effects during the analysis or in the sample digestions for the ICP-MS and ICP-AES, or simply because the techniques are focusing on different groups of elements and not all the elements behave in the same manner in each site.

5.4.4 Future Developments

Future work should be directed towards targeting the complexities associated with interpreting data of this nature. One approach would be to reduce the number of elements analysed at one time (chapter 8), as opposed to looking at them collectively, to ascertain whether there are particular elements that hold more discriminative power between sites than others, and if these elements consistently prove to be successful in doing so, or whether it varies from location to location.

Additionally end-member modelling (chapter 8), a statistical model used in environment and climate reconstruction, that assigns provenance(s) to the sediment in the sample and the proportions of each of these provenances present, could be applied to the elemental data. This approach obviously offers desirable benefits. However, problems may arise when applying it to samples of mixed provenance where the original sources are similar to one another.

Another option would be to include additional forms of analysis such as isotope analysis via IRMS (chapter 6) which has been touched upon briefly (Croft and Pye, 2003). However, despite the promising results, this has not been further pursued. QEMSCAN (chapter 7) would be another viable option, as this allows for mineral mapping to be performed on the sample as well as providing elemental and particle information on a minimal amount of sample.

Each of these avenues will be explored throughout the rest of this thesis.

5.5 Conclusion

This study set out to establish the capability of LOI, XRF, ICP-MS and ICP-AES to distinguish between sites that are of close proximity to one another and to discriminate between mixed provenance sites and the control sites over a period of one year.

Each of the control samples and artificial mixtures were subjected to analysis by each of the stated techniques. ANOVA and CDFA statistical assessments were applied to the control site data, to determine the significance of the variation between and within the sites. Paired t-tests and PCA were used to ascertain if there was a significant difference between the artificial mixtures and the control sites from which they were created.

It was found that sites of a close proximity to one another in discrete locations were able to be distinguished based on their elemental composition determined by XRF and ICP-AES. These findings are in agreement with the pilot study conducted (Cheshire *et al.*, 2016), despite involving different locations. This further supports the premise that geochemical techniques are capable of discriminating between close proximity sites within urban environments. This is of great use to forensic investigation as elemental analysis through these techniques requires a minimal amount of sample and can be performed relatively quickly.

Though the findings show promise, a definitive conclusion cannot be offered at this stage due to issues associated with the interpretation of mixed provenance samples. A theoretical foundation needs to be established for interpreting mixed source soil/sediment samples in order for it to be developed to include the role of human exhibits and evidence dynamics in real crime events. Even then, these geochemical techniques should be used in conjunction with other independent forms of analysis, where sample size and budgets allows, to enable meaningful inferences of sample provenance to be contributed to the investigation.

Chapter 6 Site Discrimination: Forensic Discrimination of Mixed and Single Source Soil/Sediment Samples of a Discrete Location by Stable Isotope Analysis

6.1 Introduction

Isotope analysis has been utilised effectively to discriminate between materials in a number of fields including archaeology, biomedical sciences, biosynthesis, environment, extraterrestrial chemistry, food science, forensic science, humic substances, microbiology, organic geochemistry, and soil science (Lichtfouse, 2000). Isotopes are elements with a nucleus composed of the same or unchanging number of protons (Z), but a different number of neutrons (N), thus altering the mass number, (A) (i.e. $A = N + Z$) (Allègre and Sutcliffe, 2008). Isotopes are generally considered in two main categories; stable or unstable (Hoefs, 2009). Stable isotopes are chemically stable and are a result of chemical fractionation (White, 2015). Unstable refers to radiogenic isotopes that are produced as a result of radioactive decay, for example, strontium 87/89 ratios (Capo *et al.*, 1989; Hoefs, 2009). In some cases, a third class of isotopes may be considered, known as cosmogenic isotopes, which are a product of radioactive decay, chemical fractionation and/or nuclear processes (White, 2015). Cosmogenic isotopes can be found in surface soil/sediment material, and are used to provide approximations for the timing and rate of geomorphic processes within an environment (Cockburn and Summerfield, 2004). The predictability of changes in isotope abundances as elements cycle through a system make them a useful proxy in environment reconstruction (Peterson and Fry, 1987). The majority of the elements are made up of multiple isotopes (e.g. ^{12}C, ^{13}C and ^{14}C). However, there are some exceptions where the elements are composed of only one stable isotope (e.g. ^{27}Al), these are known as pure elements (Hoefs, 2009). Elements carbon (C), nitrogen (N), oxygen (O), hydrogen (H), and sulphur (S), each have multiple isotopes and are of particular interest in geoscience studies (see table 6.1).

Table 6.1: Isotopes of interest and their application

Isotope	Application	Reference
Carbon	Aging of biological systems (^{14}C dating) Identify vegetation and provenance Identifying climate changes Determining dietary sources (i.e. plant or animal)	Goh, 1991 Cerling *et al.*, 1989 Boutton and Yamasaki, 1996 Richards and Trinkaus, 2009
Nitrogen	Identify vegetation and provenance Identifying climate changes Determining dietary sources (i.e. plant or animal)	Cerling *et al.*, 1989 Boutton and Yamasaki, 1996 Richards and Trinkaus, 2009
Oxygen	Identifying changes in temperature and precipitation	Gat, 1996 Belknap, 2015
Hydrogen	Identifying changes in temperature and precipitation	Gat,1996
Sulphur	Temperature required for sulphur-mineral production Identifying origin of sulphur in ores	Hoefs, 2009
Strontium	Understanding mineral weathering Identify vegetation and provenance	Miller *et al.*, 1993 Beard and Johnson, 2000

Techniques such as time-of-flight mass spectrometry (TOF-MS), ion capture, or single quadrupoles, do not possess the adequate sensitivity to detect the slight variances in natural-occurring isotopes (Muccio and Jackson, 2009). Instrumentation known as a multi-collector magnetic sector mass spectrometer, i.e. an isotope ratio mass spectrometer (IRMS) (White, 2015), or multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS), is therefore required. MC-ICP-MS has been extensively addressed in the published literature (Mason *et al.*, 2006; Carlson *et al.*, 2007; Santamaria-Fernandez and Hearn, 2008), and has been demonstrated to be particularly effective for the determination of sulphur isotopes in the environmental sciences (Clough *et al.*, 2006) for a plethora of applications, including the behaviour of sulphur within environments (McArdle and Liss, 1995; Rai *et al.*, 2005) origin of groundwater (Allen, 2004); sulphur retention and mechanism patterns in soils (Mayer *et al.*, 2001); authenticity of food (Boner, 2004); monitoring controls for acid mine drainage (Hsu and Maynard, 1999); and monitoring composition of basalts and volcanic gases (Sakai *et al.*, 1982). The IRMS is composed of four key components (figure 6.1), but has multiple options for introductory systems; Element Analyser (EA-IRMS) and Gas Chromatography (GC-IRMS) being the most popular choices (Muccio and Jackson, 2009), as use of an EA introductory system means the technique is applicable to both solids and non-volatile liquids

(Carter and Barwick, 2011), and the additional GC column in GC-IRMS allows for a more effective separation of gases in more complex samples resulting in a higher discrimination (Muccio and Jackson, 2009). Some research into the applications of Liquid Chromatography (LC-IRMS) has been conducted, but has shown limited success due to restrictions in the mobile face and the type of interface used, i.e. moving wire interface (Sessions *et al.*, 2005), or wet-chemical oxidation interface (Krummen *et al.* 2004; Godin *et al.*, 2007), which has shown more promise (Godin *et al.*, 2005; McCullagh *et al.*, 2006; Cabanero *et al.*, 2009; Tremblay and Paquin, 2007). GC-IRMS and LC-IRMS can provide isotopic measurements of complex mixtures and consequently offers more information and a higher discriminatory power though the preparation and analysis is a more involved procedure (Muccio and Jackson, 2009). GC-IRMS has been shown to have a precision rate of 0.12 $^{o}/_{oo}$, accuracy -1.11 ± 2.16%, and reproducibility of 1.48 $^{o}/_{oo}$ (Wong *et al.*, 1995). However, there are multiple factors, whose impact upon these measurements still require determination, including ion current (Jochmann *et al.*, 2006), bit board size dependence (Nygren *et al.*, 2006), and the material of the sample vessel (Nelson, 2000). The elemental analyser allows for bulk analysis, giving an average isotopic ratio measurement for the entirety of the sample. The advantage of this form of analysis is that sample preparation is minimal, fast and inexpensive (Muccio and Jackson, 2009). Solid samples are weighed into a tin or silver capsule and placed into the autosampler, where it is then introduced into the system and undergoes a series of processes before reaching the IRMS (figure 6.2).

Figure 6.1: Key components of a Mass Spectrometer (Allègre and Sutcliffe, 2008)

Figure 6.2: EA-IRMS schematic (adapted from Muccio and Jackson 2009)

The traditional geological applications of isotope analysis (table 6.1) look to characterise an environment and identify similarities between previous records to establish timescales for changes within that environment. Sample characterisation through isotope assessment can similarly be applied to forensic geological samples, however an exclusionary approach needs to be utilised and the timescale for these reconstructions is necessarily shorter i.e. days/months/years as opposed to hundreds/thousands of years. Isotope ratios are of particular interest in forensic investigation as they are affected by thermodynamic and kinetic processes in the environment which makes them particularly effective at discriminating between samples of different provenance, even when the elemental composition is otherwise seemingly indistinguishable (Muccio and Jackson, 2009). This concept has been shown to have value in undertaking exclusionary comparative analysis between samples in forensic casework; for example, XRD and microscopic assessment could not identify a difference in the mineralogy or morphology between wooden match samples collected from the crime scene and the residence of the suspect, whereas isotopic assessments of C, H and O through IRMS identified that the samples were in fact different from different batches (Farmer *et al.*, 2007). Therefore, if the isotopic data were unavailable, investigators would have been reliant upon the findings from XRD and microscopic assessment, resulting in the erroneous interpretation of the evidence (i.e. a false positive conclusion). In other studies, the determination of strontium isotopes from skeletal remains have been used to identify the geographical movement and diet of deceased individuals (Beard and Johnson, 2000), and even the deposition date for skeletal remains unveiled in a mass grave discovered in Dorset (White, 2015). Isotopes also have applications in nuclear forensic investigation, where focus is predominantly on the use of radioactive isotopes uranium and plutonium, to identify the origin of the material and to monitor the illicit trafficking of the materials or weapon (Wallenius *et al.*, 2006; Mayer *et al.*, 2007; Fahey *et al.*, 2010; Kristo and Tumey, 2013). More recent research in forensic geoscience has utilised stable isotope data for carbon and nitrogen to infer provenance of a sample of interest (Croft and Pye, 2003; Croft and Pye, 2004; Pye *et al.*, 2006; Philip, 2007; Roelofse and Hortsmann, 2008), e.g. collected from an individual or an exhibit, to ascertain the presence of the individual or item at the scene of crime. However, the feasibility for discriminating between sites of close proximity and between mixtures has not been addressed nor conclusively determined. This is necessary to determine, as crimes often occur over shorter distances that the offender is familiar with (Felson, 2008), and this information, if possible to obtain, could aid with reconstructing suspect/victim movements pre-, syn- and post-forensic event (Croft and Pye, 2003).

For the purposes of this study, experiments were designed to test the feasibility of isotope analysis through IRMS, to discriminate between close proximity sites and soil/sediment material of different origins within a mixed provenance sample. This was to determine whether IRMS may be used in conjunction with other techniques during a forensic investigation, such as the elemental techniques used in chapter 5 to either support the conclusions reached or to offer further discriminatory power.

Aims and Objectives

The research in this chapter aimed to identify the feasibility of using stable isotope analysis to assess soil/sediment material in a forensic investigation.

In order to address this aim, the following objectives were identified:

1. To establish the stable isotope properties of known single source soil samples using IRMS.
2. To establish the stable isotope properties of known mixed source soil samples using IRMS.
3. To establish the feasibility of stable isotope analysis via IRMS to discriminate between known single source and mixed source soil samples from close proximity sites.

6.2 Method

6.2.1 Sampling

The sampling procedure carried out was the same as for the elemental analysis study presented in this thesis (section 3.1).

6.2.2 Analysis

Soil/sediment samples recovered from the Nottingham and London sample locations (as described in section 3.1) were prepared and analysed as detailed in section 3.9.

6.3 Results

Stable isotope analysis using IRMS was performed on bulk (i.e. combined organic and inorganic content) samples detailed in table 6.2, in order to ascertain the degree of intra- and inter-site spatial variability and the distinction of single and mixed source soil/sediment samples.

Table 6.2: Samples subjected to stable isotope analysis

Sample Type	Collection	Nottingham	London
Control	October (n=15)	KC10NA1-5 (n=5)	KC10LA1-5 (n=5)
		KC10NB1-5 (n=5)	KC10LB1-5 (n=5)
		KC10NC1-5 (n=5)	KC10LC1-5 (n=5)
	January (n=3)	KC01NA1	KC01LA1
		KC01NB1	KC01LB1
		KC01NC1	KC01LC1
	April (n=3)	KC04NA1	KC04LA1
		KC04NB1	KC04LB1
		KC04NC1	KC04LC1
	July (n=3)	KC07NA1	KC07LA1
		KC07NB1	KC07LB1
		KC07NC1	KC07LC1
Artificial Mixture	October (n=4)	KC10NAB	KC10LAB
		KC10NAC	KC10LAC
		KC10NBC	KC10LBC
		KC10NABC	KC10LABC
	January (n=4)	KC01NAB	KC01LAB
		KC01NAC	KC01LAC
		KC01NBC	KC01LBC
		KC01NABC	KC01LABC
	April (n=4)	KC04NAB	KC04LAB
		KC04NAC	KC04LAC
		KC04NBC	KC04LBC
		KC04NABC	KC04LABC
	July (n=4)	KC07NAB	KC07LAB
		KC07NAC	KC07LAC
		KC07NBC	KC07LBC
		KC07NABC	KC07LABC

6.3.1 Single Source Samples

From the stable isotope data collected (see appendix 6.1, summarised in table 6.3), the precision of the data was identified as having a standard error of 0.028 $^{o}/_{oo}$ ($\delta^{15}N$) and 0.20 $^{o}/_{oo}$ ($\delta^{13}C$), for the Nottingham sample set run, and 0.07 $^{o}/_{oo}$ ($\delta^{15}N$) and 0.12 $^{o}/_{oo}$ ($\delta^{13}C$), for the London sample set run, based on OEA Labs Alenine standard. Isotope ratios are expressed in standard delta units relative to the VPDB (carbon) and air (nitrogen) standards used.

Table 6.3: Summary of stable isotope ratios for the Nottingham and London sample sites

Collection	Sample	Nottingham		London	
		C $^{o}/_{oo}$ (VPDB)	N $^{o}/_{oo}$ (Air)	C $^{o}/_{oo}$ (VPDB)	N $^{o}/_{oo}$ (Air)
October	A1	-28.2	3.76	-28.5	1.2
	A2	-28.7	3.11	-28.6	1.41
	A3	-28.2	3.79	-28.4	1.74
	A4	-26.8	3.99	-28.6	1.32
	A5	-27	3.87	-28.7	1.36
	B1	-29.2	4.97	-26.7	4.52
	B2	-29	4.98	-26.3	4.7
	B3	-29	5.29	-26.5	4.57
	B4	-28.5	5.48	-27.3	4.38
	B5	-28.7	5.32	-27.5	5.09
	C1	-28.5	4.56	-28.3	6.2
	C2	-29	4.12	-27.9	6.21
	C3	-29.3	4.3	-28.3	5.74
	C4	-29.1	4.05	-28	6.15
	C5	-29	4.2	-28.1	6.09
	AB	-28.8	4.67	-27.1	5.28
	AC	-28.7	4.03	-28.3	4.84
	BC	-29.3	4.52	-27.6	2.67
	ABC	-29.1	4.64	-27.7	5.12
January	A1	-28.5	4.16	-28.6	1.33
	B1	-27.9	5.18	-27.6	4.26
	C1	-28.9	4.09	-27.7	6.63
	AB	-28.6	4.44	-28.1	2.67
	AC	-28.8	3.94	-28.1	4.76
	BC	-28.6	4.67	-27.6	5.82
	ABC	-28.7	4.29	-28	4.38
April	A1	-28.2	4.01	-28.3	1.59
	B1	-28.8	4.91	-26	4.96
	C1	-29	4.48	-27.7	6.38
	AB	-28.5	4.62	-27.2	2.53
	AC	-28.5	4.28	-27.7	4.11
	BC	-28.8	4.8	-26.8	5.75
	ABC	-28.7	4.51	-27.1	4.65
July	A1	-28.2	3.91	-29.6	1.46
	B1	-28.3	4.88	-29.5	4.41
	C1	-29.1	4.51	-27.8	6.64
	AB	-28.4	4.6	-27.7	2.73
	AC	-33.8	4.33	-30.6	3.51
	BC	-28.6	4.83	-27	5.58
	ABC	-28.6	4.72	-27.9	3.42

No definitive pattern can be observed in the raw data for the Nottingham samples that distinguishes one control site ($\delta^{13}C$ -26.8 to -29.3, $\delta^{15}N$ 3.11 to 5.48) from the other or illustrates any clear relationship between the artificial mixtures and their corresponding control site (table 6.3). However, for the London sample sites, site A is generally lower in $\delta^{15}N$ (cf. 1.4 $^{o}/_{oo}$), followed by site B and C respectively (cf. 4.5 $^{o}/_{oo}$ and 6 $^{o}/_{oo}$), and $\delta^{13}C$ the values are similar to one another in the range of -26.3 to -29.6. For the London artificial mixtures, typically mixtures containing site C had higher readings in $\delta^{15}N$ (i.e. in comparison to mixture AB), and mixture BC had the highest $\delta^{15}N$ reading over all other mixtures, with the exception of the October collection. Additionally, it is observed that the readings for each site appear consistent over time, which suggests that the temporal variation is minimal. Statistical assessment of the data was performed as outlined in section 3.11. The ANOVA assessment (table 6.4) indicated that there is a significant difference in the $\delta^{13}C$ and $\delta^{15}N$ between the Nottingham control sites and the London control sites at the 95% significance level.

Table 6.4: ANOVA statistical output on $\delta^{13}C$ and $\delta^{15}N$ isotope data for the October sample collection

Sample Site	Isotope	Sum of squares	df	Mean Square	F	Sig.
Nottingham	**$\delta^{13}C$**					
	Between	4.340	2	2.170	7.472	.008
	Within	3.485	12	.290		
	Total	7.825	14			
	$\delta^{15}N$					
	Between	5.802	2	2.901	41.815	.000
	Within	.833	12	.069		
	Total	6.635	14			
London	**$\delta^{13}C$**					
	Between	7.650	2	3.825	35.570	.000
	Within	1.290	12	.108		
	Total	8.940	14			
	$\delta^{15}N$					
	Between	57.329	2	28.665	566.048	.000
	Within	.608	12	.051		
	Total	57.937	14			

For CDFA, the five control samples from sites A, B and C from the Nottingham sample location were 100 % correctly classified (table 6.7). CDFA revealed that it is possible to distinguish between Nottingham control sites where $p = 0.000 > 0.05$ at the 95 % significance level (table 6.6), with function 1 isotopes (table 6.8) contributing 98.6 % of this variance (table 6.5). This supports the findings of the ANOVA and from the CDFA graphical output (figure 6.3), it is evident that the within site variation is greater than that observed for the elemental data (chapter 5), with the most spatial variation observed in site A.

Table 6.5: CDFA eigenvalues for the Nottingham sample collection

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	26.300	98.6	98.6	.982
	2	.362	1.4	100.0	.515

Table 6.6: CDFA Wilks' Lambda values for the Nottingham sample collection

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
October	1 through 2	.027	41.581	4	.000
	2	.734	3.552	1	.059

Table 6.7: CDFA classification results for the Nottingham sample collection

Collection	Site	Predicted Group Membership			Total
		A	B	C	
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 6.8: CDFA structure matrix for the Nottingham sample collection (isotopes contributing most to each function in descending order)

Collection	Isotope	Function 1	Function 2
October	C	-0.185	0.983
	N	0.505	0.863

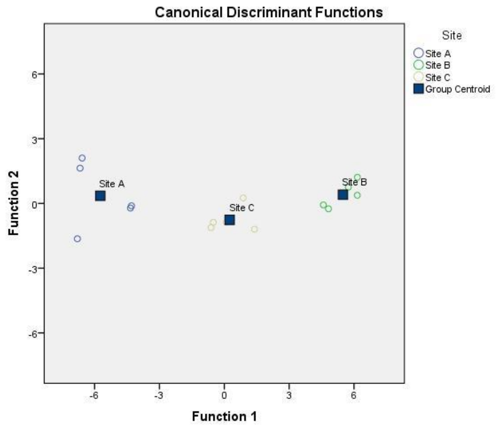


Figure 6.3: CDFA chart for the IRMS data for the Nottingham sample sites in October

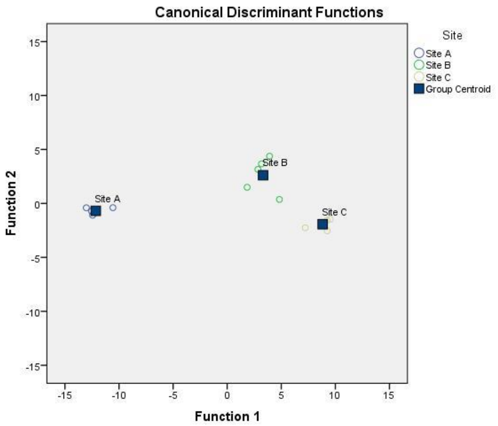


Figure 6.4: CDFA chart for the IRMS data for the London sample sites in October

For the London sample collection, 100 % of the sites were correctly classified by CDFA (table 6.11), and it was revealed that sites were able to be discriminated with a p-value of 0.000 at the 95 % significance level (table 6.10) for function 1 and 2 isotopes (table 6.12). Function 1 isotopes account for the majority of the variance at 95.6 %, and function 2 isotopes account for the remaining 4.4 % (table 6.9). These findings are in agreement with the ANOVA assessment. It is evident that there is a separate clustering of each of the control sites (figure 6.4). However, this grouping appears less defined than that observed for the elemental assessment in chapter 5, particularly with regards to sites B and C. This complicates the interpretation of this data, where a *priori* knowledge of the sites involved is absent.

Table 6.9: CDFA eigenvalues for the London sample collection

Collection	Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
October	1	98.488	95.6	95.6	0.995
	2	4.587	4.4	100.0	0.906

Table 6.10: CDFA Wilks' Lambda values for the London sample collection

Collection	Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
October	1 through 2	0.003	72.685	4	0.000
	2	0.179	19.784	1	0.000

Table 6.11: CDFA classification results for the London sample collection

Collection	Site	Predicted Group Membership A	B	C	Total
October	A (n)	5	0	0	5
	B (n)	0	5	0	5
	C (n)	0	0	5	5
	A%	100	0	0	100
	B%	0	100	0	100
	C%	0	0	100	100

Table 6.12: CDFA structure matrix for the London sample collection (isotopes contributing most to each function in descending order)

Collection	Isotope	Function 1	Function 2
October	C	0.120	0.993
	N	0.978	-0.210

6.3.2 Single Source versus Mixed Source Samples

Paired t-tests (tables 6.13 and 6.14), revealed no significant difference at the 95 % significance level for 93 of the 96 pairs compared (i.e. control site against artificial mixture). P-values were found to be in the range of 0.056 - 0.993 > 0.050 for the Nottingham sample location and 0.066 - 0.984 > 0.050 for the London sample location. The only exceptions were Nottingham site B compared to mixture ABC ($p = 0.042$), and London site A to mixture ABC ($p = 0.034$), and site C to mixture AC ($p = 0.040$)

Replicate control samples for the monitoring of variability within each site were analysed for the October collection only. PCA (tables 6.15 and 6.16), revealed no clear distinction between the Nottingham control sites or the mixtures, with the exception of three control samples from site A (figure 6.5A) but for the London sample location it is possible to distinguish between sites. A clear clustering of the five replicate samples within each London control site can be identified, with mixtures associating more closely with one site than another in some cases e.g. mixture AC to site C and mixture AB to site B (figure 6.6A). For the three other collections, the mixture data points are observed in-between the corresponding control sites (figures 6.5B-D and 6.6B-D) from which they were created in the laboratory. An even distribution of the mixtures between control sites is witnessed for the January and April collections for both locations (figures 6.5B-C, figure 6.6B-C).

It is evident from figures 6.5B to 6.5D that the $\delta^{15}N$ isotope ratio value is consistently more significant for the variance observed in site B, than sites A and C. However, $\delta^{13}C$ isotope ratio value is more significant for the variance observed in site A (October and April), site C for (July), and site B (January), for the Nottingham sample collection. Figure 6.6 indicates that the $\delta^{13}C$ isotope ratio value is consistently more significant for the variance observed in site B, than sites A and C, and $\delta^{15}N$ isotope ratio value for site C for the London collection.

Table 6.13: Paired t-test statistics for the $\delta^{13}C$ and $\delta^{15}N$ isotope data obtained through IRMS for the Nottingham sample collections

Collection	Pair	T	Df	Sig. (2-tailed)
October	A - AB	-0.205	1	.871
	A - AC	0.299	1	.815
	A - BC	0.183	1	.885
	A - ABC	0.011	1	.993
	B - AB	-0.143	1	.910
	B - AC	0.306	1	.811
	B - BC	1.571	1	.361
	B - ABC	0.535	1	.687
	C - AB	0.463	1	.724
	C - AC	2.212	1	.270
	C - BC	1.105	1	.468
	C - ABC	0.765	1	.584
January	A - AB	-0.436	1	.738
	A - AC	5.889	1	.107
	A - BC	-0.500	1	.705
	A - ABC	0.350	1	.786
	B - AB	11.333	1	.056
	B - AC	4.905	1	.128
	B - BC	7.000	1	.090
	B - ABC	15.182	1	.042
	C - AB	-10.667	1	.060
	C - AC	0.250	1	.844
	C - BC	-2.314	1	.260
	C - ABC	-4.714	1	.133
April	A - AB	-0.271	1	.832
	A - AC	0.156	1	.901
	A-BC	-0.113	1	.929
	A - ABC	0.048	1	.970
	B - AB	-0.017	1	.989
	B - AC	0.385	1	.766
	B - BC	0.692	1	.614
	B - ABC	0.600	1	.656
	C - AB	-1.848	1	.316
	C - AC	-0.385	1	.766
	C - BC	-3.923	1	.159
	C - ABC	-1.250	1	.430
July	A - AB	-0.568	1	.671
	A - AC	0.860	1	.548
	A - BC	-0.405	1	.755
	A - ABC	-0.373	1	.773
	B - AB	1.545	1	.366
	B - AC	1.224	1	.436
	B - BC	1.476	1	.379
	B - ABC	5.000	1	.126
	C - AB	-1.321	1	.412
	C - AC	1.079	1	.476
	C - BC	-5.923	1	.106
	C - ABC	-2.615	1	.232

*statistically significant values highlighted

Table 6.14: Paired t-test statistics for the $\delta^{13}C$ and $\delta^{15}N$ isotope data obtained through IRMS for the London sample collections

Collection	Pair	T	Df	Sig. (2-tailed)
October	A - AB	-2.011	1	.294
	A - AC	-1.098	1	.470
	A - BC	-3.900	1	.160
	A - ABC	-1.505	1	.373
	B - AB	-0.299	1	.815
	B - AC	0.668	1	.625
	B - BC	2.936	1	.209
	B - ABC	0.245	1	.847
	C - AB	-0.128	1	.919
	C - AC	1.015	1	.495
	C - BC	0.673	1	.623
	C - ABC	0.278	1	.827
January	A - AB	-2.392	1	.252
	A - AC	-1.374	1	.401
	A - BC	-1.580	1	.359
	A - ABC	-1.563	1	.362
	B - AB	1.789	1	.324
	B - AC	-0.042	1	.973
	B - BC	-1.013	1	.496
	B - ABC	0.467	1	.722
	C - AB	1.200	1	.442
	C - AC	1.493	1	.376
	C - BC	0.780	1	.578
	C - ABC	1.239	1	.432
April	A - AB	-10.895	1	.058
	A - AC	-1.571	1	.361
	A - BC	-2.116	1	.281
	A - ABC	-2.273	1	.264
	B - AB	2.919	1	.210
	B - AC	2.868	1	.214
	B - BC	0.025	1	.984
	B - ABC	1.756	1	.330
	C - AB	0.750	1	.590
	C - AC	1.018	1	.494
	C - BC	-0.182	1	.886
	C - ABC	0.479	1	.716
July	A - AB	-4.735	1	.132
	A - AC	-0.358	1	.781
	A - BC	-4.605	1	.136
	A - ABC	-18.600	1	.034
	B - AB	-0.037	1	.976
	B - AC	9.571	1	.066
	B - BC	-2.746	1	.222
	B - ABC	-0.241	1	.849
	C - AB	0.921	1	.526
	C - AC	15.919	1	.040
	C - BC	0.104	1	.934
	C - ABC	1.019	1	.494

*statistically significant values highlighted

Table 6.15: PCA eigenvalues and cumulative percentage of variance for the Nottingham sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.6762	67.62	1.000
	2	0.3238	100.0	
January	1	0.9283	92.83	1.000
	2	0.0717	100.0	
April	1	0.8613	86.13	1.000
	2	0.1387	100.0	
July	1	0.9745	97.45	1.000
	2	0.0255	100.0	

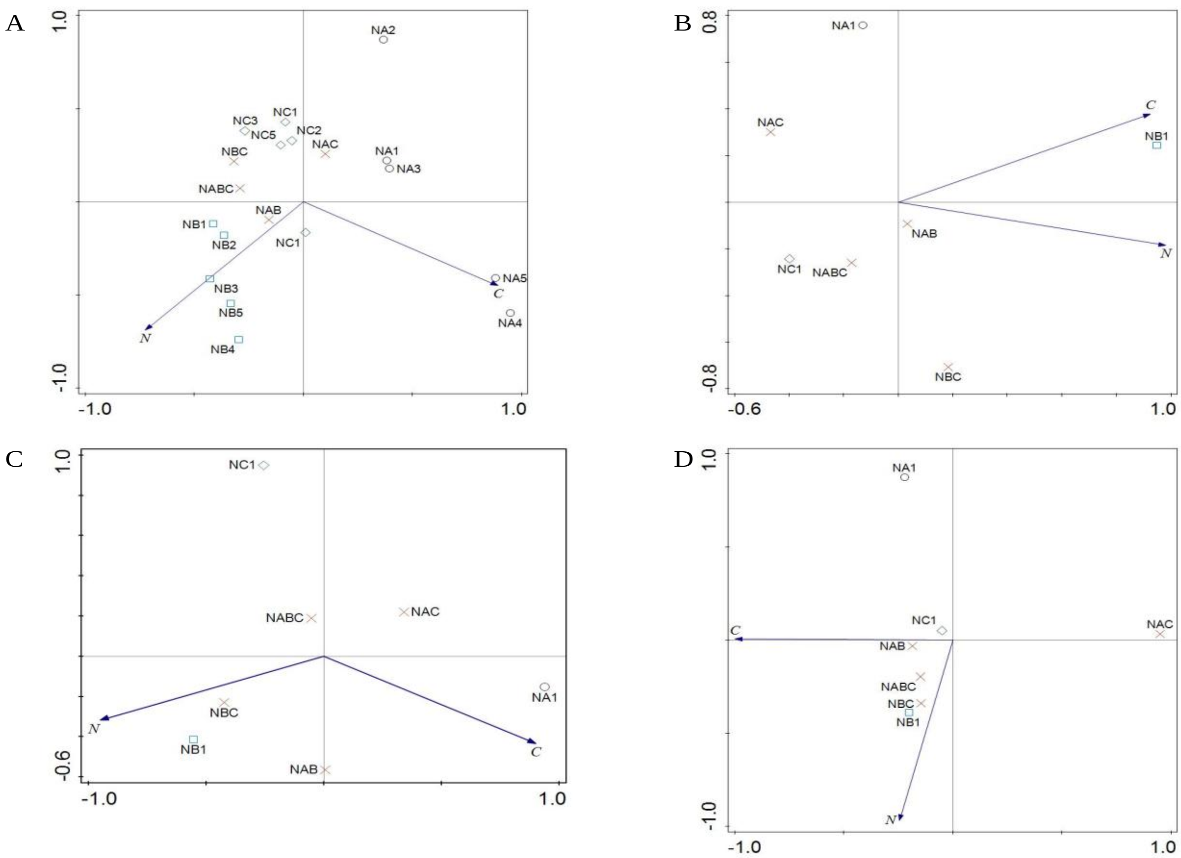


Figure 6.5: PCA biplot for single source and mixed source sample data determined by IRMS for the Nottingham sample collections (A - October, B - January, C - April, D - July: axis 1 - horizontal, axis 2 - vertical)

Table 6.16: PCA eigenvalues and cumulative percentage of variance for the London sample collections

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
October	1	0.8890	88.90	1.000
	2	0.1110	100.0	
January	1	0.9885	98.5	1.000
	2	0.0115	100.0	
April	1	0.8735	87.35	1.000
	2	0.1265	100.0	
July	1	0.7558	75.58	1.000
	2	0.2442	100.0	

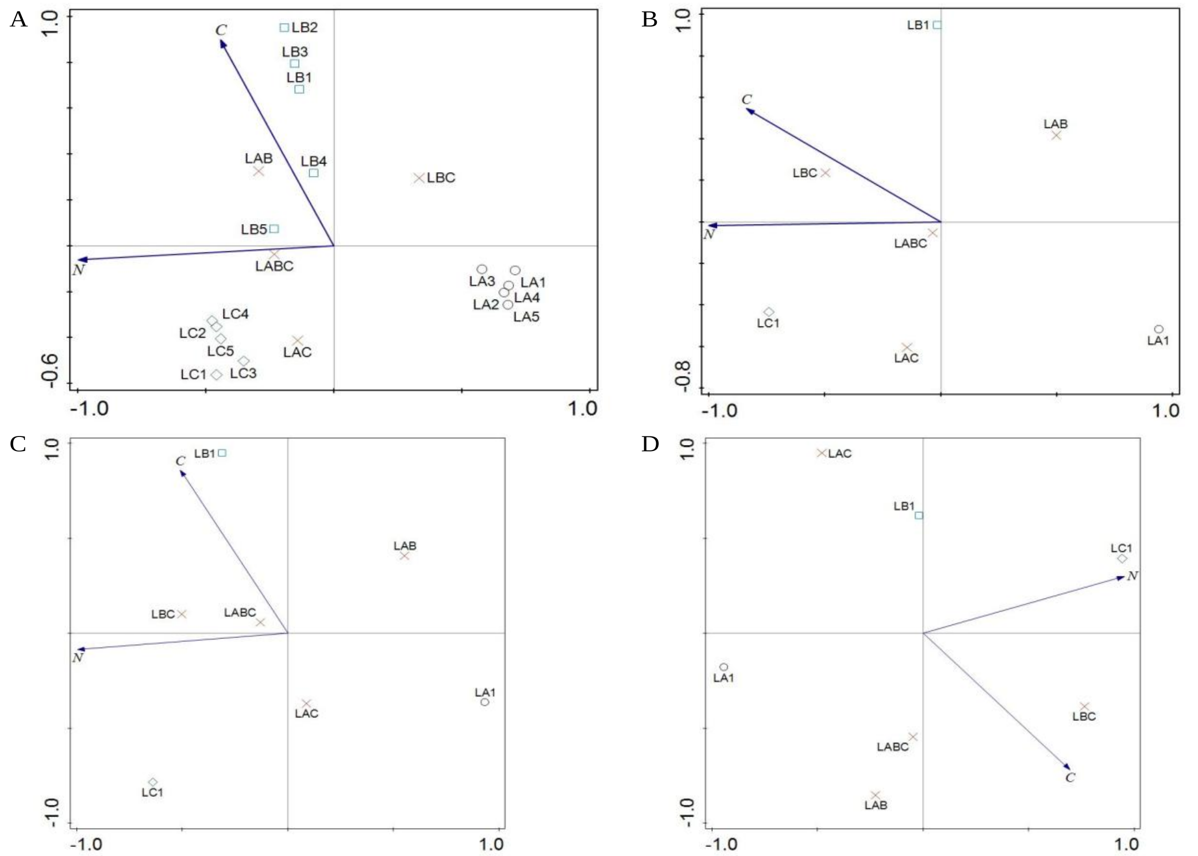


Figure 6.6: PCA biplot for single source and mixed source sample data determined by IRMS for the London sample collections (A - October, B - January, C - April, D - July: axis 1 - horizontal, axis 2 - vertical)

6.4 Discussion

6.4.1 Single Source Samples

Analysis of $\delta^{13}C$ and $\delta^{15}N$ isotope ratios in soil/sediment samples by IRMS identified a significant difference between control sites A to C for both the Nottingham (tables 6.4, 6.5 - 6.8 and figure 6.3) and the London sample location (tables 6.4, 6.9 - 6.12 and figure 6.4). This further supports the findings from performing elemental analysis of the sites (chapter 5), and is beneficial to forensic investigation given crime events tend to unfold over shorter distances with which an offender is familiar (Canter, 2003; Felson, 2008). Nottingham site A is a crop field, and while the within site variation is greater than sites B and C, it is consistently discriminated from these sites (figure 6.3 and 6.5). This may be a result of the fertiliser treatments that the site undergoes, which can alter the nitrogen and carbon composition (Teece and Fogel, 2004; Michalski *et al.*, 2010), making it distinctive from sites B (a public walkway) and site C (a cattle field).

IRMS in this study has produced data with high precision, with error rates of 0.028 $^{o}/_{oo}$ ($\delta^{15}N$) and 0.20 $^{o}/_{oo}$ ($\delta^{13}C$), and 0.07 $^{o}/_{oo}$ ($\delta^{15}N$) and 0.12 $^{o}/_{oo}$ ($\delta^{13}C$), for the two the Nottingham and London sample set analyses respectively. It has also shown promise at distinguishing between sites of close proximity, and therefore offers another form of analysis that can be put to use when other techniques are deemed unsuccessful, or as a corroborative technique. For instance, due to the thermodynamic processes that isotopes undergo in the environment, isotopes can be used to identify differences between samples where other variables cannot such as elemental composition (Muccio and Jackson, 2009) or mineral composition (e.g. Farmer *et al.*, 2007). Therefore, isotopes may offer further discriminatory power allowing for an exclusionary approach to be taken (Morgan *et al.*, 2008), and more statistically robust and reliable forensic evidence which is necessary for use in court to avoid erroneous verdicts (Ruffell *et al.*, 2013). In forensic investigations, sample size is often minimal, sometimes as little as 100 mg (Pirrie *et al.*, 2009), which can restrict the forms of analyses that may be undertaken (Murray and Solebello, 2002). In this study, the maximum amount of soil/sediment sample used to provide quantitative data from IRMS was 10 mg, which means other forms of independent analysis may still be conducted, which is necessary to provide more reliable conclusions (Morgan and Bull, 2007a). This may prove particularly useful in situations where investigators are seeking to identify the provenance of an unknown sample. For this to be possible, supplementary information from a comprehensive database or a localised database of samples relevant to the particular location(s) associated with the crime, would be required in a similar manner to elemental assessment (Pye and Blott, 2009). However, such a database is not available as of yet, and therefore analysis of other parameters such as minerals and pollen, which are considered most effective at discrimination and identification of provenance (Ruffell *et al.*, 2013), may be required.

Though discrimination between sites has been successful in this study, the within site variation appears greater than that observed for elemental analysis, and could complicate discrimination when *a priori* knowledge of sites involved is absent. This highlights that discrimination is not only dependent upon the technique used, but also the type of soil/sediment, the parent material, and the land-use of the site of interest, both past and present (Pye *et al.*, 2006a). This gives further emphasis to the complexity of interpretation, and the need to obtain as much information about the samples through multiple forms of independent analysis, and thorough investigation of potential sources (Morgan and Bull, 2007a). It also highlights that the sampling requirements are variable and potentially site specific. For instance, distinction between the control sites is more apparent in London sites (e.g. figure 6.6A) than in the Nottingham sample sites (e.g. figure 6.5A). Therefore, the specificities of the location and the crime event should be taken under consideration, with regards to the number of samples collected and time period covered (Murray, 2004; McKinley and Ruffell, 2007), so as to obtain enough data to enable reliable conclusions without generating an overwhelming, and potentially unnecessary, amount of data (Pye *et al.*, 2006a).

6.4.2 Single Source Versus Mixed Source Samples

Paired t-tests revealed no significant difference between any of the control sites and the artificial mixtures created from these sites (e.g. A - AB) from both Nottingham and London sample locations at the 95 % significance level (tables 6.13 and 6.14). More critically, a statistically significant difference also could not be identified between artificial mixtures and single source control samples that did not contribute to the mixture (e.g. A - BC), thus highlighting the complexity of interpreting chemical data generated on mixed provenance geoforensic samples when *a priori* knowledge is absent. Further to this, PCA was performed on the data in order to visualise this relationship between the control sites and the mixtures (see tables 6.15 to 6.16 and figures 6.5 to 6.6). As was identified by the CDFA, distinguishable control site clustering is observable in the PCA biplot for the Nottingham sample sites (figure 6.5A) and the London sample sites (figure 6.6A). Given that the mixtures were composed using equal proportions of the control sites, i.e. mixture AB is a 1:1 ratio of control sites A and B, it may be expected that the data point for mixture AB would be equidistant from data point(s) for control site A and the data point(s) for control site B. However, though mixtures data points are observed in-between the control site data points, some mixtures associate more with one control site than another (e.g. mixture AC with control site C in figure 6.6A), and in other cases the mixtures can be seen to cluster together (e.g. Nottingham mixtures AB, BC and ABC, figure 6.5D). In this study, the control samples and mixtures are known. However, if they were not, it could lead to the samples being incorrectly classified as a different single source control site or mixtures that are composed of soil/sediment from the same locations. This highlights the issue of interpreting mixed provenance samples without a *priori* knowledge, and to the potential for false negative or false positive conclusions, which can have serious ramifications on the criminal justice system (Morgan and Bull, 2007a; Morgan and Bull, 2007c). Information regarding all sites relevant to a case is not always known due to the absence or inaccuracies in suspect or witness testimony (Walker and Hemmer, 2011). It is therefore vital to establish a means of accurately interpreting samples without *a priori* knowledge, in order to allow empirically grounded and robust inferences and assessment (Morgan and Bull, 2006).

The reason for the inconsistencies observed in the degree of association between mixed source samples with one particular control site over another at this stage is unknown and requires further investigation. It may be due to the treatment of the data by the statistical assessment itself, such as the data sorting and probabilistic weightings assigned (Pye *et al.*, 2006b; Reidy *et al.*, 2013), or due to events that may occur in the preparation and analysis of the sample. For instance, in casework these discrepancies might be explained by cross-contamination during sampling (Dawson and Hillier, 2010), or sub-sampling inconsistencies (Pye *et al.*, 2006b). However, in this experimental study, sampling and handling as being a source for this issue has been minimised, as sampling and sub-sampling conditions were conducted in a controlled a consistent manner. For instance, all samples were packaged and stored separately, and the equipment and laboratory surfaces were cleaned in-between handling different samples to avoid cross-contamination. All samples were handled by the same analyst, and consistent sample weights were used for each location (10 mg Nottingham and 6 mg London). Additionally, sample preparation and analysis was conducted using the same equipment within the same controlled laboratory environment. These precautions were employed to prevent the occurrence of errors in the data and subsequent interpretations as a result of inconsistencies in the procedure.

6.4.3 Synopsis

From this study it can be seen that IRMS shows promise in the forensic assessment of soil/sediment samples from close proximity sites. However, the within site variation is greater than that observed for the elemental data, and could complicate interpretations where knowledge of the sites involves is unknown, and therefore emphasises that the discrimination is not dependent on the technique alone but also on the type of soil/sediment being assessed. It is essential to explore how the isotope ratios vary within a space to ascertain what degree of variance is to be typically expected of the site, in order to highlight when an irregular reading is obtained and what this variance(s) might be attributed to. This coupled with the need for sub-sampling to be conducted carefully to ensure that the sub-samples being assessed are representative of the site, and accurate interpretations can be made, to provide robust evidence relevant to the specific case being worked on.

6.5 Conclusion

This study set out to establish the feasibility of isotope analysis through IRMS to discriminate between close proximity sites, and discriminate between mixed provenance sites and the control sites from which they are composed over the course of a year. ANOVA and CDFA statistical assessments were used to identify between and within site variation. Paired t-tests and PCA were used to determine if a significant difference existed between single source control sites and the artificial mixtures.

For both the Nottingham and London sample locations, control sites were able to be distinguished. No significant difference was identified between the control sites and the artificial mixtures from the Nottingham sample sites and from the London sample sites, which would suggest that erroneously excluding locations associated with the crime event from an investigation could be prevented. However, discrimination of samples that did not have components in common (e.g. A-BC) was also inconsistent, and highlights the potential for false positive conclusions to be drawn. It should be noted, that in this study, the samples are of known provenance and the identity, and proportions of control sites used in the mixtures are known. However, in a real forensic investigation this would not be the case, and would be subject to more variability which complicates the interpretation. Though a definitive protocol regarding how to approach interpreting stable isotope data for mixed provenance material cannot be provided at this time, the study has highlighted the promise of isotope analysis on forensic soil/sediment samples to discriminate between samples derived from close proximity locations. Further research should be conducted to address the following factors:

1. The behaviour and variances of stable isotopes within different sample locations
2. The effect of different mixture compositions on findings (i.e. number of sources and the ratio at which these sources are present).
3. The potential of temporal variation in isotope abundances influencing findings

It is necessary to address these factors in order to build a solid foundation in which to base interpretations, and to identify when this form of analysis can be best used within a forensic investigation. Until this time, as with all forms of analysis, it should be used with other independent lines of enquiry and only in an exclusionary approach to enable robust evidence to be presented in a court of law.

Chapter 7 Site Discrimination: Forensic Discrimination of Mixed and Single Source Soil/Sediment Samples of a Discrete Location by Mineralogy

7.1 Introduction

Geological material, such as soil and some sediments, are composed of an organic and inorganic fraction that can provide beneficial information to a forensic investigation (Ruffell *et al.,* 2013). The inorganic fraction is typically inert, and these parameters can provide valuable evidence as they are considered to be less influenced by temporal changes, storage conditions, and sample nature (Pirrie *et al.,* 2009). Parameters that may be examined in the inorganic fraction include pH, bulk colour, particle size distribution, isotope geochemistry, bulk chemistry and mineral, mineralloid, and man-made material chemistry (Pirrie *et al.,* 2009). In geological analysis, minerals are typically split between two classifications; primary and secondary (Brady, 1989), both of which are strongly dependent on the parent material, but also have differences from one another. Primary minerals are larger in size and can be observed either by the naked eye or through light microscopy, they are less variable in their composition, and dominate the coarser fractions of the soil e.g. quartz. Secondary minerals are formed as a result of weathering during soil formation, and dominate the finer fraction of the soil, e.g. clay minerals. Electron microscopy is usually required in order to visualise these minerals (Brady, 1989). These both can be a good indicator of the environmental conditions within the area of which the samples originate. For example, if the sample is from a particularly humid environment, the primary minerals will have undergone significant weathering; and areas where rainfall is high will be indicated by the absence of certain secondary minerals e.g. gypsum, calcite or dolomite, as they are soluble in water (Brady, 1989; Murray, 2011). The primary and secondary mineral elements can also be a good indicator of the vegetation within the environment (Kabata-Pendias, 2010; Hinsinger, 2013), which may be used in combination with other intelligence gathering to infer a provenance in forensic investigation, and a number of case examples where mineralogy has been utilised are outlined by Murray (2011).

Traditional methods for mineral identification include optical polarising light microscopy on thin sections, manual SEM, automated SEM, XRD, and electron microprobe analysis (Pirrie *et al.*, 2009; Knappett *et al.*, 2010). However, such techniques can be time consuming, and the interpretation is subjective as it is reliant upon the knowledge and experience of the analyst (Pirrie *et al.*, 2004). In forensic investigation, it is vital that a robust form of analysis is selected so that the results obtained are reproducible between different analysts and laboratories, in order to provide confidence in their application, which has led to the investigation and development of existing technology such as QEMSCAN (Pirrie *et al.* 2009; Ruffell *et al.*, 2013).

QEMSCAN technology was designed to be used in conjunction with SEM to allow for the imaging, mapping and quantitative assessment of minerals within geological sample material, as well as porosity structure (Pirrie *et al.*, 2004). The instrument is an electron beam source coupled with up to four energy dispersive X-ray spectrometers. The backscattered electron and induced secondary X-ray emission spectra are then compared to a database of known spectra to identify the minerals (Ayling *et al.*, 2012). Typically 200 000 mineralogical determinations can be made per hour (Pascoe *et al.*, 2007). However, this is dependent on the amount of sample being analysed and the resolution being used; the higher the analysis resolution, the longer the analysis (Ayling *et al.*, 2012). Samples are typically mounted into a resin and carbon-coated for conductivity, and for smaller/trace amounts, samples are mounted onto carbon tape (Pirrie *et al.*, 2004). The instrument then produces qualitative and quantitative data on the elemental composition of the minerals, the distribution and angularity of minerals (Ayling *et al.*, 2012). It was initially developed for implementation in the mining industry in the 1970s, to complement bulk chemical data in order to make informed decisions regarding mineral processing, metal refining and exploration (Pirrie *et al.*, 2004). Further refinement of the technology has lead to its application into archaeology (e.g. Knappett *et al.*, 2010), environment and climate studies (e.g. Speirs *et al.*, 2008; Ayling *et al.*, 2012), and forensic science (Romolo and Margot, 2001; Pirrie *et al.*, 2009; Ruffell *et al.*, 2013; Eby *et al.*, 2014).

The advantages and limitations for adopting QEMSCAN to characterise minerals within soil/sediment samples are described in table 7.1. For instance, the sample analysis is rapid, operator independent, and there is minimal sample preparation required. This means that not only is the analysis itself quicker, but the analyst is also required for less time than when using more traditional means (i.e. binocular microscopy or manual SEM), and therefore it is cheaper. Simultaneous qualitative and quantitative data is obtained at low detection limits, which means even trace amounts of particular minerals or elements can be identified without having to conduct different sample preparations (Pirrie *et al.*, 2004; Pirrie *et al.*, 2009). The instrument has demonstrated good reproducibility (Pirrie *et al.*, 2009), meaning that the analyst can have confidence in reporting the findings and using them to draw inferences as to the provenance of the crime event and other related scenes. Simultaneous identification of both natural and anthropogenic particles (e.g. cement or brick dust) within a sample is highly advantageous, especially for urban soil/sediment samples, as manmade materials within samples are frequently encountered which can be difficult to distinguish when working with trace amounts of sample like that of a forensic investigation. Additionally, there is also the ability to produce mineral maps and imaging of singular minerals, which can give a visual representation of the differences or similarities between sample which can be used to more clearly illustrate findings in court.

There is one issue with the use of this technique that may limit its use in comparing samples with similar parent material, as their elemental and mineral composition may be less varied (Brady, 1989; Rawlins and Cave, 2004). In these cases, identifying differences between scenes may be reliant upon the presence of anthropogenic particles within the sample that are potentially rare in the environment generally, and therefore, distinctive to the scenes of forensic interest, which in turn is dependent on the representativeness of the sampling (Morgan and Bull, 2007c).

Despite this disadvantage, there are a still a number of advantages that QEMSCAN has to offer which make it a worthwhile technique to further investigate and determine the feasibility of its reliability and routine use in forensic analysis of soil/sediment samples.

Table 7.1: The advantages and limitations of QEMSCAN assessment of soil/sediment samples*

Advantages	Limitations
Fully quantitative mineral assessment using a minimal amount of material	QEMSCAN cannot distinguish between mineral polymorphs
Operator independent (unlike manual SEM)	QEMSCAN cannot distinguish between minerals that have a very similar chemistry
Simple sample pre-treatment (sample is mounted into a resin, polished and carbon coated)	Expensive start up costs for the instrument (including purchase of the instrument).
Rapid analysis compared to manual SEM (spectra is acquired at around 10 ms per pixel)	The accuracy of mineral identification is highly reliant on the knowledge and experience of the and the amount of samples used to build the database by which samples are compared to.
Low detection limits (can perform analysis on a particle-by-particle basis)	
Good reproducibility (instrument variability less than natural variability in samples)	
Unlike other techniques QEMSCAN can effectively characterise both natural and anthropogenic particles in soil automatically.	
The textural relationships of different mineral phases within a particle can be imaged	

*(compiled from Pirrie *et al.* 2004; Pirrie *et al.*, 2009; Knappett *et al.*, 2011)

Previous applications of QEMSCAN (or automated SEM-EDX) within forensic investigation and research have looked at identifying gunshot residue (Romolo and Margot, 2001), nuclear post-detonation debris (Eby *et al.*, 2014), and airborne particulate matter (Sitzmann *et al.*, 1999). The work of Romolo and Margot (2001) evaluates methods used to characterise GSR, and where QEMSCAN is deemed more appropriate. Studies of the morphological and elemental characteristics of different residues within GSR are conducted (i.e. burnt and unburnt particles from discharge of the firearm and components from the primer, bullet, cartridge case and firearm itself). Typically, particles being examined are around 10 um, and require a tape or vacuum lift to enable recovery. Previously analysis has been done using manual SEM, and Romolo and Margot (2011) comment on the subjective nature of the interpretation, i.e. what constitutes as being "very specific" residue to the firearm in question, QEMSCAN allowed for a more objective interpretation as it is operator independent.

Eby *et al.* (2014) used QEMSCAN to identify post-detonation debris, which focuses on identifying trinity glasses produced during bomb testing; this is highly complex, and exacerbated further when bomb detonation takes place in urban environments where other manmade materials are contributed, which QEMSCAN was able to successfully identify.

Sitzmann *et al.* (1999) looked at identifying airborne particulate matter for commuters on the London underground and on the roads for those who cycled by automated SEM-EDX; filter papers adhered to the participants were used to collect the airborne particulates. 300 particles per sample (total n=70) were analysed for X-ray count, particle size, and morphology; the provenances were then determined using this information, as each were identifiable based on different element combinations and abundances.

Previously the focus of geological analysis in forensic investigations has been directed towards soil/sediment material from rural environments, due to a high abundance of material (Murray, 2011). More recently, interest has been directed towards the effectiveness of QEMSCAN at identifying particulates in urban environments. Often urban environments are overlooked, as there is less unconsolidated sediment in these areas, and consequently trace geological evidence from these areas are more difficult to transfer and analyse using the techniques mentioned previously (Ruffell *et al.*, 2013). However, due to the combination of different pollen assemblages, soil/sediments, rock dust, and man-made trace materials, urban environments can offer highly distinctive soil/sediment samples (Morrisson *et al.*, 2009). This is of high forensic value due to the high spatial resolution this can provide, i.e. the identification of micro-environments associated with the crime event within the greater urban area being investigated (Pirrie *et al.*, 2009; Ruffell *et al.*, 2013). Therefore, geological trace evidence from urban environments should not be overlooked and requires further examination.

Aims and Objectives

The research in this chapter aimed to identify the feasibility of using automated mineral analysis to assess soil/sediment material in a forensic investigation.

In order to address this aim, the following objectives were identified:

1. To establish the mineralogical properties of known single source soil samples using QEMSCAN.
2. To establish the mineralogical properties of known mixed source soil samples using QEMSCAN.
3. To establish the feasibility of mineral analysis via QEMSCAN to discriminate between known single source and mixed source soil samples from close proximity sites.

The ability of QEMSCAN to discriminate between samples of this nature will determine whether it may be used in conjunction with elemental and isotopic assessment techniques used in chapters 5 and 6, where sample size allows, or as an alternative means of assessment where deemed necessary to assist in forensic investigation.

7.2 Method

Samples recovered from the Nottingham and London sample locations during the October collection (as described in section 3.1), were prepared and analysed as detailed in section 3.10.

7.3 Results

7.3.1 Single Source Samples

From the mineral maps (figures 7.1 and 7.3) produced in the QEMSCAN analysis, and the percentage composition bar charts (figures 7.2 and 7.4) of the raw data (see appendices 7.1 and 7.2), it is possible to identify the bulk mineral composition in the sample sites. 20 minerals were identified for each sample analysis and any components that could not be identified were assigned in an unidentified category. It is evident that the Nottingham sample sites are rich in clays and quartz (figures 7.1 and 7.2a), and that for the London sample sites there is a high abundance of quartz and plagioclase (figures 7.3 and 7.4a). When these are removed from the plots, the minerals that are more identifiable, and present in a lower abundance of the sites, become visible. For Nottingham sample sites, it is evident (figure 7.2b) that minerals apatite, calcite and dolomite vary in their abundances for sites A, B and C; for example site A has a larger abundance of calcite (0.22 %) and dolomite (0.35 %), in comparison to sites B (0.11 % and 0.17 %) and C (0.03 % and 0.21 %). Additionally, all mixed provenance samples that contain site A in them also appear to have a higher abundance of calcite, with 0.07 to 0.12 %, compared to mixture BC with 0.05%, and for dolomite in mixtures AB, AC and ABC a percentage range of 0.27 - 0.44 % compared to mixture BC 0.13 %. It is also apparent (figure 7.2c), that sample mixture BC contains a high percentage of Iron Oxide/Carbonate (4.61 %) in comparison to all other samples which is also visible in mineral map (figure 7.1f).

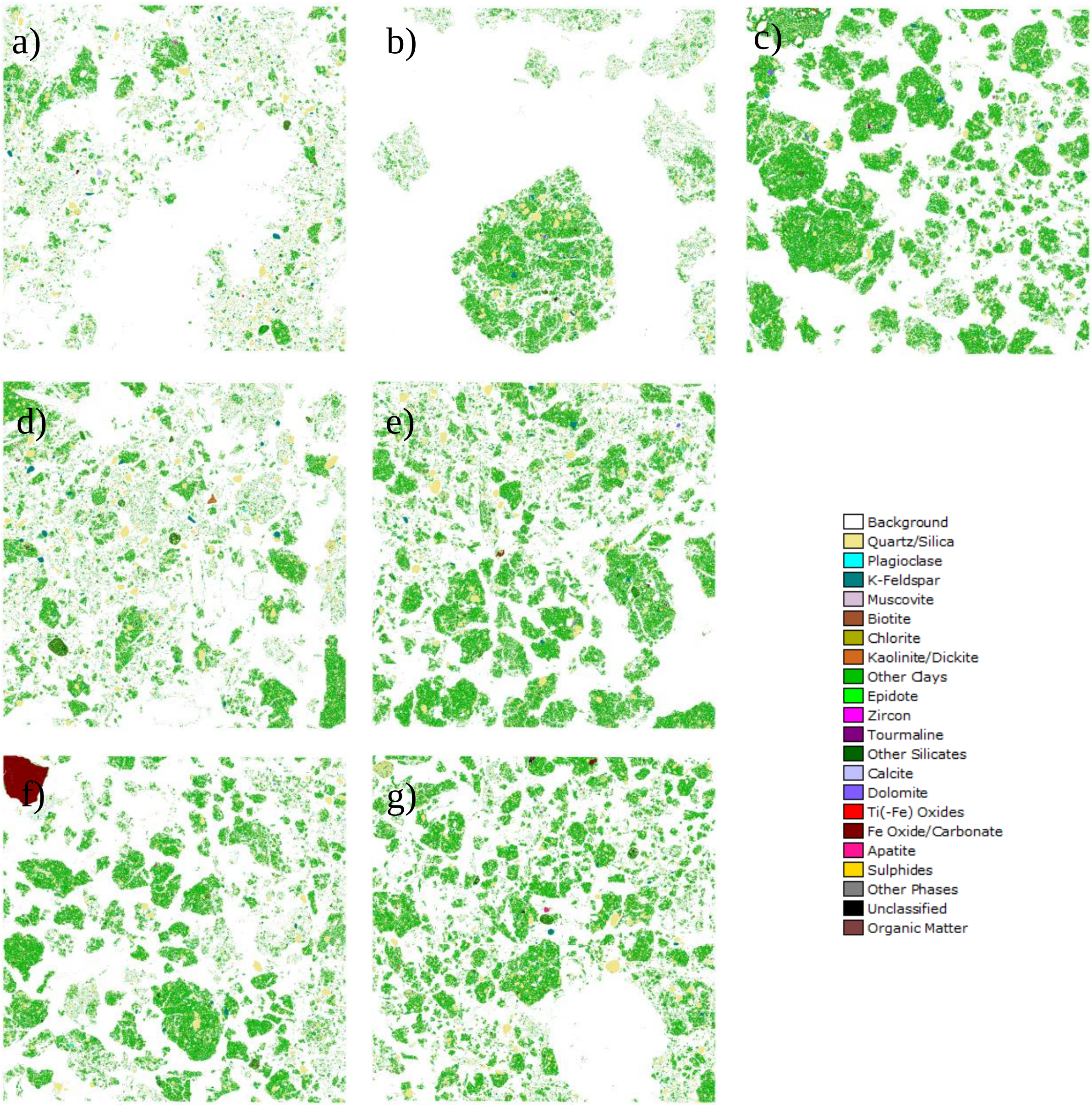


Figure 7.1: Nottingham mineral maps a) site A, b) site B, c) site C d) mixture AB, e) mixture AC, f) mixture BC and g) mixture ABC

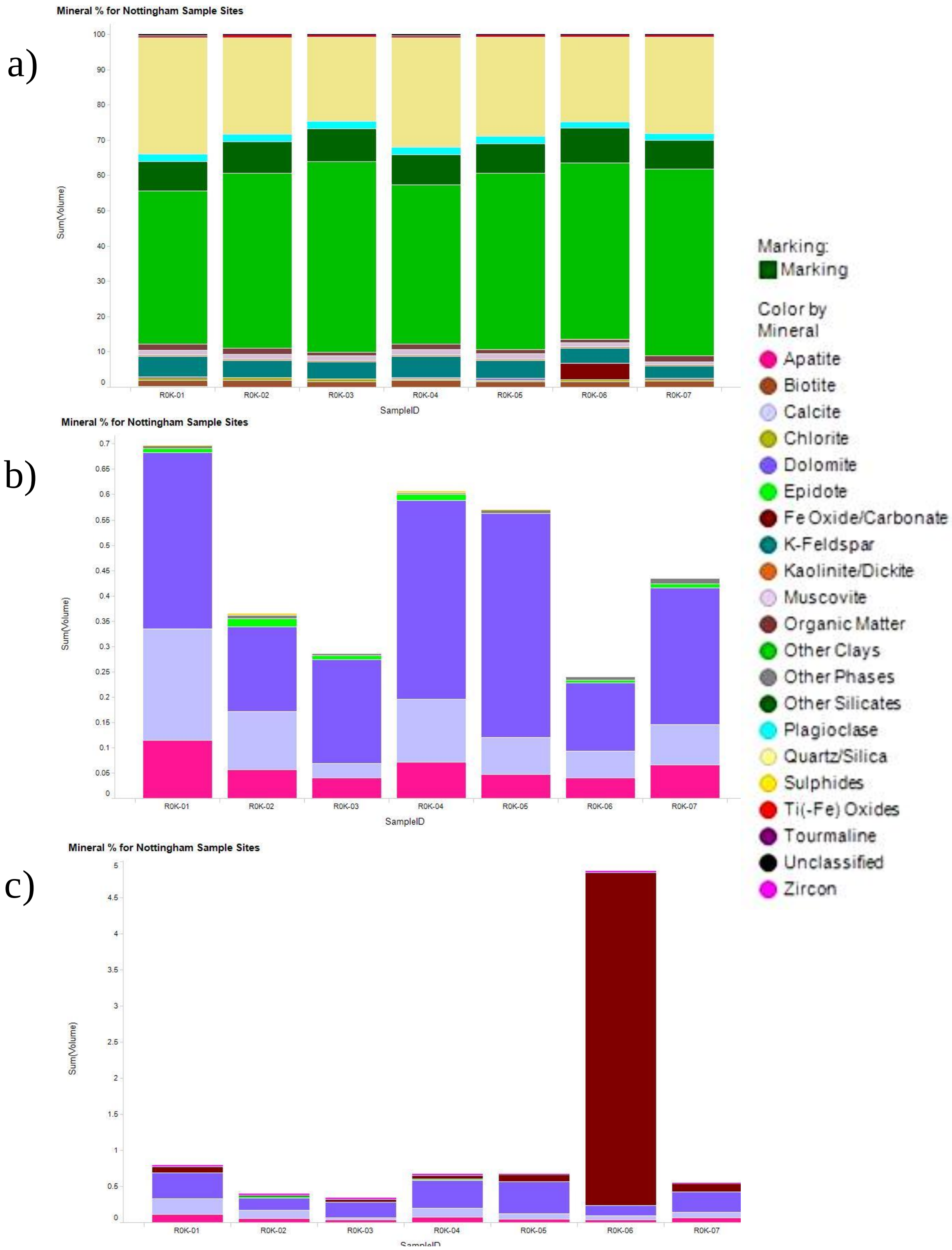


Figure 7.2: Nottingham Mineral % (ROK-01 site A, ROK-02 site B, ROK-03 site C, ROK-04 mixture AB, ROK-05 mixture AC, ROK-06 mixture BC, ROK-07 mixture ABC)

For London sample sites, minerals chlorite, dolomite and epidote aid in the discrimination between sites (figure 7.4b); Site B is richer in chlorite (1.62 %) and dolomite (0.66 %), compared to 0 % dolomite in Sites A and C, and 0.13 % chlorite in Site A and 0.10 % in Site C. Additionally dolomite is absent from mixture AC, but present in mixture AB (0.19 %), BC (0.07 %) and ABC (1.48 %), chlorite mixture AC 0.15 % compared to mixtures AB (1.66 %), BC (3.97 2.46 %), and ABC (1.48 %). Epidote is more abundant in Site C, with 0.63 % (Site B - 0.20 %, Site A - 0.06 %), However, mixture AC (0.08 %) does not reflect this, as it has a lower percentage than mixtures AB (0.22 %), BC (1.98 %) and ABC (0.79 %). From the mineral maps (figure 7.3), it is also evident that plagioclase is in a greater abundance in site B (figure 7.3b) than sites A (figure 7.a) and C (figure 7.c), and all mixtures containing B plagioclase has a strong presence (figure 7.d, 7.f and 7.g).

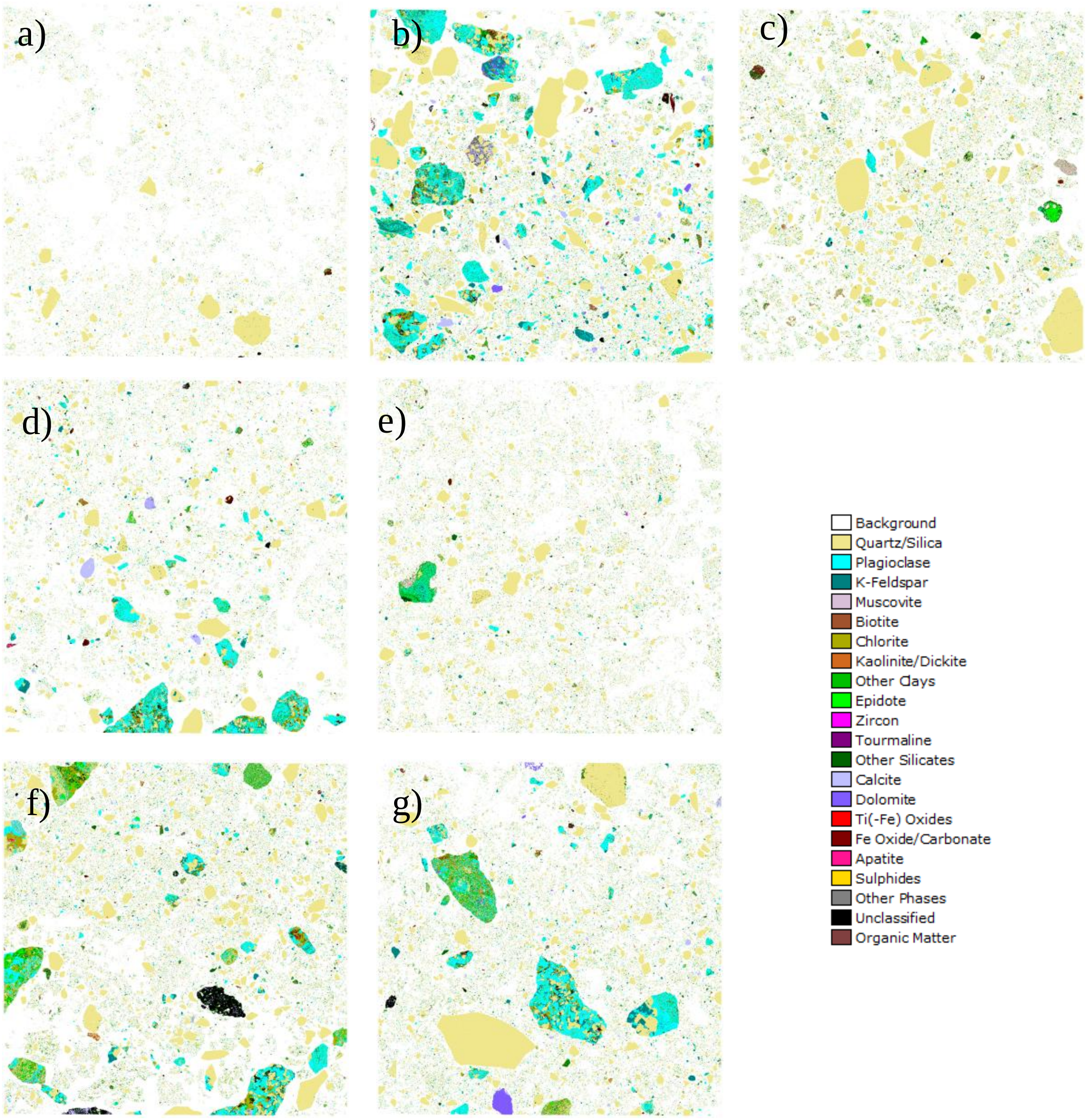


Figure 7.3: London mineral maps a) site A, b) site B, c) site C d) mixture AB, e) mixture AC, f) mixture BC and g) mixture ABC

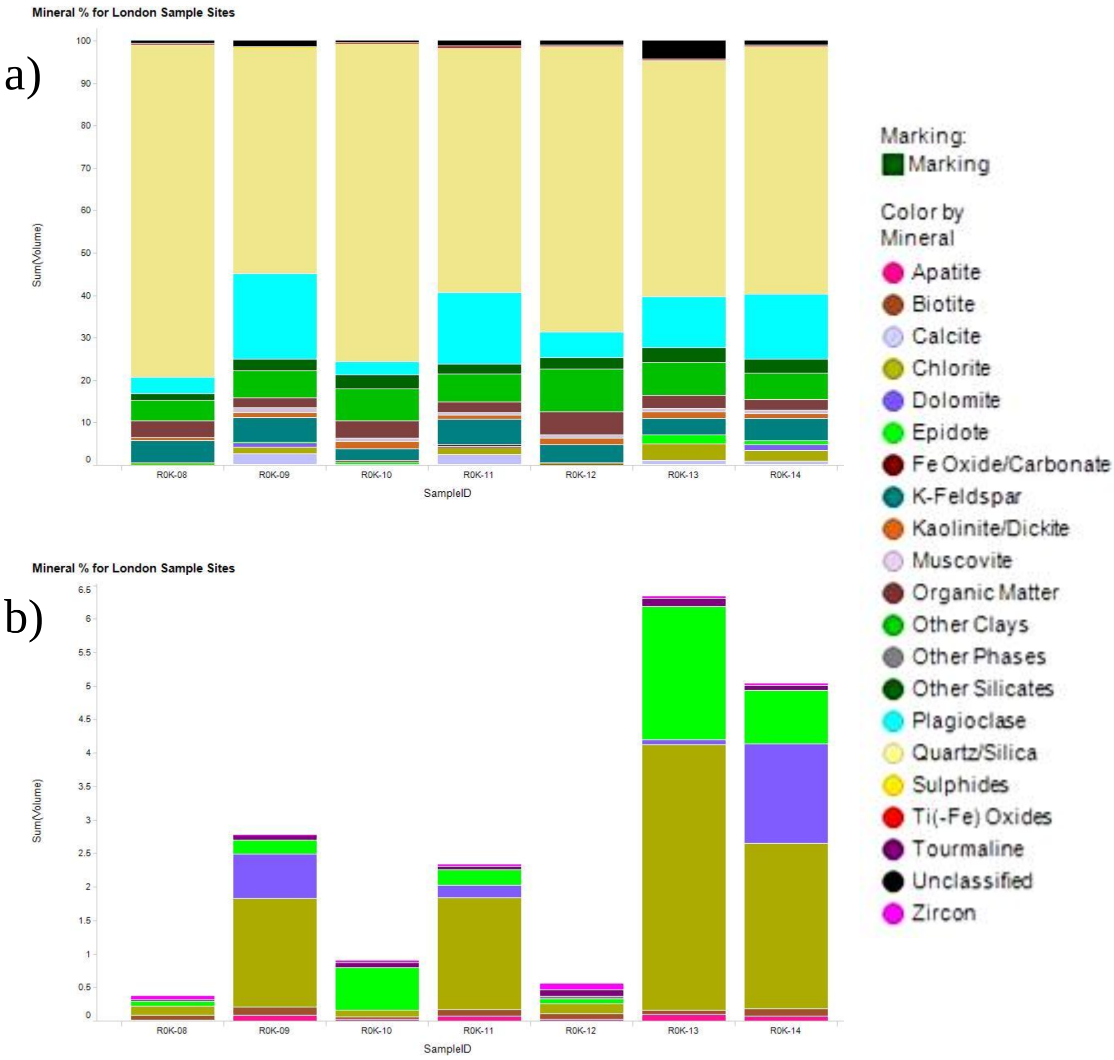


Figure 7.4: London mineral percentages (ROK-08 site A, ROK-09 site B, ROK-10 site C, ROK-11 mixture AB, ROK-12 mixture AC, ROK-13 mixture BC, ROK-14 mixture ABC)

7.3.2 Single Source Versus Mixed Source Samples

As mentioned in section 7.3.1, some similarities were observed in the mixed source samples when compared to the single source sites that they are composed of (e.g. the higher abundance of calcite and dolomite in Nottingham Site A then mixtures AB, AC and ABC). Statistical assessments (section 3.11.1) were used to identify the significance of any relationships that might be present between the single source samples and the mixed source samples created from the single source material. Paired t-tests identified that there was no significant difference at the 95 % significance level ($p = 0.602 - 0.999 > 0.05$ for Nottingham and $p = 0.881 - 0.993 > 0.05$ for London) between the mixed source samples and the single source samples contributing to that mixture for both Nottingham and London sample locations (Table 7.2).

Table 7.2: Paired t-test statistics of the mineralogy for the Nottingham and London sample collections

Collection	Pair	T	Df	Sig. (2-tailed)
Nottingham (October)	A - AB	-.049	19	.961
	A - AC	-.060	19	.953
	A - BC	-.044	19	.965
	A - ABC	.014	19	.989
	B - AB	-.050	19	.961
	B - AC	-.530	19	.602
	B - BC	-.120	19	.906
	B - ABC	-.001	19	.999
	C - AB	.038	19	.970
	C - AC	.013	19	.990
	C - BC	.005	19	.996
	C - ABC	.174	19	.863
London (October)	A - AB	-.055	19	.956
	A - AC	.125	19	.901
	A - BC	-.032	19	.975
	A - ABC	-.054	19	.958
	B - AB	.021	19	.983
	B - AC	.148	19	.884
	B - BC	.069	19	.945
	B - ABC	.032	19	.975
	C - AB	-.072	19	.944
	C - AC	.152	19	.881
	C - BC	-.047	19	.963
	C - ABC	-.072	19	.944

From PCA (table 7.3), a clear distinction between each of the single source control sites can be made for both Nottingham (figure 7.5) and London samples (figure 7.6), and the data points for the mixtures are distributed between the control sites (e.g. mixture AB between sites A and B - figure 7.5). However, in some cases mixtures associate with one control site more than the other (e.g. mixture AC associating more with Site C for London - figure 7.6).

PCA revealed the minerals that are most responsible for distinguishing one site from another (figure 7.5B and figure 7.6B). It is apparent that for Nottingham, the most significant minerals are calcite, dolomite, quartz and plagioclase for Site A (figure 7.5B), which further supports the observations made from plotting the raw data (figure 7.2); apatite, biotite and epidote for Site B, and silicates and zircon for site C. For London, the most significant minerals are iron oxides for site A; calcite, dolomite and plagioclase for site B and zircon for site C (figure 7.6B).

Table 7.3: PCA eigenvalues and cumulative percentage of variance for the Nottingham and London sample collection

Collection	Axes	Eigenvalues	Cumulative Percentage of variance	Total Variance
Nottingham	1	0.421	42.1	1.000
	2	0.222	64.3	
	3	0.165	80.8	
	4	0.146	95.4	
London	1	0.397	39.7	1.000
	2	0.301	69.9	
	3	0.113	81.2	
	4	0.088	90.0	

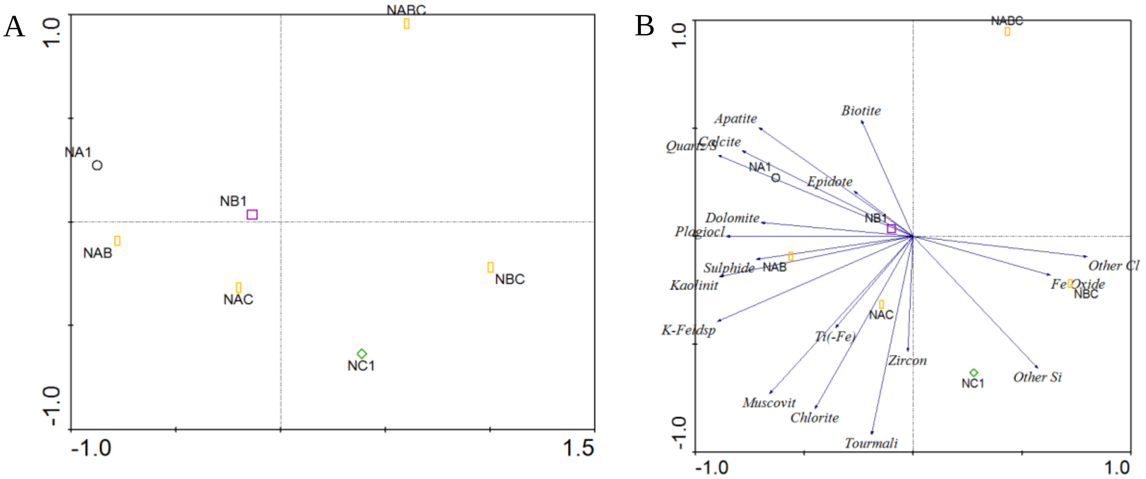


Figure 7.5: PCA biplot for single source and mixed source samples determined by QEMSCAN for the Nottingham sample collection; A - sites and mixtures only, B - minerals significant for variance between sites and mixtures (axis 1 - horizontal, axis 2 - vertical).

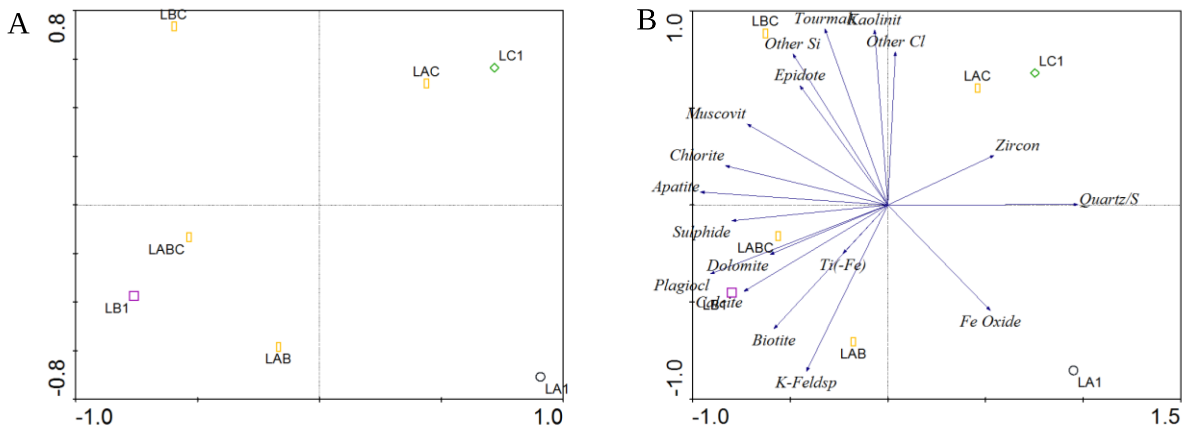


Figure 7.6: PCA biplot for single source and mixed source samples determined by QEMSCAN for the London sample collection; A - sites and mixtures only, B - minerals significant for variance between sites and mixtures (axis 1 - horizontal, axis 2 - vertical).

7.4 Discussion

7.4.1 Single Source Samples

Although the statistical significance of the differences between the control sites could not be determined due to the limited amount of samples that were able to be analysed, differences between the single source control sites could be observed both from the mineral maps (figure 7.1 and figure 7.3) and from plots of the mineral abundance (figure 7.2 and figure 7.4). For instance, there is a large abundance of plagioclase present in London site B (figure 7.3b and 7.4), but not sites A and C (figure 7.3a, 7.3c and 7.4a), which enables this site to be distinguished from A and C. The mineral maps generated through QEMSCAN offer further diagnostic value by illustrating the minerals associated with these large plagioclase grains including minerals such as K-feldspar, quartz, chlorite or Ti(-Fe) oxides in varying assemblages and abundances. Through traditional means of mineral analysis, such as XRD, qualitative and quantitative data can be produced on these minerals even from minute traces of material to assist in the discrimination between sites (Ruffell and Wiltshire, 2004). However, when mineral abundances are too similar to distinguish, these QEMSCAN mineral maps could offer further diagnostic value that could facilitate the discrimination of close proximity sites. Thus establishing when it most beneficial to implement QEMSCAN within a forensic investigation.

7.4.2 Single Source Versus Mixed Source Samples

The large feldspar minerals observed in London site B are also then observed in mixtures that contain material from site B (figure 7.3d, f and g), and could offer insight when dealing with mixed provenance samples. These are commonly encountered in forensic investigations due to the nature of the exhibits that the material is likely to be recovered from, i.e. shoes, tyres, vehicle interiors (Pye and Blott, 2009). Therefore, it is necessary to determine a means of appropriately analysing and interpreting this material, to allow for the correct conclusions to be drawn (Morgan and Bull, 2006). Paired t-tests revealed no significant difference between single source and mixed source samples at the 95 % significance level ($p = 0.602 - 0.999$ for Nottingham and $p = 0.881 - 0.983 > 0.05$ London, table 7.2). More importantly, this was not just the case when comparing mixed source samples to the single source samples that had been used to create those mixtures (e.g. A - AB), but also between single source samples that did not contribute to the mixture (e.g. A - BC). This finding is in agreement with the elemental and stable isotope analyses (chapter 5 and chapter 6 respectively), and therefore provides further emphasis of the complex nature of interpreting geochemical data for mixed provenance material. PCA was also applied to the data in order to visualise the relationship between single source and mixed source samples (figures 7.5 for the Nottingham samples and 7.6 for the London samples). As with the elemental data, it might be expected that the data points for the mixed source samples would be equidistant from the control sites it is composed of, given the mixtures are composed of an equal abundance (1:1 or 1:1:1) of each single source. However, this may not necessarily be the case, as the components are not composed of mutually exclusive components. In figure 7.5 there is some evidence of mixture data points being equidistant between control sites contained within that mixture; mixture AC data point is in-between that of site A and site C; mixture AB between site A and site B. However, without *a priori* knowledge, this would be difficult to interpret. For instance, Nottingham mixture AC could be incorrectly identified as being composed of sites B and C instead, and mixture BC could be considered a different site entirely. This emphasises the potential for a false positive or false negative conclusion occurring within a forensic investigation where a *priori* knowledge is often unavailable. This is an issue that has been articulated in the literature with regards to geochemical evidence (e.g. Morgan and Bull, 2007a). The data obtained in this study supports this theory, thus further highlighting the need to acknowledge and make efforts to address this issue if geochemical analysis is to be reliably used within a forensic investigation. At this stage, such data may be of questionable value in many situations until the issues are rectified. With the London sample sites, in some cases it is observed that a mixture associates more with one control site that then other, e.g. mixture AC with site C or mixture ABC with site B, yet mixture BC is equidistant from sites B and C and mixture AB is between sites A and B. This is a phenomenon that was observed with the elemental data presented in chapter 5 and also in the pilot study (Cheshire *et al.*, 2016), which highlights the complexities surrounding the interpretation of mixed provenance samples even when the control samples and the mixture are known like in this study. In a forensic investigation, this information is not always known, i.e. if it is single or mixed source, the source(s), the number of sources, the proportions of each source or whether it is contributed pre-, syn- and post-forensic event, combined with additional variables to consider such as the analytical technique or sample material itself (Pye *et al.*, 2006a), evidence dynamics (Chisium and Turvey, 2000) or sample preparation (Morgan and Bull, 2007a), which adds complexity to the interpretation of geological material.

7.4.3 Synopsis

In summary, mineralogy determined by QEMSCAN has the potential to discriminate between single source soil/sediment material from close proximity urban locations. However, as with elemental and stable isotope analysis, the interpretation of mixed provenance material is incredibly complex. It highlights the necessity to conduct further experimental studies, to assess the degree of mineral variability within each site and at additional locations, different mixture ratios and forensic reconstructions to establish whether it is feasible to develop an approach that can assist in the discrimination between mixed and single source samples.

7.5 Conclusion

This study set out to assess the feasibility of mineralogy determined via QEMSCAN to distinguish between soil/sediment material from close proximity sites and to discriminate between known mixed source samples and the single source control samples from.

Raw data was plotted in order to observe any identifiable mineral markers that might be used to distinguish between the single source sites and consequently anything that might be observed in mixed source samples that is diagnostic of the source. Paired t-test statistics and PCA were used to assess the significance of potential differences between the mixed source samples and the single source samples from which the mixtures were composed.

Variations in the mineralogy abundances between sites were identified when examining the smaller fractions over the larger fractions in raw data plots, which allowed for effective single source sample discrimination. For example, dolomite and calcite in Nottingham site A compared to clays and quartz, which was further supported through PCA, and indicates the potential for discrimination between single source close proximity sites based on mineralogy. The mixed source samples, however, are inherently more complex. It may be necessary to seek an alternative approach in which the particulate mineral maps are used to characterise a sample based on particle characteristics over bulk sample properties (composition percentages), to identify site specific particles that therefore enable effective single-mixed source discrimination. Whilst further experimentation is necessary, these preliminary findings support those of the elemental assessments performed in chapter 5 and the pilot study (Cheshire *et al.* 2016), which is promising as it provides an additional independent analytical technique that may be used in the assessment of geological evidence to enable robust conclusions to be derived for use in court. Although QEMSCAN analysis may be considered undesirable due it initial start-up costs and the expense of purchasing the instrumentation, it gives a comprehensive assessment with high reproducibility (Pirrie *et al.*, 2009), and the sample preparation is much quicker and easier ,which is beneficial due to the limited time present in a forensic investigation, and reduced cost to cover operator time. Whilst QEMSCAN can provide a wealth of information from the sample, including mineral identity, mineral mapping, surface morphology, elemental composition and particle size, it should still be used in conjunction with other independent lines of enquiry, e.g. mineral surface textures, bacterial DNA, or organic approaches such as pollen analysis or plant wax signatures, to enable the analysis of as many components of the soil sample as possible to enable independent lines of enquiry to be provided that can contribute to more transparent and robust interpretations to be made in comparative approaches that can reduce the opportunities for false negative or false positive conclusions.

Chapter 8 Multivariate Statistical Analysis and End-Member Modelling of Critical Elements to Address Geochemical Evidence Interpretation Issues

8.1 Introduction

In the previous chapters, the complexities associated with the interpretation of single and mixed provenance soil/sediment material have been demonstrated. These are empirical findings that support concerns articulated in the literature regarding the feasibility of geochemical analysis to reliably discriminate forensically relevant geological evidence (e.g. Morgan and Bull, 2007a). There are number of factors that could be contributing to the complexities experienced when interpreting geochemical data for single and mixed source samples. In addition to the role of evidence dynamics in real casework (i.e. the transfer and persistence of the material and mixing that occurs on the recipient surface during movement) and additional mixing in the sample preparation (i.e. homogenisation and/or dissolution), other factors include the number of elements that are being assessed via the elemental techniques in the first place, the ability of the techniques to assess certain elements (e.g. lighter elements such as Na are problematic for XRF analysis) and the statistical methods adopted to evaluate the data (Rawlins and Cave, 2004; Morgan and Bull, 2006; Morgan and Bull, 2007c).

In previous published work (e.g. Pye *et al.*, 2006b), a large number of elements are assessed when analysing geological evidence; typically 16 elements on ICP-AES, and 33 elements via ICP-MS. XRF spectrometers can assess up to 82 elements, from Sodium (^{11}Na) to Uranium (^{92}U) (HORIBA, 1996-2016). It has been asserted that the larger the suite of elements examined, the greater the discrimination between samples (Rawlins and Cave, 2004; Pye *et al.*, 2006b). However, there is an absence of systematic data to support this theory, and it has come under question (e.g. Bull *et al.*, 2008; Morgan and Bull, 2007c) as it contradicts the findings of other studies (e.g. Jarvis *et al.*, 2004). It is important to acknowledge that the degree of variation in elemental abundances over short and long distances is not consistent. For instance, over short distances the concentrations may differ greatly within one location, but remain steady in another; a driving factor in this would be the contribution of anthropogenic material from human or animal activity. Additionally, when comparing samples over large distances, more substantial differences are expected. However, should the parent material of these sites be the same (e.g. limestone), these differences may be more subtle (Rawlins and Cave, 2004), and discrimination again would depend on anthropogenic contributions in the surface sediment. Therefore, it is necessary to determine whether the elements of interest are site specific, or if there could be a particular suite of elements that can be consistently used between different sites to offer an effective level of discrimination, not only between single source samples but of mixed source samples too. Assessing fewer elements could potentially reduce the interpretation complications between single and mixed source samples, whilst also lowering the cost and time of analysis, which is of great benefit to forensic investigation where timing can be crucial and the funding is limited.

Another factor to consider is the statistical means in which the data are assessed and interpreted. Determining the evidential value, i.e. the level of similarity or dissimilarity, is crucial for decisions regarding the exclusion of evidence and/or persons of interest and consequently ensuring that the appropriate avenues are investigated (Horrocks and Walsh, 1998; Morgan and Bull; 2007), and statistical analysis can provide an objective means in which to do this, provided the method employed is relevant to address the question being asked (Isphording, 2004). If the incorrect statistics are applied, incorrect conclusions may be drawn and the evidence can be discredited, which can also affect how other evidence and its interpretations are perceived (Lagnado and Harvey, 2008). However, there is no standardised approach to the statistical assessment of a number of evidence types (Curran, 2013), including geological evidence, and rigorous testing is required to ascertain the reliability of methods (Risinger and Saks, 2003). Some methods commonly adopted within forensic science and traditional geosciences include multivariate statistics (Johnson and Erhlich, 2002; Mudge, 2007; Morgan and Bartick, 2007; Greenacre and Primicerio, 2014) and Bayesian modelling (Aitken and Taroni, 2004; Jackson *et al.*, 2006; Robin *et al.*, 2010; Kruse, 2013; Shennan *et al.*, 2014).

Multivariate statistics are used to examine large data sets in order to ascertain how the variables are related to one another (if at all) by identifying trends and patterns in the data. These trends and patterns then allow for samples to either be distinguished from one another or illustrate how they are associated (Greenacre and Primicerio, 2014) e.g. a fibre originating from a different batch or from the same batch as the evidentiary exhibit. These statistical methods function to reduce these large data sets to identify the key contributors that enable discrimination (Miller and Miller, 2010). Methods that have been effectively used in forensic science and geology to identify patterns or discriminate samples include Principal Component Analysis (PCA) (Johnson *et al.*, 2002), factor analysis such as CDFA (Barata *et al.*, 2012; Morgan and Bull, 2006), multivariate regression analysis (Johnson and Ehrlich, 2002; Pringle *et al.*, 2010), and cluster analysis (Morgan and Bull, 2006; Kaufman and Rousseeuw, 2009). In previous chapters, the use of CDFA and PCA to explore data sets has been examined, as they have frequently shown success at discriminating samples based on elemental and isotopic data (e.g. Boyd *et al.*, 2006; Morgan and Bartick, 2007; Singh *et al.*, 2011; Bailey *et al.*, 2012; Reidy *et al.*, 2013). However, it has been demonstrated that interpreting such statistical outputs for mixed provenance geological material is fraught with complications where a *priori* knowledge is absent, as would occur in a true forensic investigation. This increases the potential occurrence of false negative or positive conclusions resulting in erroneous verdicts in court (Morgan and Bull, 2006).

Bayesian modelling involves producing statistical models based on Bayes theorem (figure 8.1). It is particularly popular in forensic science, as Bayesian modelling has the ability to determine uncertainties (Kruse, 2013) with applications to a number of different trace evidence types documented, including glass (Bennett *et al.*, 2003), paint (Massonett *et al.*, 2014), fibres (Grieve and Dunlop, 1992; Roux and Robertson, 2013), geological material (Small *et al.*, 2004; Horrocks and Walsh, 1998; Mildenhall *et al.*, 2006), and biological i.e. DNA (Biedermann and Taroni, 2012), as it allows for likelihood ratios (figure 8.1) for the occurrence of the evidence based on the nature of the material (e.g. comparison to databases) and the case circumstances (Aitken and Taroni, 2004).

$$\frac{\Pr(H_p|\text{Evidence})}{\Pr(H_d|\text{Evidence})} = \frac{\Pr(\text{Evidence}|H_p)}{\Pr(\text{Evidence}|H_d)} = \frac{\Pr(H_p)}{\Pr(H_d)}$$

Figure 8.1: Bayes theorem likelihood ratios for forensic science (Adapted from Bell (2006)).

Where Hp = the prosecution hypothesis and Hd = the defence hypothesis; the posterior odds are how probable the hypothesis is given the evidence; the prior odds are how probable the hypothesis is before observing evidence; and the likelihood ratio is the probability of the evidence occurring given the prosecution hypothesis over the probability of the evidence occurring given the defence hypothesis.

Issues arise in Bayesian modelling when it is required to estimate probabilities due to the absence of sufficient information, e.g. a comprehensive database to compare evidence data to, which allows for a level of inter-subjectivity to be introduced which can result in biased outcomes (Uusitalo, 2007; Kruse, 2013). This has lead to reservations on the use of Bayesian modelling in forensic investigation being articulated in the literature (e.g. Risinger, 2013). There is a lack of relevant databases within forensic geoscience, particularly with regards to the elemental composition of soil/sediment (Morgan and Bull, 2006), which would complicate the determination of probabilities required to conduct statistical assessments such as Bayesian modelling. Additionally the application of Bayesian modelling to determine spatial and temporal aspects of the sample is a tedious and time consuming process, due to the inability to introduce feedback loops in the model (Uusitalo, 2007), which is undesirable in forensic casework as timing can be crucial to solving a case, and as lengthier analysis results in increased financial costs.

Another method which is yet to be considered within the forensic interpretation literature is end-member modelling (EMM) which can be used to statistically interpret samples that are suspected of being mixtures (e.g. containing soil from more than one location). EMM is considered a more robust algorithm that has better convergence properties than other statistical methods, including those previously mentioned, to solve the unmixing problem (Weltje, 1997). It is more commonly adopted within traditional geoscience applications to determine multiple provenances within mixtures i.e. from sediment cores (Weltje, 1997; Weltje and Prins, 2003). Mixtures in this context can be defined as the combination of sediment from two or more sources, of which there is no chemical reaction between, therefore, leaving the constituents (or end members) unaltered (Christophersen and Hooper, 1992). Whilst interpretation of EMM outputs are greatly improved if it is known that samples are mixtures it is not requirement (e.g. like a prior in a Bayesian model). There are two forms; linear unmixing, in which the end-members are known, and bilinear inversion, where values of end members and the mixing proportions are unknown, and therefore require to be estimated (Weltje, 1997). Typically it is applied to particle size data (e.g. Tjallingi *et al.* 2008; Dietze *et al.*, 2012; McGee *et al.*, 2013), where particular grain size distributions are identified as the end members, though applications to geochemical data have been documented (e.g. Hanson *et al.*, 1993; Douglas *et al.*, 2003; Mulitza *et al.*, 2010; Laceby and Olley, 2015; Négrel *et al.*, 2015), in which elemental composition and/or abundance are the end members which may be identified through PCA (Christophersen and Hooper, 1992; Murphy and Morrison, 2014). Applications have been also been documented within forensic science e.g. Linford and Platzman (2004), where EMM was applied to magnetic susceptibility of iron measurement data, to determine origin and movement of archaeological remains. The fundamental differences between traditional geoscience and forensic geoscience are the amount of material available for analysis, and the approach taken i.e. reconstructions based on similarities versus exclusion (Morgan and Bull, 2007a); in traditional geoscience, there is a greater abundance of material than in forensic science, where typically trace amounts of material are being dealt with. Therefore, it should be established if EMM is feasible to address unmixing on geochemical evidence obtained from smaller sample sizes like that experienced in forensic cases.

Aims and objectives

The research in this chapter aimed to reduce the number of elements assessed (and subsequently the time and cost of analysis), and to ascertain the most effective statistical means for the reliable interpretation of mixed provenance geological evidence.

In order to address these aims, the following objectives were identified:

1. To establish if multivariate statistical analyses (e.g. CDFA, PCA) can be successfully performed on a smaller number of elements to discriminate between single and mixed source samples
2. To establish the feasibility of EMM to solve the 'unmixing' issue on geochemical evidence.

8.2 Method

8.2.1 Critical Elements

Sub-sets of elements (table 8.1), have been selected based on the findings of ANOVA, CDFA and PCA from chapter 5. Only elements that were identified as statistically significant in every collection (October, January, April and July) were selected to provide consistency. These have then been subjected again to statistical analyses described in section 3.11.1, to ascertain if samples may still be discriminated based on these reduced element sets, and to seek a reduced and common set of elements to be utilised for the discrimination of single and mixed source samples of close proximity sites.

8.2.2 End-Member Modelling

Suitable end-members were identified using the combined outputs from ANOVA, CDFA and PCA of the elemental data obtained in chapter 5 and subjected to EMM (see section 3.11.2). First elements identified as being statistically significant for each of these statistical analyses were identified, this sub-set of elements was then further reduced by selecting those only with the lowest p-values (i.e. those equal to 0.000).

8.3 Results

8.3.1 Critical Elements - Single Source Samples

Table 8.1 identifies common elements identified to be discriminatory (i.e. statistically significant between sites, $p < 0.050$) for the study sites used in this thesis (see section 3.1.1) based on previous statistical assessments (tables 5.7, 5.20 and 5.33, chapter 5). The elements identified as crucial to site discrimination have been selected to determine whether their discriminatory power is lessened by the removal of elements deemed to be non-significant in the original findings (chapter 5). Selecting a reduced number of discriminatory elements may currently be difficult to incorporate into forensic investigation. However, it should first be identified if it is possible to do so, by testing this theory on the sites in this study. The application of this approach in other locations can then subsequently be resolved and therefore allow it to be implemented in forensic investigation.

Table 8.1: Elements found to be consistently most discriminative by previous assessments

	XRF	ICP-MS	ICP-AES
Nottingham reduced elements	Mg, Al, Si, P, S, Cl, K, Ca, Ti, Fe, Zn, Ga, Rb, Sr, Y, Sn, Ba, Pb.	Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U.	Al, Fe, K, Ni, P, Ti.
London reduced elements	Mg, Al, Si, P, Ca, Fe, Co, Ni, Cu, Zn, Ga, Se, Rb, Sr, Y, Zr, Cs, Ta, Pb, Th.	V, Co, Cu, Sr, Y, Nb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, U.	Al, Be, Fe, Mg, Mn, Ni, P, Ti and Zn.
Common elements	Mg, Al, Si, P, Ca, Fe, Zn, Ga, Rb, Sr, Y, Pb.	Sm, Eu, Gd, Tb, Dy, Ho, Er, U.	Al, Fe, Ni, P, Ti.

ANOVA statistical outputs are summarised for Nottingham (table 8.2) and London (table 8.3; see appendix 8.1 - 8.48 for full output), and it was identified that sites were still effectively discriminated based on the reduced data set. However, in some cases, elements that were identified as being statistically significant between sites previously became statistically non-significant e.g. Nottingham Be (October) and Ti (January) determined via ICP-AES (table 8.2 (new) versus table 5.33 (original).

Table 8.2: ANOVA statistical output on the reduced element data for the Nottingham sample collections

Technique	Element	Statistical Significance of Element for Each Collection			
		October	January	April	July
XRF	S	.000	.001	.000	.000
	Cl	.042	.002	.005	.315
	K	.000	.000	.000	.000
	Ti	.003	.000	.000	.000
	Sn	.002	.004	.005	.012
	Ba	.033	.000	.000	.000
	Si	.025	.000	.000	.002
	P	.002	.000	.000	.000
	Zn	.002	.001	.000	.000
	Mg	**.000**	**.000**	**.000**	**.001**
	Al	**.000**	**.000**	**.000**	**.000**
	Ca	**.001**	**.011**	**.002**	**.003**
	Fe	**.000**	**.000**	**.000**	**.000**
	Ga	**.007**	**.000**	**.000**	**.004**
	Rb	**.000**	**.000**	**.000**	**.001**
	Sr	**.000**	**.000**	**.038**	**.011**
	Y	**.012**	**.000**	**.000**	**.000**
	Pb	**.004**	**.001**	**.000**	**.000**
ICP-MS	Tm	.004	.007	.002	.037
	Yb	.009	.008	.001	.065
	Lu	.006	.003	.001	.062
	Sm	**.009**	**.003**	**.000**	**.014**
	Eu	**.012**	**.012**	**.000**	**.013**
	Gd	**.014**	**.012**	**.000**	**.011**
	Tb	**.008**	**.005**	**.000**	**.028**
	Dy	**.009**	**.033**	**.000**	**.010**
	Ho	**.005**	**.009**	**.000**	**.038**
	Er	**.016**	**.003**	**.000**	**.030**
	U	**.042**	**.024**	**.000**	**.000**
ICP-AES	K	.002	.001	.000	.000
	Be	.059	.000	.035	.002
	Al	**.000**	**.000**	**.000**	**.000**
	Fe	**.000**	**.000**	**.000**	**.000**
	Ni	**.022**	**.000**	**.007**	**.001**
	P	**.003**	**.000**	**.000**	**.000**
	Ti	**.000**	**.076**	**.000**	**.000**

*values in bold represent the common element set (see table 8.1)

**P values > 0.05 (i.e. statistically non-significant) are highlighted in grey

Table 8.3: ANOVA statistical output on the reduced element data for the London sample collections

Technique	Element	Statistical Significance of Element for Each Collection			
		October	January	April	July
XRF	Co	.010	.000	.004	.033
	Ni	.000	.000	.000	.000
	Cu	.000	.000	.011	.001
	Se	.000	.000	.046	.000
	Zr	.000	.000	.045	.000
	Cr	.001	.001	.040	.000
	Ta	.000	.000	.012	.001
	Th	.000	.001	.015	.000
	Mg	.000	.000	.020	.000
	Al	.000	.000	.000	.000
	Ca	.000	.000	.007	.000
	Fe	.000	.000	.010	.000
	Ga	.001	.006	.019	.022
	Rb	.000	.005	.039	.001
	Sr	.000	.000	.008	.000
	Y	.000	.000	.002	.000
	Pb	.003	.000	.046	.009
ICP-MS	V	.000	.000	.000	.000
	Co	.000	.000	.000	.000
	Cu	.000	.000	.001	.000
	Sr	.000	.000	.000	.000
	Y	.000	.000	.000	.000
	Nb	.002	.001	.000	.002
	La	.000	.000	.007	.000
	Ce	.000	.000	.009	.000
	Pr	.000	.000	.005	.000
	Nd	.000	.000	.004	.000
	Sm	.005	.000	.009	.000
	Eu	.004	.000	.006	.000
	Gd	.001	.000	.006	.000
	Tb	.003	.000	.008	.000
	Dy	.000	.000	.003	.000
	Ho	.001	.000	.004	.000
	Er	.002	.000	.006	.000
	U	.003	.001	.042	.001
ICP-AES	Mg	.000	.000	.001	.000
	Zn	.004	.000	.001	.002
	Mn	.017	.000	.002	.011
	Al	.000	.000	.000	.000
	Be	.000	.000	.000	.000
	Fe	.000	.000	.000	.000
	Ni	.000	.000	.000	.000
	P	.000	.000	.000	.000
	Ti	.000	.001	.000	.001

*values in bold represent the common element set (see table 8.1)

For CDFA 100 % of the sites were correctly classified for both the Nottingham and London sample locations. From CDFA of the reduced element data sets for each location, it was identified, for the most part, that sites could be discriminated between, with the exception of elements contributing to function 2 determined by ICP-MS ($p = 0.933 > 0.05$) in April and ICP-AES ($p = 0.216 > 0.05$) in October, for the Nottingham sites (table 8.5). However, as these functions account for only 0.8 % (ICP-MS) and 2 % (ICP-AES) of the variance, it has minimal influence on the findings. Sites could not be discriminated using element data determined by XRF for the April collection in the London sample location only, where 98.2% of the variance is explained by function 1 through 2 elements ($p = 0.110 > 0.050$) and 1.8 % from function 2 elements where $p = 0.917 > 0.050$ (tables 8.7 and 8.8). For the common reduced element set, a significant difference could be identified between the single source sites, with the exception of ICP-MS data for Nottingham sample sites; all functions from the October ($p = 0.107$ and 0.569), April ($p = 0.211$ and 0.888) and July ($p = 0.112$ and 0.543) collections, and function 2 of the January ($p = 0.066$) collection were non-significant (table 8.11), and function 2 elements determined by XRF for the April ($p = 0.835$) collection in London (table 8.14). Additionally, from the CDFA graphical outputs produced, it is evident that although sites are clearly discriminated, the within site variation appears greater for the common reduced element sets than the original data sets analysed in chapter 5. For example, for the Nottingham ICP-MS data (figure 8.9), intra-sample site variability is observed, in particular for sites B and C in the October collection, and for the October and July collections based on assessments of the ICP-AES data (figure 8.10). Similarly, within site variation is observed for the London sample sites; XRF data for the April collection (figure 8.11), ICP-MS data (figure 8.12) and ICP-AES data for April (figure 8.13).

Table 8.4: CDFA eigenvalues for the reduced element data for the Nottingham sample collections

Technique	Collection	Function	Eigenvalue	Percentage of Variance	Cumulative Percentage	Canonical Correlation
XRF	October	1	284.870	90.7	90.7	.998
		2	29.213	9.3	100.0	.983
	January	1	1269.128	96.8	96.8	1.000
		2	41.764	3.2	100.0	.988
	April	1	1372.523	90.4	90.4	1.000
		2	145.211	9.6	100.0	.997
	July	1	801.970	97.5	97.5	.999
		2	20.951	2.5	100.0	.977
ICP-MS	October	1	16.392	68.3	68.3	.971
		2	7.599	31.7	100.0	.940
	January	1	109.547	80.2	80.2	.995
		2	27.080	19.8	100.0	.982
	April	1	145.296	99.2	99.2	.997
		2	1.147	.8	100.0	.731
	July	1	57.871	76.2	76.2	.991
		2	18.074	23.8	100.0	.973
ICP-AES	October	1	99.160	98.0	98.0	.995
		2	2.074	2.0	100.0	.821
	January	1	2021.792	99.3	99.3	1.000
		2	13.378	.7	100.0	.965
	April	1	47.719	67.0	67.0	.990
		2	23.467	33.0	100.0	.979
	July	1	33.799	55.0	55.0	.986
		2	27.633	45.0	100.0	.982

Table 8.5: CDFA Wilks' Lambda values for the reduced element data for the Nottingham sample collections

Technique	Collection	Function	Wilks' Lambda	Chi Square	Df	Sig.
XRF	October	1 through 2	.000	58.915	24	.000
		2	.033	22.154	11	.023
	January	1 through 2	.000	76.318	24	.000
		2	.023	26.290	11	.003
	April	1 through 2	.000	79.366	24	.000
		2	.007	32.403	11	.001
	July	1 through 2	.000	63.551	24	.000
		2	.046	20.077	11	.044
ICP-MS	October	1 through 2	.007	40.061	24	.002
		2	.116	17.213	11	.028
	January	1 through 2	.000	52.263	24	.001
		2	.036	21.678	11	.027
	April	1 through 2	.003	37.372	24	.040
		2	.466	4.966	11	.933
	July	1 through 2	.001	49.166	24	.001
		2	.052	20.638	11	.024
ICP-AES	October	1 through 2	.003	48.704	16	.000
		2	.325	9.547	7	.216
	January	1 through 2	.000	87.362	16	.000
		2	.070	22.658	7	.002
	April	1 through 2	.001	60.209	16	.000
		2	.041	27.177	7	.000
	July	1 through 2	.001	58.685	16	.000
		2	.035	28.514	7	.000

Table 8.6: CDFA structure matrix for the reduced element data for the Nottingham sample collections (elements contributing most to each function in descending order)

Technique	E	October		E	January		E	April		E	July	
		F1	F2		F1	F2		F1	F2		F1	F2
XRF	Mg	-.140	.008	Ba	.307*	.183	Ga	-.286*	.029	Pb	-.290*	.043
	Ba	-.118	.100	Ga	.297*	-.114	Sn	.215*	-.081	Zn	.025	.422*
	S	.108	.023	Pb	.275*	-.043	Rb	-.200*	.108	Fe	-.023	-.358*
	Ti	-.073	.067	Zn	.110*	.028	Pb	.090*	-.071	Rb	-.133	-.346*
	Sn	-.222	-.432*	Sn	.090*	-.016	Mg	-.084*	.079	P	.031	.340*
	Sr	-.023	.422*	P	.053*	.019	Zn	.066*	-.036	Sn	.276	.312*
	Fe	-.175	.337*	Si	.059	-.457*	Fe	-.064*	.021	Mg	-.034	-.278*
	Y	-.208	.292*	Ti	.035	-.418*	Ba	-.092	.460*	Al	-.040	-.275*
	Zn	.037	.270*	K	.025	-.345*	S	.082	-.263*	Ti	-.044	-.267*
	Pb	.048	-.268*	Y	.294	-.342*	Sr	.135	.230*	S	.076	.263*
	Ca	.015	-.267*	Rb	.034	-.323*	Si	-.067	.217*	Ba	-.055	-.255*
	Rb	-.096	.203*	Al	.001	-.317*	Ti	-.090	.195*	Ca	-.022	.246*
	Al	-.128	.182*	Sr	.033	-.279*	Y	-.060	.147*	Ga	-.020	-.241*
	Cl	.028	-.127*	Fe	-.002	-.267*	K	-.083	.136*	K	-.049	-.215*
	K	-.094	.102*	Mg	-.021	-.220*	Al	-.091	.127*	Si	-.039	-.178*
	P	.076	-.098*	Cl	-.002	.204*	P	.057	-.077*	Y	-.130	-.172*
	Ga	-.062	.078*	Ca	.019	-.129*	Cl	.023	-.069*	Sr	-.041	.157*
	Si	-.051	.063*	S	.038	.084*	Ca	.030	.057*	Cl	-.008	.088*
ICP-MS	U	-.063*	-.007	Sm	.119*	.057	Dy	-.144*	.138	Eu	.136*	.009
	Pb	.402	.483*	Tb	.105*	.081	Lu	-.115	.506*	Gd	.135*	-.064
	Ho	.177	.344*	Gd	.098*	.035	Tm	-.109	.427*	Sm	.133*	-.013
	Sm	.135	.340*	Ho	.094*	.087	Ho	-.174	.368*	Dy	.132*	-.090
	Dy	.143	.333*	Eu	.093*	.070	Yb	-.122	.309*	Tb	.118*	.028
	Tm	.197	.331*	U	.087*	-.029	Eu	-.156	.297*	Er	.117*	.005
	Gd	.118	.328*	Dy	.077*	.063	Tb	-.159	.286*	Ho	.112*	-.001
	Tb	.158	.328*	Pb	-.078	.199*	Sm	-.143	.249*	Tm	.103*	.083
	Eu	.140	.320*	Lu	.107	.131*	Er	-.183	.249*	Yb	.100*	.004
	Er	.137	.298*	Er	.105	.116*	U	-.132	.221*	Lu	.095*	.063
	Yb	.189	.288*	Yb	.093	.102*	Gd	-.147	.198*	Pb	.084	.394*
	Lu	.180	.247*	Tm	.096	.098*	Pb	.042	-.195*	U	.227	-.374*
ICP-AES	K	-.060	-.819*	Be	-.040*	-.027	Fe	.319*	-.248	P	.448*	.005
	Ni	-.012	-.649*	P	.027	-.360*	Ti	.274	-.504*	Ti	-.394*	-.153
	Fe	-.218	-.640*	Mn	.004	.221*	K	.173	-.498*	Al	-.368*	-.108
	P	.094	.628*	Al	-.033	.173*	P	-.217	.416*	Fe	-.343*	-.006
	Al	-.187	-.564*	K	-.032	.162*	Al	.289	-.396*	K	-.316*	-.224
	Mn	-.010	-.460*	Ti	-.012	.135*	Be	.045	-.167*	Ni	-.254*	-.055
	Ti	-.161	-.390*	Fe	-.081	.130*	Mn	-.086	-.157*	Be	-.226*	-.002
	Be	-.073	-.195*	Ni	-.047	.103*	Ni	.131	-.140*	Mn	-.038	-.186*

*largest absolute correlation between each variable and any discriminant function

E - element F1 - function 1 F2 - function 2

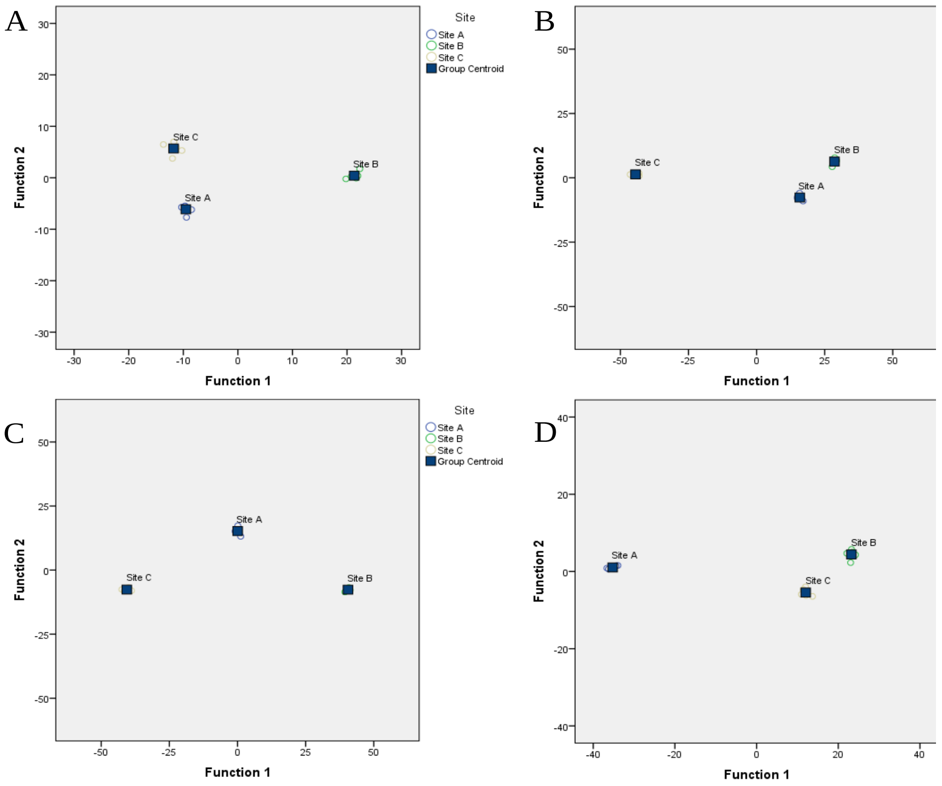


Figure 8.2: CDFA chart for XRF reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

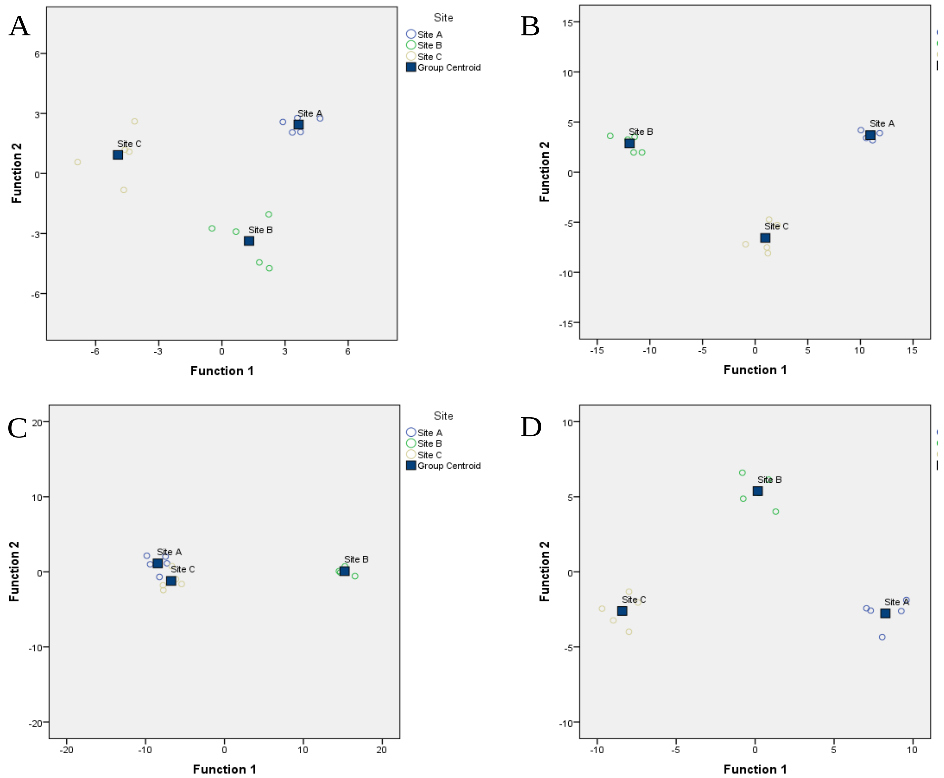


Figure 8.3: CDFA chart for ICP-MS reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

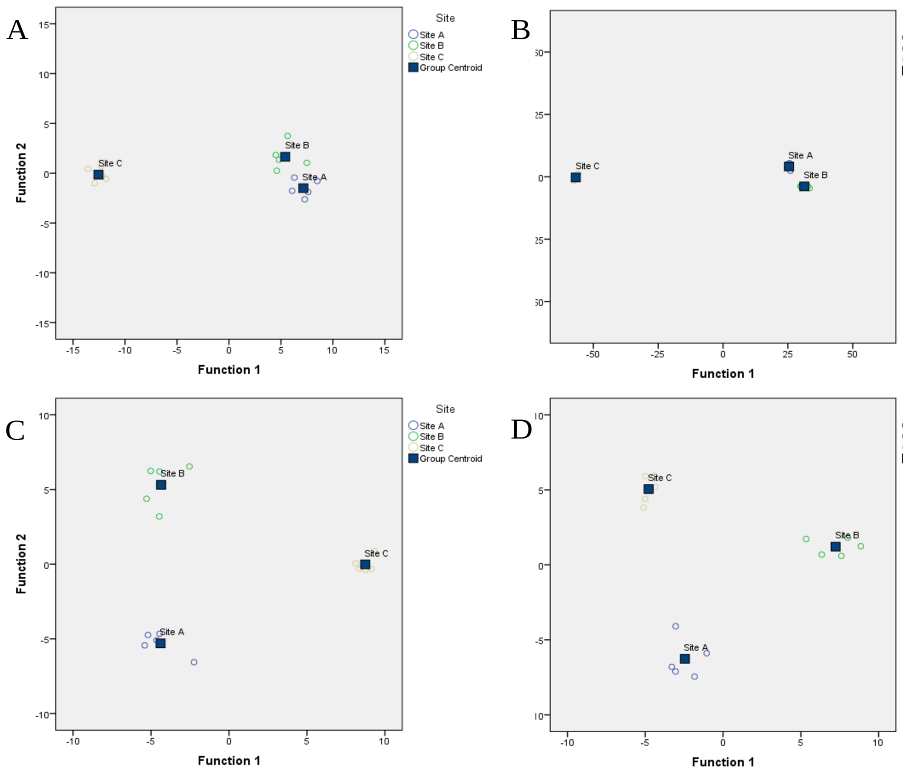


Figure 8.4: CDFA chart for ICP-AES reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

Table 8.7: CDFA eigenvalues for the reduced element data for the London sample collections

Technique	Collection	Function	Eigenvalue	Percentage of Variance	Cumulative Percentage	Canonical Correlation
XRF	October	1	10576.558	84.5	84.5	1.000
		2	1939.242	15.5	100.0	1.000
	January	1	14233.395	95.3	95.3	1.000
		2	708.354	4.7	100.0	.999
	April	1	67.309	98.2	98.2	.993
		2	1.250	1.8	100.0	.745
	July	1	797.421	78.5	78.5	.999
		2	218.940	21.5	100.0	.998
ICP-MS	October	1	272.897	73.0	73.0	.998
		2	101.149	27.0	100.0	.995
	January	1	737.256	83.9	83.9	.999
		2	141.743	16.1	100.0	.996
	April	1	140.880	75.7	75.7	.996
		2	45.313	24.3	100.0	.989
	July	1	2086.759	97.9	97.9	1.000
		2	44.843	2.1	100.0	.989
ICP-AES	October	1	917.754	80.1	80.1	.999
		2	227.803	19.9	100.0	.998
	January	1	266.428	72.4	72.4	.998
		2	101.725	27.6	100.0	.995
	April	1	125.648	73.0	73.0	.996
		2	46.506	27.0	100.0	.989
	July	1	482.232	67.8	67.8	.999
		2	228.706	32.2	100.0	.998

Table 8.8: CDFA Wilks' Lambda values for the reduced element data for the London sample collections

Technique	Collection	Function	Wilks' Lambda	Chi Square	Df	Sig.
XRF	October	1 through 2	.000	109.441	24	.000
		2	.001	49.209	11	.000
	January	1 through 2	.000	104.831	24	.000
		2	.001	42.668	11	.000
	April	1 through 2	.007	32.727	24	.110
		2	.444	5.270	11	.917
	July	1 through 2	.000	78.494	24	.000
		2	.005	35.057	11	.000
ICP-MS	October	1 through 2	.000	71.674	22	.000
		2	.010	32.385	10	.000
	January	1 through 2	.000	80.957	22	.000
		2	.007	34.727	10	.000
	April	1 through 2	.000	61.533	22	.000
		2	.022	26.848	10	.003
	July	1 through 2	.000	80.283	22	.000
		2	.022	26.776	10	.003
ICP-AES	October	1 through 2	.000	98.047	18	.000
		2	.004	43.463	8	.000
	January	1 through 2	.000	81.767	18	.000
		2	.010	37.056	8	.000
	April	1 through 2	.000	69.618	18	.000
		2	.021	30.887	8	.000
	July	1 through 2	.000	92.938	18	.000
		2	.004	43.494	8	.000

Table 8.9: CDFA structure matrix for the reduced element data for the London sample collections (elements contributing most to each function in descending order)

Technique	E	October		E	January		E	April		E	July	
		F1	F2		F1	F2		F1	F2		F1	F2
XRF	Ta	-.212*	-.111	Ta	.150*	.024	Ta	.355*	.039	Cs	-.275*	.153
	Ga	.014*	.012	Pb	.066*	.063	Fe	.130*	.127	Ca	.262*	-.243
	Cs	-.155	.317*	Se	-.020*	.019	Zr	-.103*	-.044	Th	.230*	.163
	Th	.024	-.168*	Ca	.049	.222*	Rb	-.103*	-.006	Ta	.164*	.025
	Sr	-.001	.124*	Cs	.027	.187*	Cs	-.345	.496*	Al	.096*	.046
	Ca	-.006	.123*	Sr	.035	.181*	Ga	.098	.490*	Sr	.093*	-.072
	Fe	-.007	.095*	Zr	-.111	.130*	Mg	.097	.486*	Ni	.059*	-.009
	Al	.045	.078*	Al	-.007	.115*	Sr	.124	.391*	Mg	.059*	-.046
	Pb	.001	-.060*	Y	-.013	.108*	Al	.189	.353*	Ga	.033*	.012
	Mg	.005	.058*	Ni	.015	.105*	Pb	.139	-.325*	Co	.031*	.002
	Y	-.021	-.051*	Mg	.011	.090*	Ni	.206	-.290*	Zr	-.103	.211*
	Cu	-.003	.045*	Fe	.023	.077*	Th	-.079	-.246*	Fe	.150	-.155*
	Ni	.005	.045*	Cu	.020	.076*	Y	.162	-.233*	Y	.071	.154*
	Se	.028	-.031*	Co	.005	.062*	Se	.095	-.229*	Se	-.027	.131*
	Zr	.018	-.029*	Th	.030	.046*	Co	.149	.207*	Rb	-.002	-.106*
	Co	.002	.024*	Ga	-.007	.032*	Cu	.126	-.190*	Cu	.044	-.046*
	Rb	-.014	.018*	Rb	.008	-.026*	Ca	.138	.140*	Pb	.025	.034*
ICP-MS	Dy	-.202*	.188	Sr	.200*	-.048	U	-.070*	-.015	Eu	.111*	-.025
	Sm	-.199*	.161	Er	.130*	-.080	Sr	.126	.414*	Co	.089*	-.065
	La	-.108*	.104	Cu	.091*	.007	Co	.003	.314*	V	.052*	-.037
	U	-.077*	-.008	U	.049*	-.044	V	-.002	.250*	Ho	.083	-.303*
	Sr	.003	.365*	Y	.055	-.214*	Cu	.053	.215*	Er	.241	-.280*
	Co	-.070	.291*	Eu	.101	-.206*	Y	-.079	.208*	Y	.053	-.268*
	Gd	.013	.254*	Ho	.074	-.203*	Dy	-.051	.165*	Gd	.055	-.197*
	Eu	-.115	.248*	Tb	.016	-.201*	Nd	-.048	.160*	Nb	-.004	-.196*
	Tb	-.111	.236*	Dy	.075	-.199*	Er	-.067	.153*	Dy	.091	-.184*
	Cu	.014	.228*	Nd	.022	-.145*	Pr	-.051	.152*	Nd	.088	-.184*
	Ho	-.201	.216*	Co	.132	-.145*	Gd	-.083	.147*	La	.031	-.179*
	V	-.069	.198*	Pr	.059	-.143*	Ce	-.046	.138*	Ce	.031	-.172*
	Y	-.130	.160*	La	.031	-.142*	La	-.058	.132*	Pr	.038	-.170*
	Er	-.104	.153*	Ce	.032	-.134*	Nb	-.114	-.131*	Sm	.050	-.153*
	Nd	-.090	.121*	Gd	.076	-.129*	Eu	.017	.126*	U	.075	-.152*
	Pr	-.093	.116*	Nb	-.027	-.101*	Sm	-.030	.124*	Tb	.036	-.115*
	Ce	-.103	.109*	V	.054	-.084*	Ho	-.042	.115*	Sr	.050	.101*
	Nb	-.070	-.074*	Sm	.043	-.074*	Tb	-.039	.079*	Cu	.037	.089*
ICP-AES	Ti	.069*	.000	P	.196*	-.088	Fe	.046	.456*	Fe	-.180*	.180
	Mn	-.031*	-.019	Be	.185*	.089	P	-.005	.352*	P	-.072*	.038
	Al	.042	.238*	Mg	.179*	.008	Ni	.096	.329*	Zn	-.053*	.046
	Mg	-.045	.213*	Fe	.167*	-.096	Ti	.046	-.293*	Mn	-.047*	-.017
	Fe	-.058	.174*	Ni	.143*	-.055	Zn	.030	.218*	Al	-.044	.144*
	Ni	-.018	.137*	Zn	.110*	-.015	Mg	.034	.203*	Be	-.033	.122*
	Be	.018	.111*	Mn	.105*	-.097	Mn	-.032	.196*	Ni	-.062	.093*
	P	-.059	.096*	Al	.101	.159*	Be	.126	.189*	Mg	-.064	.071*
	Zn	-.023	.069*	Ti	-.046	.118*	Al	.112	.160*	Ti	.053	.066*

*largest absolute correlation between each variable and any discriminant function

E - element F1 - function 1 F2 - function 2

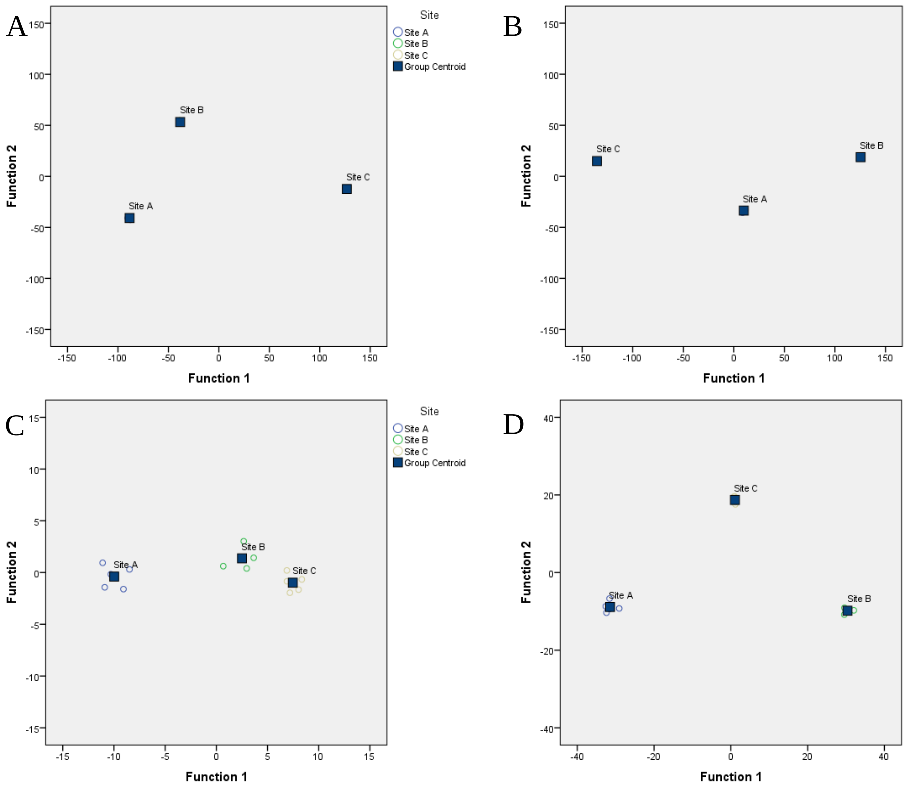


Figure 8.5: CDFA chart for XRF reduced element data for the London sample collections (A) October (B) January (C) April (D) July

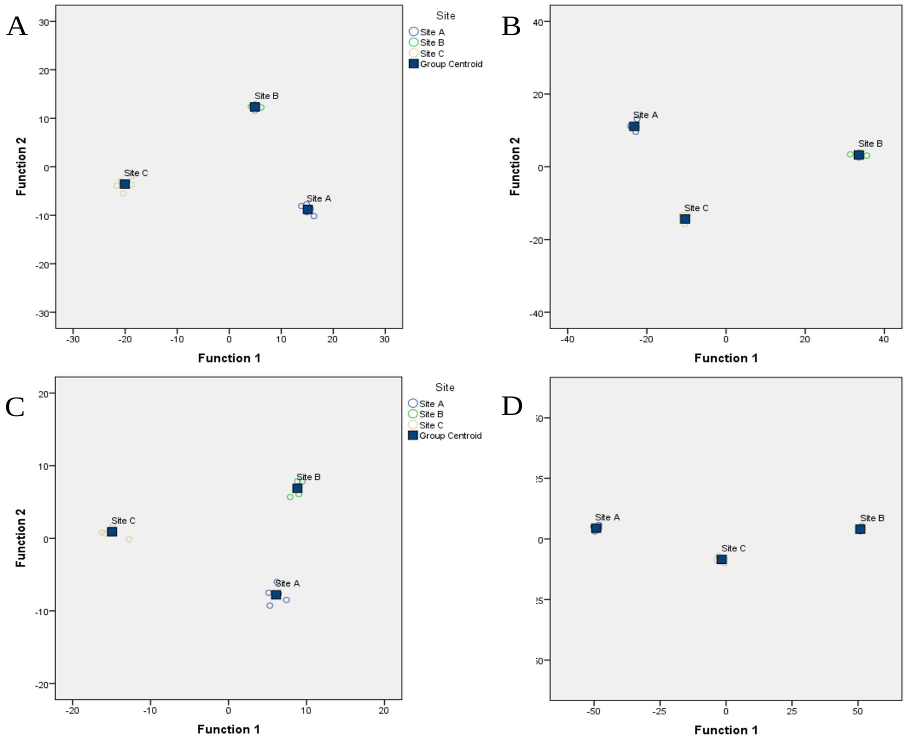


Figure 8.6: CDFA chart for ICP-MS reduced element data for the London sample collections (A) October (B) January (C) April (D) July

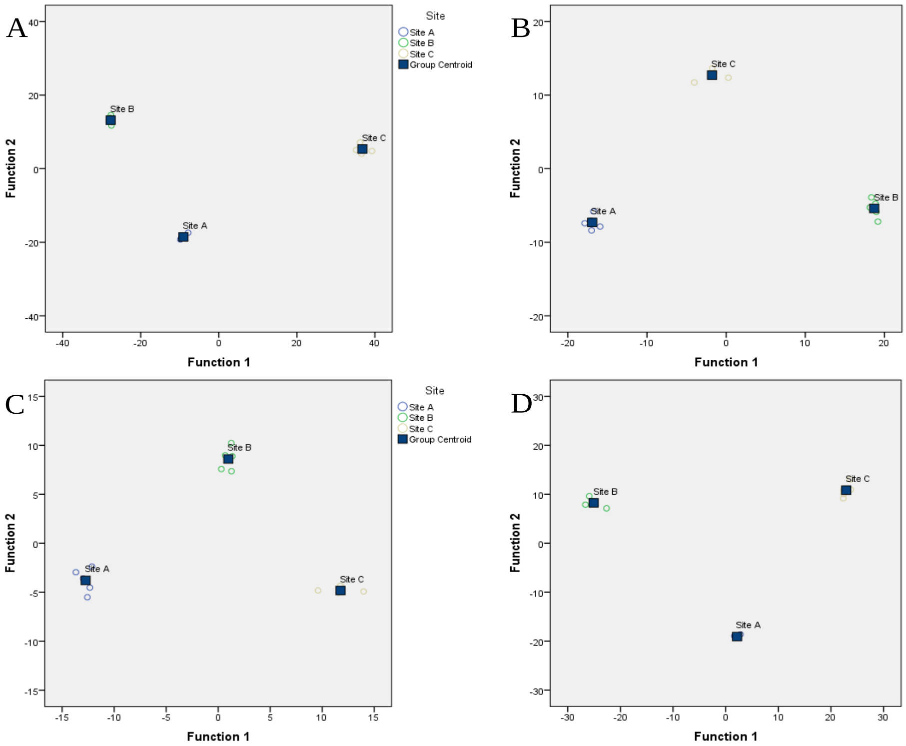


Figure 8.7: CDFA chart for ICP-AES reduced element data for the London sample collections (A) October (B) January (C) April (D) July

Table 8.10: CDFA eigenvalues for the common reduced element data for the Nottingham sample collections

Technique	Collection	Function	Eigenvalue	Percentage of Variance	Cumulative Percentage	Canonical Correlation
XRF	October	1	70.869	75.5	75.5	.993
		2	23.021	24.5	100.0	.979
	January	1	87.408	91.1	91.1	.994
		2	8.572	8.9	100.0	.946
	April	1	431.731	96.9	96.9	.999
		2	14.009	3.1	100.0	.966
	July	1	23.168	71.5	71.5	.979
		2	9.257	28.5	100.0	.950
ICP-MS	October	1	6.844	87.6	87.6	.934
		2	.968	12.4	100.0	.701
	January	1	31.265	89.2	89.2	.984
		2	3.771	10.8	100.0	.889
	April	1	6.590	94.0	94.0	.932
		2	.418	6.0	100.0	.543
	July	1	6.471	86.4	86.4	.931
		2	1.018	13.6	100.0	.710
ICP-AES	October	1	15.622	94.3	94.3	.969
		2	.941	5.7	100.0	.696
	January	1	307.815	99.2	99.2	.998
		2	2.617	.8	100.0	.851
	April	1	33.625	84.5	84.5	.985
		2	6.146	15.5	100.0	.927
	July	1	26.409	88.1	88.1	.982
		2	3.571	11.9	100.0	.884

Table 8.11: CDFA Wilks' Lambda values for the common reduced element data for the Nottingham sample collections

Technique	Collection	Function	Wilks' Lambda	Chi Square	df	Sig.
XRF	October	1 through 2	.001	59.630	18	.000
		2	.042	25.432	8	.001
	January	1 through 2	.001	53.927	18	.000
		2	.104	18.071	8	.021
	April	1 through 2	.000	70.230	18	.000
		2	.067	21.669	8	.006
	July	1 through 2	.004	44.104	18	.001
		2	.097	18.623	8	.017
ICP-MS	October	1 through 2	.065	23.260	16	.107
		2	.508	5.753	7	.569
	January	1 through 2	.006	42.811	16	.000
		2	.210	13.282	7	.066
	April	1 through 2	.093	20.198	16	.211
		2	.705	2.969	7	.888
	July	1 through 2	.066	23.062	16	.112
		2	.496	5.968	7	.543
ICP-AES	October	1 through 2	.031	33.003	12	.001
		2	.515	6.301	5	.278
	January	1 through 2	.001	66.674	12	.000
		2	.276	12.213	5	.032
	April	1 through 2	.004	52.355	12	.000
		2	.140	18.682	5	.002
	July	1 through 2	.008	45.892	12	.000
		2	.219	14.438	5	.013

Table 8.12: CDFA structure matrix for the common reduced element data for the London sample collections (elements contributing most to each function in descending order)

Technique	E	October		E	January		E	April		E	July	
		F1	F2		F1	F2		F1	F2		F1	F2
XRF	Ca	.169*	-.072	Pb	.163*	-.020	Y	.137*	-.029	Ca	.267*	-.023
	Mg	-.116	-.447*	Y	.108	.774*	Fe	.095	-.363*	Sr	.216*	.059
	Fe	-.338	-.414*	Ga	.007	.724*	Mg	.143	-.347*	Y	-.067	.568*
	Sr	.202	-.333*	Al	-.016	.698*	Ca	-.019	.333*	Al	-.099	.531*
	Al	-.209	-.330*	Sr	.104	.651*	Al	.171	-.276*	Rb	-.115	.490*
	Rb	-.196	-.217*	Rb	.018	.631*	Rb	.100	-.272*	Mg	-.118	.490*
	Pb	.085	.212*	Fe	-.026	.585*	Pb	-.083	.228*	Pb	.226	-.471*
	Y	-.070	-.181*	Mg	-.093	.459*	Sr	.007	.224*	Fe	-.219	.463*
	Ga	-.096	-.165*	Ca	.062	.305*	Ga	.098	-.153*	Ga	-.131	.354*
ICP-MS	Ho	.454*	.060	Sm	.229*	-.015	Er	.864*	.187	U	.619*	.499
	Tb	.421*	.091	Er	.215*	-.185	Ho	.830*	-.037	Eu	.211	.877*
	Dy	.412*	.148	Tb	.208*	-.093	Tb	.755*	.047	Sm	.237	.808*
	Sm	.409*	.185	Ho	.189*	-.121	Eu	.742*	.021	Tb	.154	.806*
	Eu	.398*	.133	Gd	.186*	.021	Gd	.692*	.152	Er	.185	.748*
	Gd	.382*	.219	Eu	.184*	-.076	Sm	.681*	.058	Ho	.186	.704*
	Er	.377*	.102	Dy	.154*	-.077	Dy	.677*	.242	Gd	.313	.702*
	U	.311*	.179	U	.154	.176*	U	.628*	.069	Dy	.342	.622*
ICP-AES	Fe	-.591*	.389	Be	-.101*	.070	Ti	-.513*	-.339	P	.487*	.375
	Al	-.568*	.363	P	.071	.808*	Al	-.473*	-.144	Ti	-.472*	.065
	Ti	-.462*	.131	Al	-.084	-.384*	Fe	-.429*	.139	Al	-.430*	-.031
	Be	-.216*	.093	Ti	-.031	-.303*	P	.414*	.294	Fe	-.374*	-.283
	Ni	-.100	.925*	Fe	-.209	-.276*	Ni	-.196*	-.003	Ni	-.291*	-.075
	P	.287	-.673*	Ni	-.119	-.224*	Be	-.126	-.188*	Be	-.246*	-.191

*largest absolute correlation between each variable and any discriminant function

E - element F1 - function 1 F2 - function 2

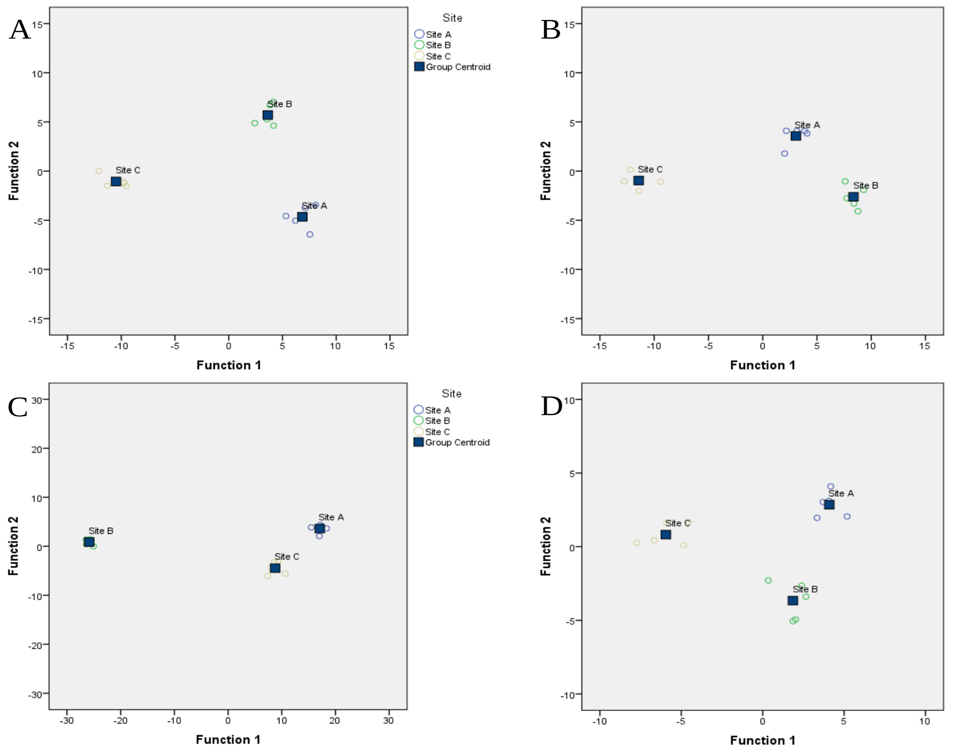


Figure 8.8: CDFA chart for XRF common reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

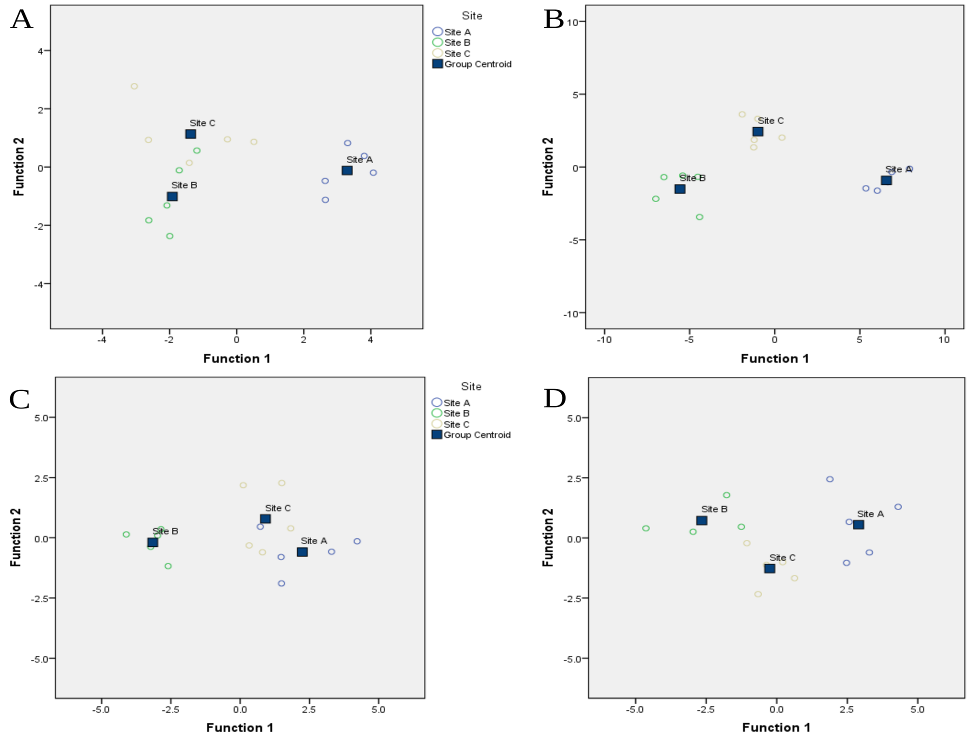


Figure 8.9: CDFA chart for ICP-MS common reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

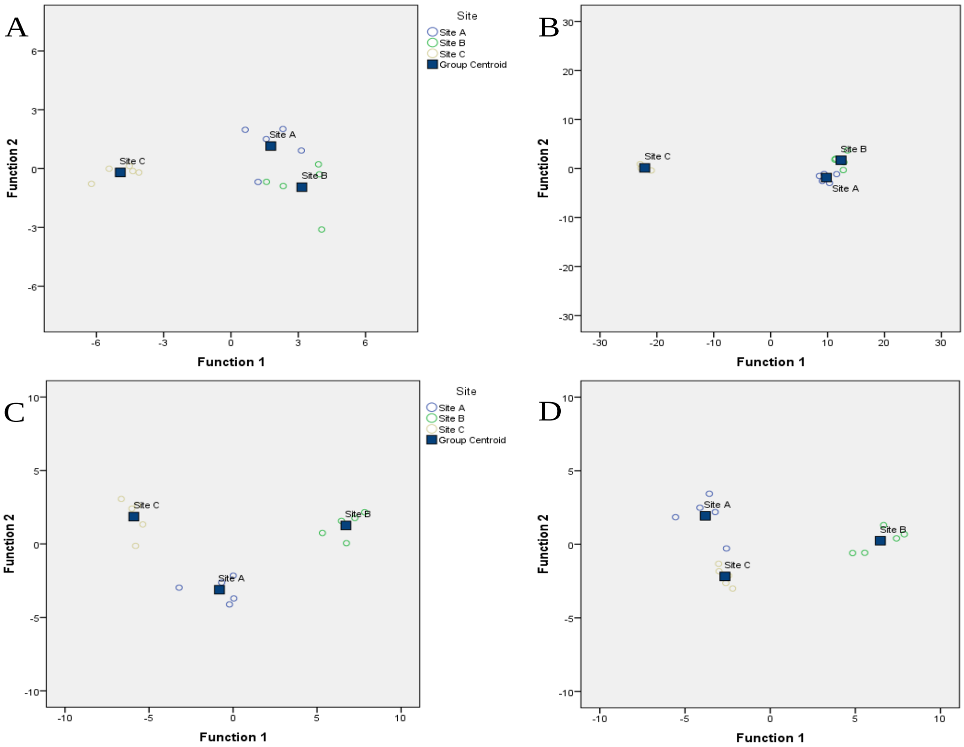


Figure 8.10: CDFA chart for ICP-AES common reduced element data for the Nottingham sample collections (A) October (B) January (C) April (D) July

Table 8.13: CDFA eigenvalues for the common reduced element data for the London sample collections

Technique	Collection	Function	Eigenvalue	Percentage of Variance	Cumulative Percentage	Canonical Correlation
XRF	October	1	5266.374	90.5	90.5	1.000
		2	554.934	9.5	100.0	.999
	January	1	2346.691	90.9	90.9	1.000
		2	235.980	9.1	100.0	.998
	April	1	35.035	98.0	98.0	.986
		2	.698	2.0	100.0	.641
	July	1	899.791	73.0	73.0	.999
		2	332.310	27.0	100.0	.998
ICP-MS	October	1	33.982	71.0	71.0	.986
		2	13.88	29.0	100.0	.966
	January	1	44.165	79.4	79.4	.989
		2	11.452	20.6	100.0	.959
	April	1	35.478	85.5	85.5	.986
		2	6.022	14.5	100.0	.926
	July	1	36.634	78.0	78.0	.987
		2	10.348	22.0	100.0	.955
ICP-AES	October	1	391.480	87.2	87.2	.999
		2	57.421	12.8	100.0	.991
	January	1	93.835	70.7	70.7	.995
		2	38.814	29.3	100.0	.987
	April	1	49.635	65.5	65.5	.990
		2	26.129	34.5	100.0	.981
	July	1	244.747	65.8	65.8	.998
		2	127.127	34.2	100.0	.996

Table 8.14: CDFA Wilks' Lambda values for the common reduced element data for the London sample collections

Technique	Collection	Function	Wilks' Lambda	Chi Square	df	Sig.
XRF	October	1 through 2	.000	119.119	18	.000
		2	.002	50.565	8	.000
	January	1 through 2	.000	105.833	18	.000
		2	.004	43.744	8	.000
	April	1 through 2	.016	32.911	18	.017
		2	.589	4.235	8	.835
	July	1 through 2	.000	100.899	18	.000
		2	.003	46.473	8	.000
ICP-MS	October	1 through 2	.002	53.166	16	.000
		2	.067	22.950	7	.002
	January	1 through 2	.002	53.824	16	.000
		2	.080	21.436	7	.003
	April	1 through 2	.004	47.139	16	.000
		2	.142	16.567	7	.020
	July	1 through 2	.002	51.484	16	.000
		2	.088	20.647	7	.004
ICP-AES	October	1 through 2	.000	95.381	12	.000
		2	.017	38.643	5	.000
	January	1 through 2	.000	78.245	12	.000
		2	.025	35.000	5	.000
	April	1 through 2	.001	68.640	12	.000
		2	.037	31.356	5	.000
	July	1 through 2	.000	98.395	12	.000
		2	.008	46.104	5	.000

Table 8.15: CDFA structure matrix for the common reduced element data for the London sample collections (elements contributing most to each function in descending order)

Technique	E	October		E	January		E	April		E	July	
		F1	F2		F1	F2		F1	F2		F1	F2
XRF	Fe	.056*	.053	Rb	.024*	-.020	Ca	-.191*	-.170	Rb	.052*	-.014
	Pb	.017*	.017	Ca	.070	.493*	Fe	-.181*	-.153	Ca	.151	.377*
	Al	.012	.243*	Sr	.046	.389*	Rb	.143*	-.005	Fe	.094	.214*
	Y	-.002	.133*	Fe	.039	.188*	Ga	-.136	-.643*	Al	-.011	.152*
	Sr	.068	.102*	Mg	.008	.177*	Mg	-.135	-.638*	Sr	.047	.135*
	Ca	.070	.083*	Al	-.039	.166*	Sr	-.172	-.508*	Y	-.066	.126*
	Mg	.028	.071*	Y	-.051	.140*	Al	-.262	-.448*	Mg	.030	.085*
	Ga	-.003	.065*	Pb	.026	.108*	Pb	-.125	.415*	Ga	-.002	.051*
	Rb	.019	-.040*	Ga	-.021	.034*	Y	-.223	.332*	Pb	.022	.047*
ICP-MS	U	-.206*	.114	Eu	.549*	.128	Eu	-.188*	.129	Tb	.515*	.011
	Eu	-.068	-.311*	Tb	.520*	.198	U	.017	.338*	Er	.504*	.065
	Gd	-.181	-.303*	Er	.491*	.267	Er	-.164	.266*	Eu	.493*	-.109
	Ho	-.198	-.285*	Gd	.476*	.204	Dy	-.187	.245*	Dy	.487*	.018
	Dy	-.216	-.270*	Sm	.460*	.149	Ho	-.181	.237*	Ho	.482*	.038
	Sm	-.116	-.258*	Dy	.457*	.226	Tb	-.161	.223*	Gd	.472*	.018
	Er	-.173	-.257*	Ho	.456*	.245	Gd	-.172	.211*	Sm	.415*	-.032
	Tb	-.156	-.246*	U	.120	.395*	Sm	-.162	.211*	U	.153	.336*
ICP-AES	Fe	.001	.417*	Be	.325*	.009	Fe	.409*	-.253	Fe	.305*	-.048
	Al	.155	.298*	Ni	.212*	.199	Ni	.350*	-.068	Al	.138*	.090
	P	-.034	.292*	Al	.212*	-.166	P	.279*	-.269	Ni	.125*	.015
	Ni	.035	.266*	P	.288	.292*	Be	.263*	.089	Be	.112*	.081
	Ti	.088	-.157*	Fe	.238	.280*	Al	.227*	.086	P	.101*	-.054
	Be	.071	.141*	Ti	-.037	-.219*	Ti	-.195	.302*	Ti	-.014	.134*

*largest absolute correlation between each variable and any discriminant function

E - element F1 - function 1 F2 - function 2

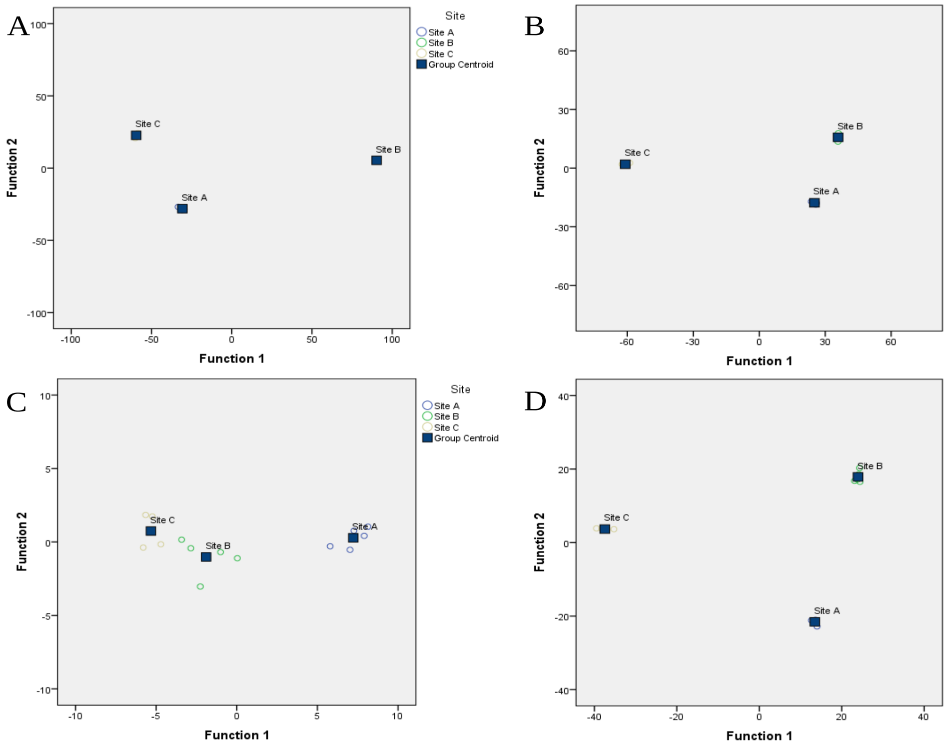


Figure 8.11: CDFA chart for XRF common reduced element data for the London sample collections (A) October (B) January (C) April (D) July

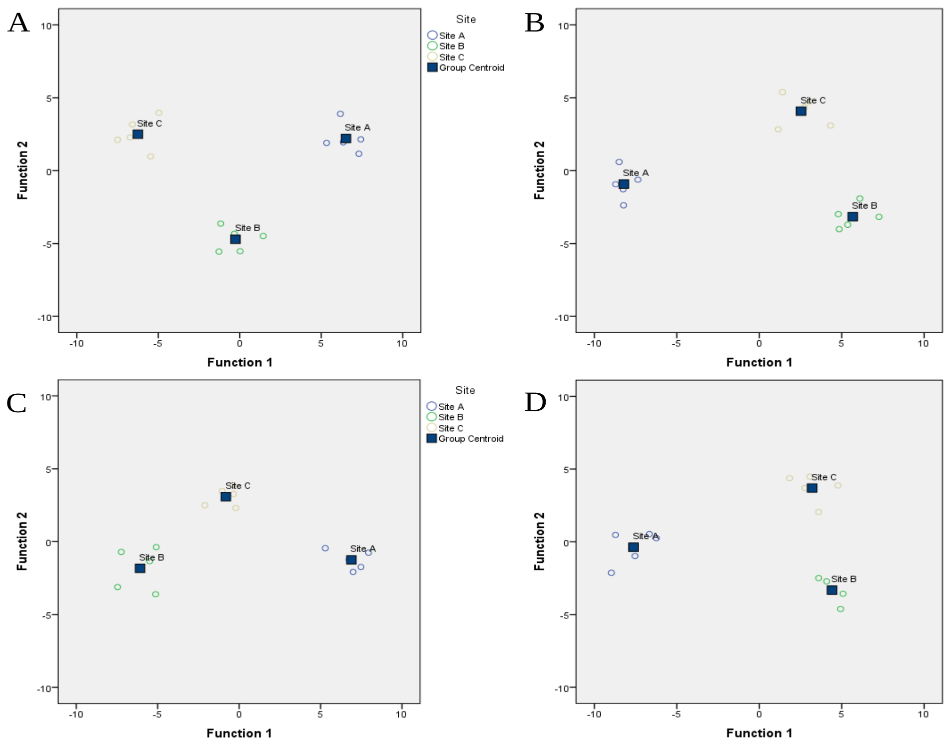


Figure 8.12: CDFA chart for ICP-MS common reduced element data for the London sample collections (A) October (B) January (C) April (D) July

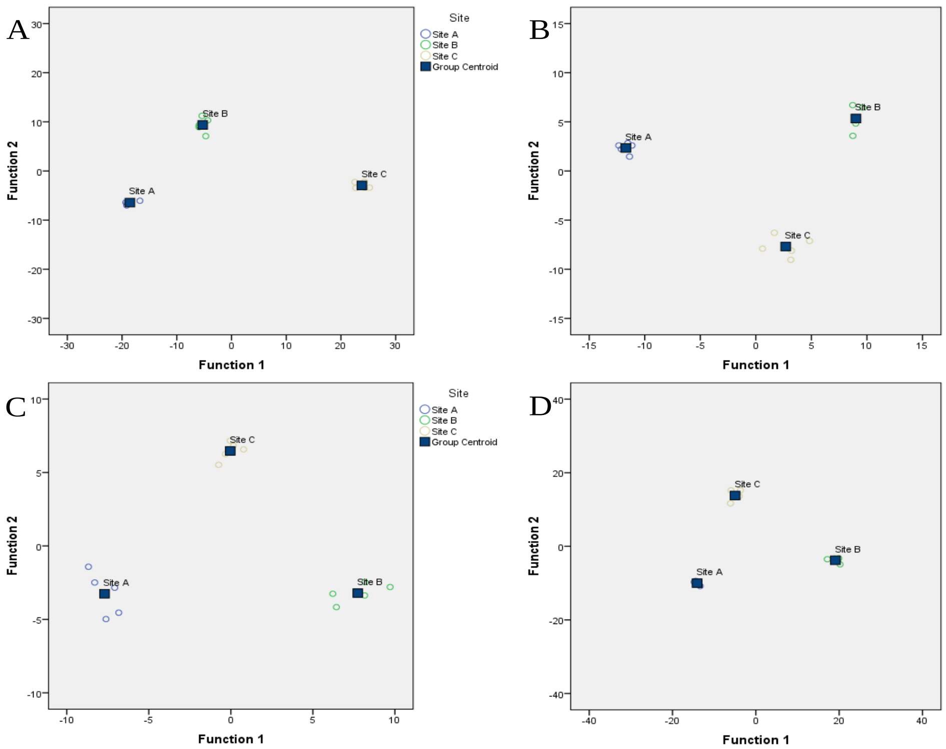


Figure 8.13: CDFA chart for ICP-AES common reduced element data for the London sample collections (A) October (B) January (C) April (D) July

8.3.2 Critical Elements - Single Source Versus Mixed Source Samples

Paired t-tests (table 8.16 and 8.17) identified no significant difference between single source and mixed source samples for the majority of cases, with the exception of the ICP-MS data (Nottingham XRF 48/48 and 47/48, ICP-MS 46/48 and 10/48 and ICP-AES 48/48 and 48/48; London XRF 48/48 and 48/48, ICP-MS 20/48 and 18/48 and ICP-AES 48/48 and 48/48 for reduced and common reduced elements respectively). This is the case not only for comparisons between mixtures and single source sites that have contributed to the mixture, but also with single source samples that have not contributed. This further emphasises the complex nature of interpreting geochemical data for single and mixed source samples of close proximity sites, even when the number of variables (i.e. the elements) has been reduced.

PCA outputs are presented in tables 8.18 to 8.21 and figures 8.14 to 8.37. A distinction between single source sites is evident, but more apparent for the London samples (figures 8.20 to 8.25). These data points for the five samples taken within each control site cluster together separately from the five samples taken for other sites, although occasional outliers are witnessed (e.g. NA4 and NB5 in figure 8.14A), and there is some evidence of inter- and intra- sample variability (e.g. sites in figure 8.16C). As demonstrated in chapters 5 through 7, mixture data points are situated between single source data point clusters, and in some cases associate with one site more than another e.g. Nottingham mixture AB with site A (figure 8.16) and London mixture AC with site A (figure 8.37).

It is clear from PCA of the common element data set that the further reduction of elements assessed (i.e. those commonly found to be significant to sample discrimination for both Nottingham and London) further complicates single-mixed source sample discrimination, at least as far as these two sample locations are concerned. The interpretations were particularly convoluted for ICP-MS data (e.g. figure 8.28), and for Nottingham samples relative to London. This suggests that the elements responsible for discrimination are location specific, and that if looking to reduce the number of elements assessed it would be necessary to cater for the site specific to the case rather than have a common reduced element set.

Table 8.16: Paired t-test statistics for the reduced element data for the Nottingham sample collections

Technique	Pair	df	T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)
XRF	A - AB	18	1.640	.118	1.659	.115	1.220	.238	.569	.576
	A - AC	18	-1.364	.190	1.492	.153	-1.003	.329	-1.346	.195
	A - BC	18	.466	.647	1.509	.149	1.285	.215	1.255	.226
	A - ABC	18	1.969	.064	1.553	.138	1.111	.281	-.215	.832
	B - AB	18	-1.351	.194	1.888	.075	-1.436	.168	-1.492	.153
	B - AC	18	-1.710	.104	1.592	.129	-1.392	.181	-1.406	.177
	B - BC	18	-1.554	.138	1.601	.127	-1.406	.177	-1.269	.221
	B - ABC	18	-1.941	.068	1.693	.108	-1.432	.169	-1.384	.183
	C - AB	18	1.690	.108	.309	.761	.623	.541	-.213	.834
	C - AC	18	1.195	.248	-.440	.665	-.989	.336	-1.575	.133
	C - BC	18	1.635	.119	1.979	.063	1.164	.259	.758	.458
	C - ABC	18	1.500	.151	.433	.670	.335	.742	-.643	.528
ICP-MS	A - AB	11	-.362	.724	-.401	.696	-.689	.505	-.989	.344
	A - AC	11	2.108	.059	1.980	.073	.766	.460	.642	.534
	A - BC	11	1.680	.121	-1.274	.229	1.291	.223	-.672	.516
	A - ABC	11	.043	.966	2.507	.029	.973	.352	-.908	.383
	B - AB	11	.993	.342	.978	.349	.915	.380	.844	.417
	B - AC	11	.935	.370	1.014	.332	.871	.403	.986	.345
	B - BC	11	.838	.420	-1.361	.201	1.067	.309	.983	.347
	B - ABC	11	.800	.440	1.035	.323	.919	.378	.919	.378
	C - AB	11	-.619	.549	-.981	.348	-1.025	.327	-1.244	.239
	C - AC	11	1.455	.173	-.708	.494	-1.212	.251	-1.347	.205
	C - BC	11	3.550	.005	-1.286	.225	1.179	.263	-1.231	.244
	C - ABC	11	-.629	.542	-.688	.506	-1.111	.290	-1.169	.267
ICP-AES	A - AB	7	1.603	.153	1.826	.111	1.496	.178	1.641	.145
	A - AC	7	.548	.601	-1.929	.095	1.178	.277	1.509	.175
	A - BC	7	1.364	.215	-1.263	.247	1.288	.239	1.536	.168
	A - ABC	7	1.515	.174	.476	.649	.968	.365	1.542	.167
	B - AB	7	1.231	.258	-1.579	.158	-1.768	.120	1.412	.201
	B - AC	7	-2.103	.074	-1.834	.109	-1.771	.120	-1.542	.167
	B - BC	7	-1.716	.130	-1.905	.099	-1.767	.121	1.316	.230
	B - ABC	7	.463	.658	-1.815	.112	-1.826	.111	-.318	.760
	C - AB	7	1.885	.101	1.973	.089	1.811	.113	1.906	.098
	C - AC	7	1.921	.096	1.895	.100	1.834	.109	1.837	.109
	C - BC	7	1.894	.100	1.922	.096	1.838	.109	1.758	.122
	C - ABC	7	1.870	.104	1.977	.089	1.795	.116	1.795	.116

*statistically significant values highlighted

Table 8.17: Paired t-test statistics for the reduced element data for the London sample collections

Technique	Pair	df	October		January		April		July	
			T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)
XRF	A - AB	16	-1.844	.084	-1.965	.067	-1.192	.251	-1.937	.071
	A - AC	16	-1.428	.173	-1.426	.173	-1.329	.202	-1.439	.170
	A - BC	16	-1.803	.090	-1.736	.102	-1.333	.201	-1.916	.073
	A - ABC	16	-1.797	.091	-1.739	.101	-1.265	.224	-1.855	.082
	B - AB	16	.923	.370	1.919	.073	1.743	.101	1.959	.068
	B - AC	16	1.401	.180	1.609	.127	1.327	.203	1.938	.071
	B - BC	16	1.833	.086	1.409	.178	1.579	.134	1.664	.116
	B - ABC	16	1.338	.200	1.569	.136	.991	.337	1.916	.073
	C - AB	16	-1.469	.161	-.401	.693	1.139	.271	-1.097	.289
	C - AC	16	1.919	.073	1.479	.159	.847	.409	1.619	.125
	C - BC	16	-.291	.775	-1.066	.302	.979	.342	-1.954	.068
	C - ABC	16	-.961	.351	-.022	.982	.693	.498	-1.155	.265
ICP-MS	A - AB	17	-2.808	.012	-3.868	.001	-1.687	.110	-3.203	.005
	A - AC	17	-2.576	.020	-2.978	.008	-2.610	.018	-3.256	.005
	A - BC	17	-2.577	.020	-3.125	.006	-3.263	.005	-3.549	.002
	A - ABC	17	-3.133	.006	-3.176	.006	-3.551	.002	-4.325	.000
	B - AB	17	-.576	.572	2.294	.035	2.586	.019	3.292	.004
	B - AC	17	.240	.813	2.131	.048	1.745	.099	3.216	.005
	B - BC	17	3.168	.006	-.782	.445	.289	.776	-.827	.420
	B - ABC	17	-.531	.602	.742	.468	1.584	.132	2.937	.009
	C - AB	17	-.719	.482	1.998	.062	1.760	.096	.994	.334
	C - AC	17	2.608	.018	2.888	.010	3.567	.002	2.972	.009
	C - BC	17	1.648	.118	.754	.461	.795	.438	-3.032	.008
	C - ABC	17	-.298	.770	1.786	.092	1.632	.121	.893	.384
ICP-AES	A - AB	7	-1.640	.145	-1.796	.116	-1.606	.152	-1.715	.130
	A - AC	7	-1.273	.244	-1.427	.197	-.997	.352	-1.309	.232
	A - BC	7	-1.756	.122	-1.564	.162	-1.454	.189	-1.664	.140
	A - ABC	7	-1.595	.155	-1.576	.159	-1.440	.193	-1.630	.147
	B - AB	7	.313	.763	1.644	.144	1.624	.148	1.742	.125
	B - AC	7	1.339	.223	1.404	.203	1.722	.129	1.794	.116
	B - BC	7	1.673	.138	.891	.402	1.796	.116	1.745	.125
	B - ABC	7	.904	.396	1.385	.209	1.733	.127	1.781	.118
	C - AB	7	-1.506	.176	.363	.727	-.826	.436	-1.022	.341
	C - AC	7	1.651	.143	1.335	.224	1.177	.278	1.419	.199
	C - BC	7	.071	.945	-1.205	.267	-1.750	.124	-1.840	.108
	C - ABC	7	-1.174	.279	.482	.645	-.899	.398	-.356	.733

*statistically significant values highlighted

Table 8.18: Paired t-test statistics for the common reduced element data for the Nottingham sample collections

Technique	Pair	df	October		January		April		July	
			T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)
XRF	A - AB	8	2.225	.057	2.004	.080	.558	.592	-.849	.420
	A - AC	8	-.677	.518	2.115	.067	-.552	.596	-.875	.407
	A - BC	8	1.150	.283	1.932	.089	1.382	.204	.331	.749
	A - ABC	8	2.463	.039	2.064	.073	.526	.613	-.829	.431
	B - AB	8	-1.183	.271	2.203	.059	-1.093	.306	-1.229	.254
	B - AC	8	-1.293	.232	2.245	.055	-.880	.404	-.903	.393
	B - BC	8	-.937	.376	2.141	.065	-.841	.425	-.614	.556
	B - ABC	8	-1.338	.218	2.273	.053	-.956	.367	-.917	.386
	C - AB	8	1.172	.275	1.569	.155	.288	.781	-.101	.922
	C - AC	8	.570	.584	1.142	.286	-.265	.798	-1.466	.181
	C - BC	8	1.439	.188	1.472	.179	.489	.638	.183	.859
	C - ABC	8	1.122	.295	1.560	.157	.178	.863	-.213	.837
ICP-MS	A - AB	7	2.864	.024	13.046	.000	1.838	.109	.764	.470
	A - AC	7	2.506	.041	9.664	.000	-9.172	.000	3.196	.015
	A - BC	7	1.840	.108	-4.456	.003	3.695	.008	2.793	.027
	A - ABC	7	1.840	.108	8.737	.000	-.283	.786	2.935	.022
	B - AB	7	-.087	.933	-1.729	.128	-10.256	.000	-14.777	.000
	B - AC	7	-6.351	.000	2.510	.040	-8.729	.000	-1.227	.259
	B - BC	7	-35.911	.000	-4.689	.002	3.149	.016	-.575	.583
	B - ABC	7	-22.198	.000	4.878	.002	-7.368	.000	-5.304	.001
	C - AB	7	9.953	.000	3.617	.009	-1.325	.227	-42.566	.000
	C - AC	7	13.952	.000	5.171	.001	-12.746	.000	-29.041	.000
	C - BC	7	3.151	.016	-4.689	.002	3.649	.008	-16.070	.000
	C - ABC	7	3.057	.018	5.108	.001	-7.575	.000	-19.603	.000
ICP-AES	A - AB	5	1.584	.174	1.525	.188	1.572	.177	1.580	.175
	A - AC	5	-1.359	.232	-1.552	.181	1.016	.356	1.580	.175
	A - BC	5	1.543	.183	-1.449	.207	1.431	.212	1.563	.179
	A - ABC	5	1.554	.181	-.778	.472	-1.577	.176	1.567	.178
	B - AB	5	1.589	.173	-1.467	.202	-1.395	.222	1.267	.261
	B - AC	5	-1.565	.178	-1.567	.178	-1.476	.200	-1.248	.267
	B - BC	5	-1.564	.179	-1.589	.173	-1.546	.183	1.163	.297
	B - ABC	5	-1.207	.281	-1.571	.177	-1.532	.186	-.528	.620
	C - AB	5	1.579	.175	1.569	.177	1.581	.175	1.556	.180
	C - AC	5	1.588	.173	1.515	.190	1.601	.170	1.499	.194
	C - BC	5	1.578	.175	1.554	.181	1.569	.178	1.570	.177
	C - ABC	5	1.563	.179	1.573	.177	1.585	.174	1.542	.184

*statistically significant values highlighted

Table 8.19: Paired t-test statistics for the common reduced element data for the London sample collections

Technique	Pair	df	October		January		April		July	
			T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)	T	Sig. (2-tailed)
XRF	A - AB	8	-1.986	.082	-2.156	.063	-1.197	.266	-2.118	.067
	A - AC	8	-1.468	.180	-1.451	.185	-1.355	.212	-1.479	.177
	A - BC	8	-1.938	.089	-1.828	.105	-1.356	.212	-2.083	.071
	A - ABC	8	-1.923	.091	-1.835	.104	-1.283	.235	-2.003	.080
	B - AB	8	.931	.379	2.093	.070	1.882	.097	2.148	.064
	B - AC	8	1.449	.185	1.704	.127	1.375	.206	2.122	.067
	B - BC	8	1.977	.083	1.473	.179	1.677	.132	1.773	.114
	B - ABC	8	1.378	.206	1.657	.136	1.003	.345	2.091	.070
	C - AB	8	-1.528	.165	-.413	.691	1.160	.279	-1.120	.295
	C - AC	8	2.065	.073	1.513	.169	.848	.421	1.687	.130
	C - BC	8	-.293	.777	-1.077	.313	.989	.352	-2.146	.064
	C - ABC	8	-.969	.361	-.041	.968	.690	.510	-1.192	.267
ICP-MS	A - AB	7	-7.482	.000	-19.653	.000	-1.645	.144	-4.163	.004
	A - AC	7	-5.346	.001	-12.547	.000	-.569	.587	-7.852	.000
	A - BC	7	2.181	.066	-12.725	.000	-1.618	.150	-8.962	.000
	A - ABC	7	-4.881	.002	-15.399	.000	-4.190	.004	-7.835	.000
	B - AB	7	.888	.404	7.087	.000	-.350	.737	5.254	.001
	B - AC	7	1.383	.209	-1.158	.285	.725	.492	3.160	.016
	B - BC	7	18.936	.000	-1.991	.087	-.596	.570	-.978	.361
	B - ABC	7	.209	.841	-1.902	.099	-2.796	.027	.365	.726
	C - AB	7	3.343	.012	3.802	.007	6.431	.000	10.834	.000
	C - AC	7	6.237	.000	6.755	.000	16.078	.000	12.059	.000
	C - BC	7	6.626	.000	5.377	.001	6.091	.000	-1.978	.088
	C - ABC	7	.084	.935	3.726	.007	5.101	.001	1.323	.227
ICP-AES	A - AB	5	-1.496	.195	-1.665	.157	-1.379	.226	-1.519	.189
	A - AC	5	-1.211	.280	-1.384	.225	-.924	.398	-1.249	.267
	A - BC	5	-1.567	.178	-1.500	.194	-1.279	.257	-1.512	.191
	A - ABC	5	-1.471	.201	-1.513	.191	-1.251	.266	-1.479	.199
	B - AB	5	.161	.878	1.598	.171	1.409	.218	1.547	.183
	B - AC	5	1.089	.326	1.247	.268	1.469	.202	1.560	.179
	B - BC	5	1.484	.198	.759	.482	1.507	.192	1.431	.212
	B - ABC	5	.672	.531	1.240	.270	1.490	.196	1.553	.181
	C - AB	5	-1.226	.275	.431	.685	-.513	.630	-.675	.530
	C - AC	5	1.568	.178	1.278	.257	1.114	.316	1.352	.234
	C - BC	5	.206	.845	-1.015	.357	-1.422	.214	-1.582	.174
	C - ABC	5	-.916	.402	.522	.624	-.539	.613	-.088	.933

*statistically significant values highlighted

Table 8.20: PCA eigenvalues for the **reduced element data** for the Nottingham sample collection

Technique	Axes	XRF		ICP-MS		ICP-AES		Total Variance
		Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	
OCTOBER	1	0.8897	88.97	0.7754	77.54	0.8491	84.91	1.000
	2	0.0499	93.96	0.1912	96.66	0.0758	92.49	
	3	0.0348	94.45	0.0225	98.92	0.0419	96.69	
	4	0.0167	99.12	0.0049	99.41	0.0272	99.40	
JANUARY	1	0.7679	76.79	0.9310	93.10	0.7523	75.23	1.000
	2	0.1513	91.92	0.0563	98.73	0.1257	87.81	
	3	0.0383	95.75	0.0094	99.67	0.0909	96.90	
	4	0.0248	98.23	0.0011	99.78	0.0191	98.81	
APRIL	1	0.7344	73.44	0.5583	55.83	0.7839	78.39	1.000
	2	0.1522	88.66	0.3971	95.55	0.1768	96.07	
	3	0.0659	95.25	0.0337	98.92	0.0269	98.75	
	4	0.0206	97.31	0.0031	99.23	0.0067	99.42	
JULY	1	0.6834	68.34	0.6484	64.84	0.8029	80.29	1.000
	2	0.1528	83.61	0.3146	96.30	0.1459	94.87	
	3	0.0991	93.52	0.0223	98.53	0.0417	99.04	
	4	0.0346	96.98	0.0047	99.00	0.0046	99.50	

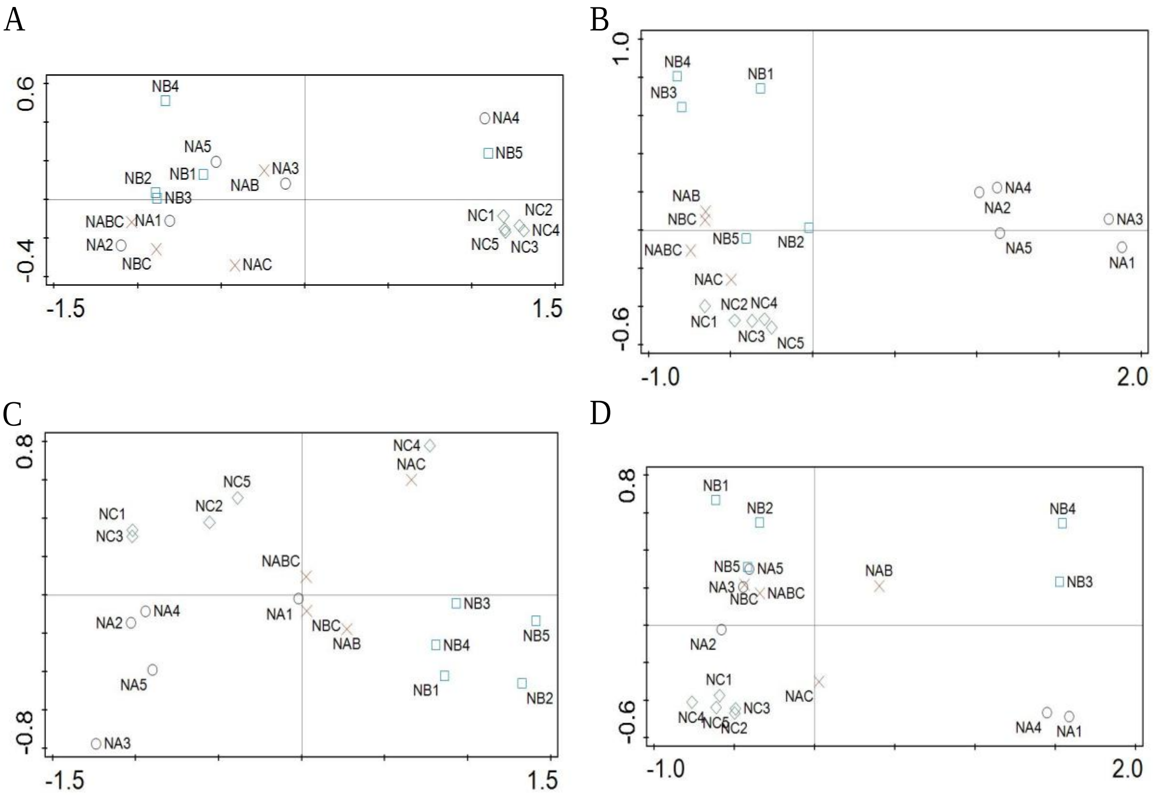


Figure 8.14: PCA biplot for single source and mixed source sample reduced element data determined by XRF for the Nottingham sample collections (A - October, B - January, C - April, D - July)

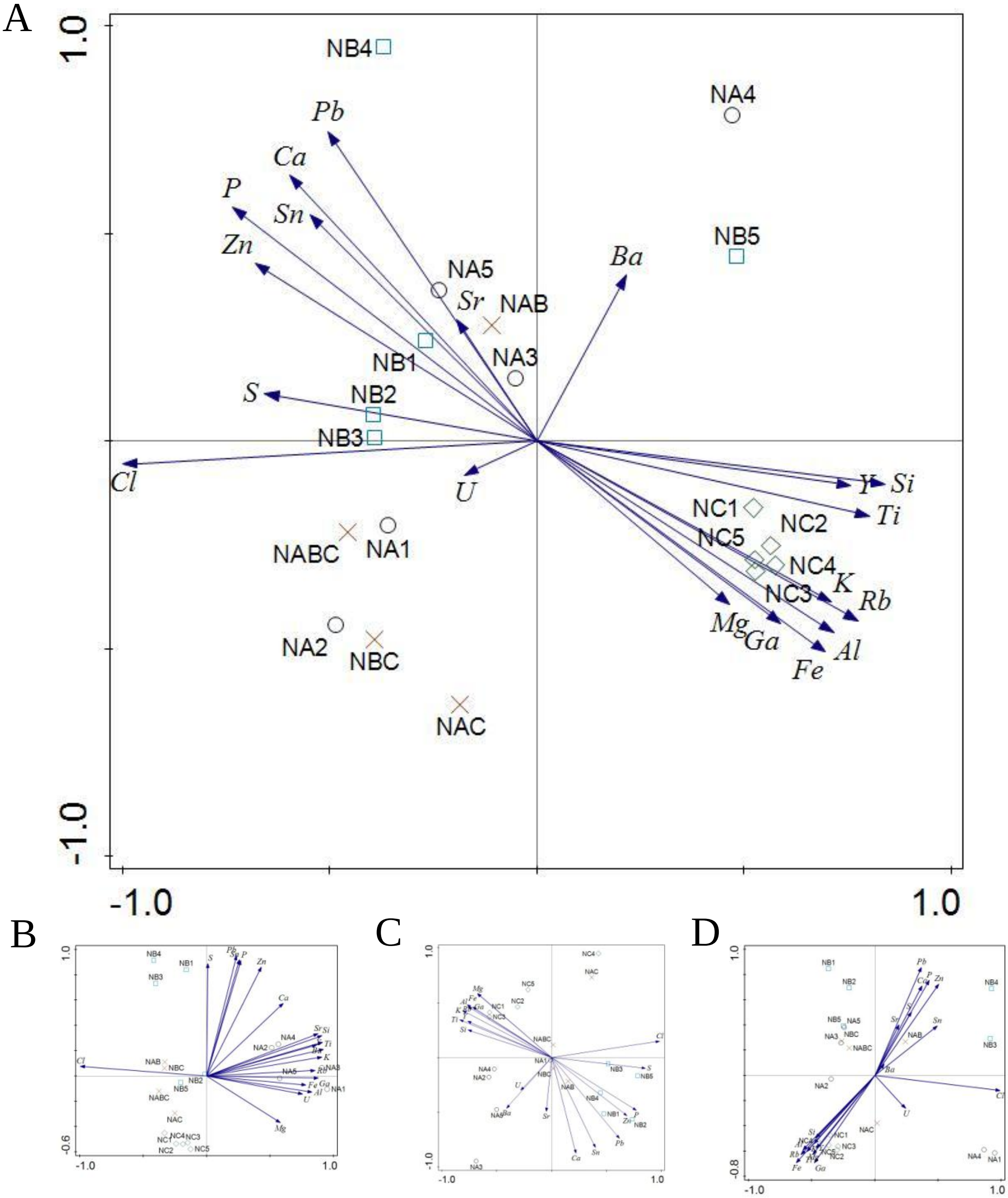


Figure 8.15: Elements responsible for the variation between sites and mixtures for the XRF reduced element data for the Nottingham sample collections (A - October, B - January, C- April, D - July) as determined by PCA

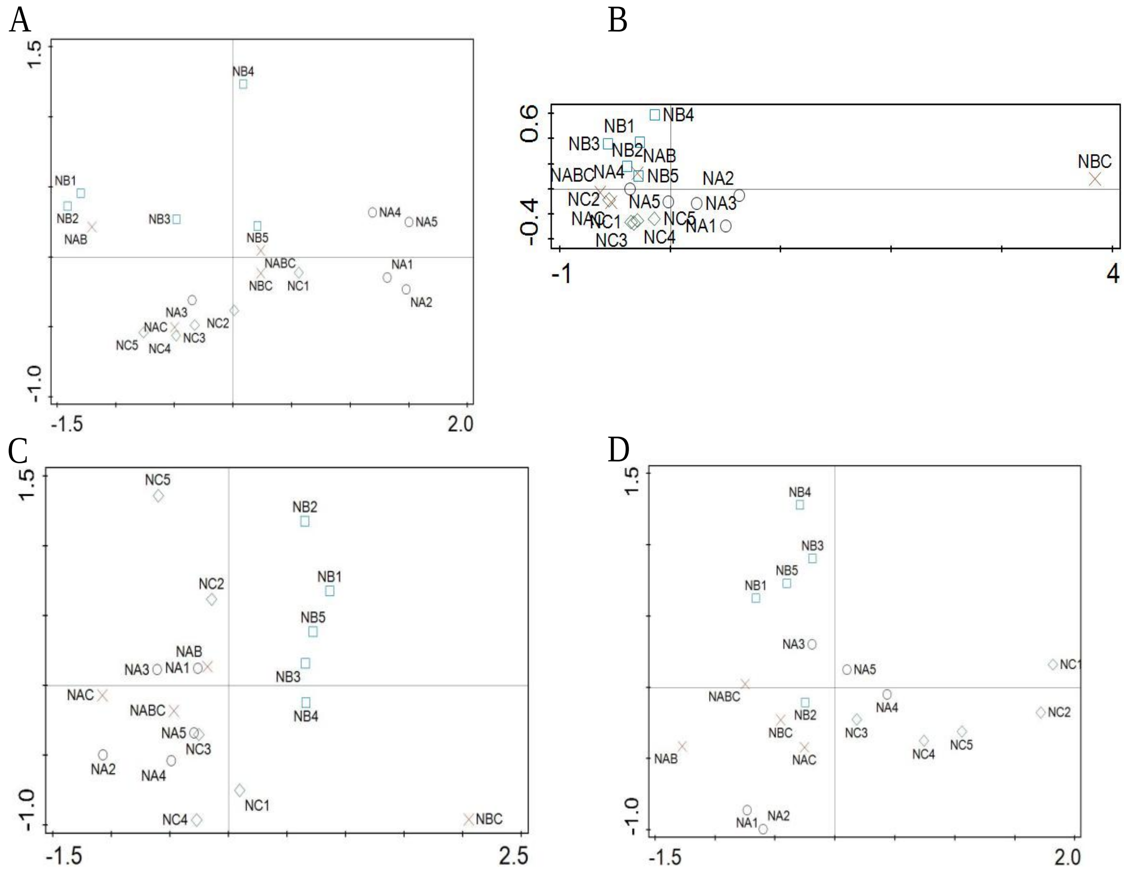


Figure 8.16: PCA biplot for single source and mixed source sample reduced element data determined by ICP-MS for the Nottingham sample collections (A - October, B - January, C - April, D - July)

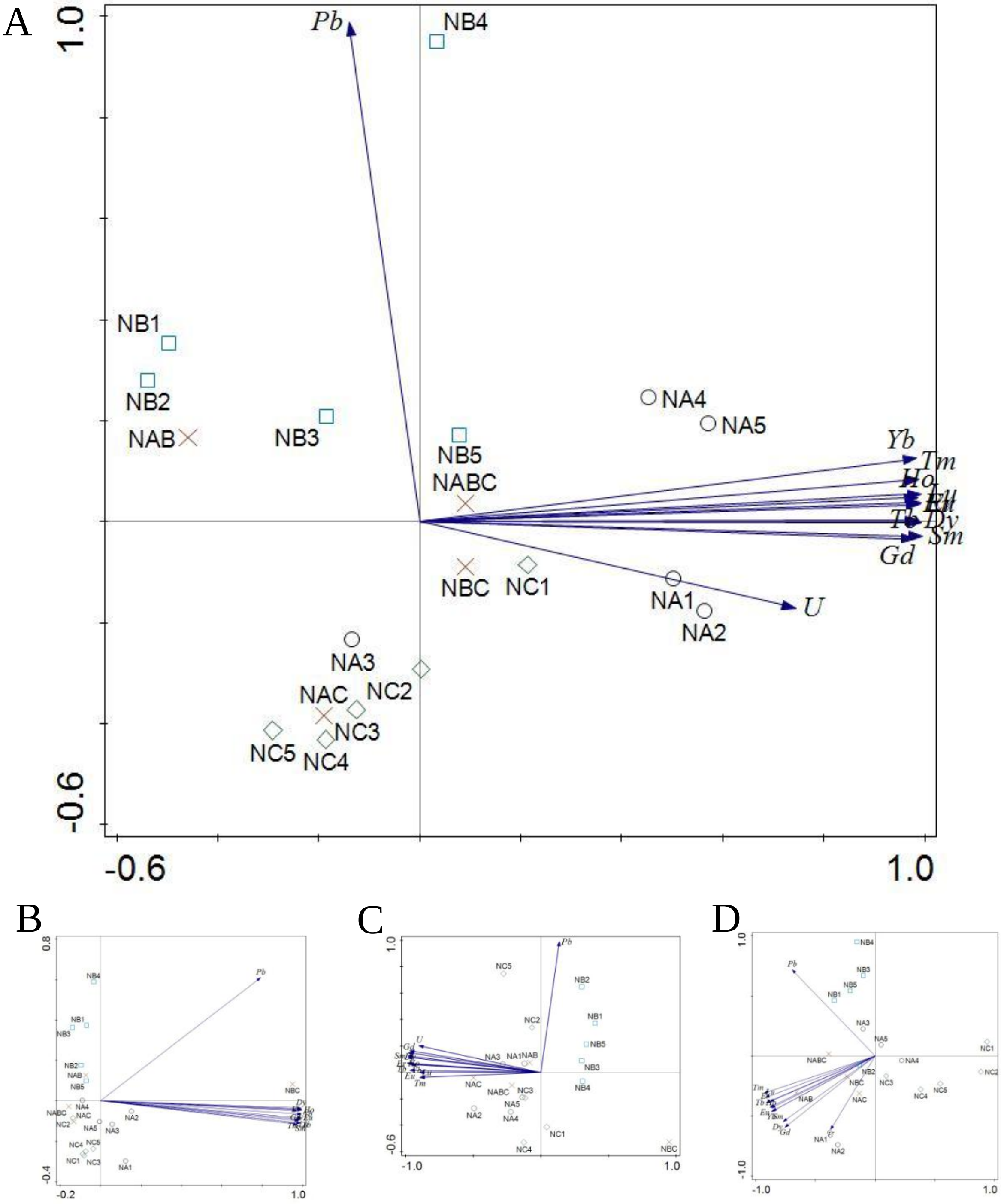


Figure 8.17: Elements responsible for the variation between sites and mixtures for the ICP-MS reduced element data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA

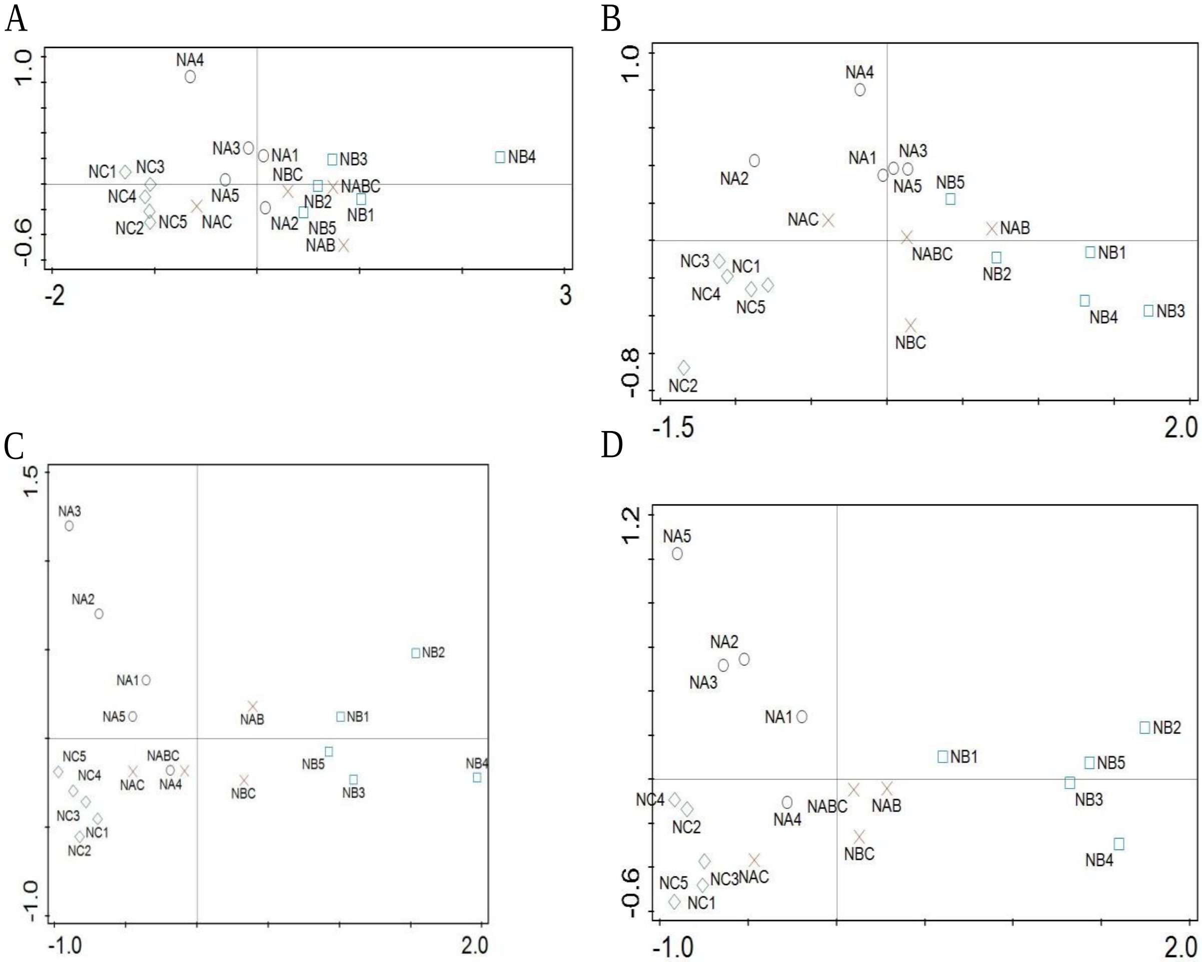


Figure 8.18: PCA biplot for single source and mixed source sample reduced element data determined by ICP-AES for the Nottingham sample collections (A - October, B - January, C - April, D - July)

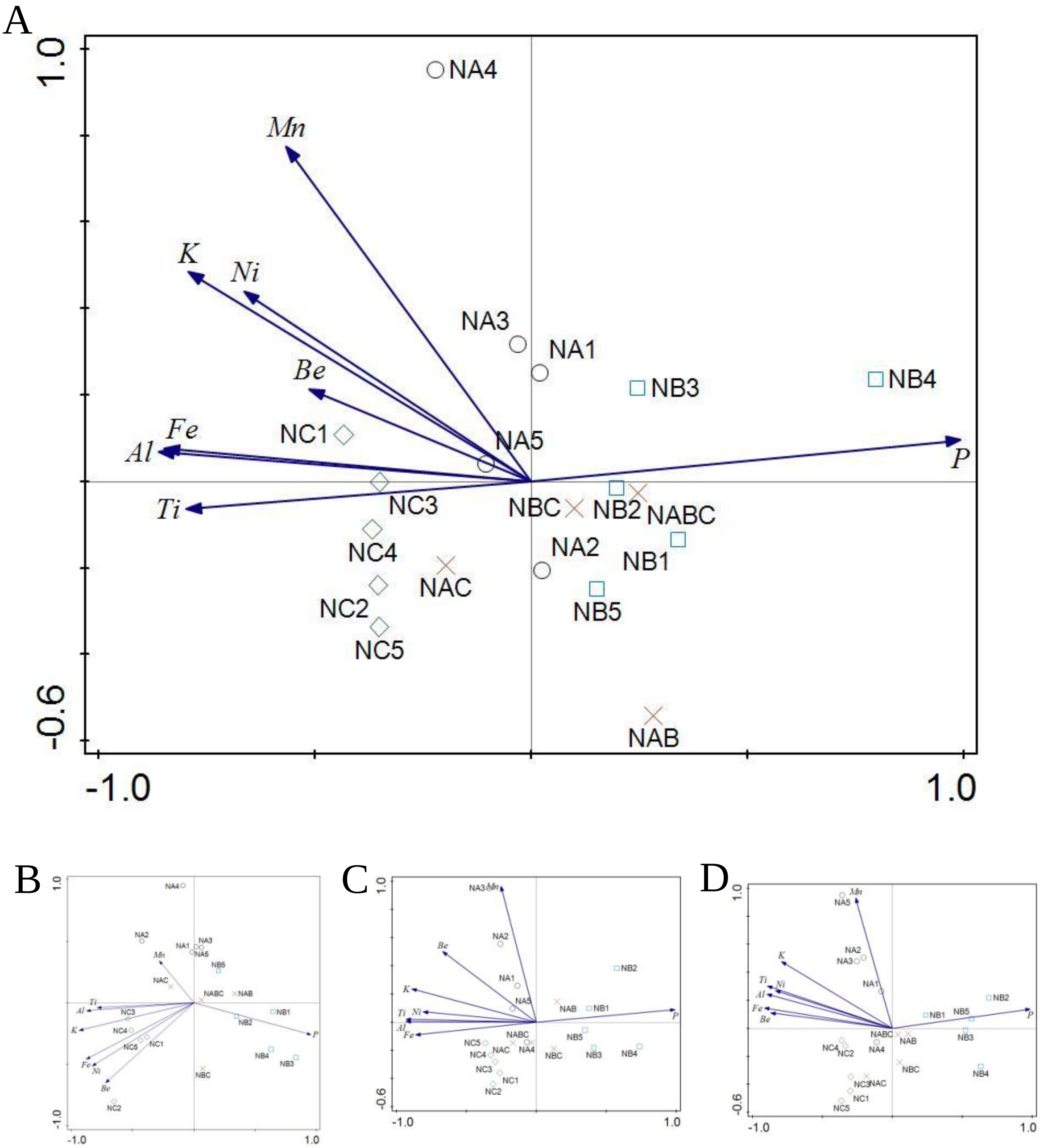


Figure 8.19 Elements responsible for the variation between sites and mixtures for the ICP-AES reduced element data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA

Table 8.21: PCA eigenvalues for the **reduced element data** for the London sample collection

Technique	Axes	XRF		ICP-MS		ICP-AES		Total Variance
		Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	
OCTOBER	1	0.7552	75.52	0.7802	78.02	0.8075	80.75	1.000
	2	0.1589	91.41	0.1501	93.04	0.1882	99.57	
	3	0.0476	96.17	0.0492	97.96	0.0037	99.94	
	4	0.0146	97.63	0.0106	99.02	0.0005	99.99	
JANUARY	1	0.7632	76.32	0.8509	85.09	0.7497	74.97	1.000
	2	0.1606	92.38	0.1262	97.71	0.2027	95.23	
	3	0.0293	95.31	0.0122	98.93	0.0331	98.54	
	4	0.0164	96.95	0.0048	99.41	0.0093	99.47	
APRIL	1	0.7771	77.71	0.7635	76.35	0.8569	85.69	1.000
	2	0.1002	87.73	0.1793	94.29	0.1050	96.20	
	3	0.0763	95.36	0.0268	96.97	0.0269	98.89	
	4	0.0215	97.51	0.0149	98.46	0.0085	99.73	
JULY	1	0.7485	74.85	0.8413	84.13	0.8777	87.77	1.000
	2	0.1094	85.78	0.1142	95.55	0.0876	96.53	
	3	0.0942	95.20	0.0249	98.04	0.0238	98.91	
	4	0.0234	97.54	0.0115	99.20	0.0079	99.70	

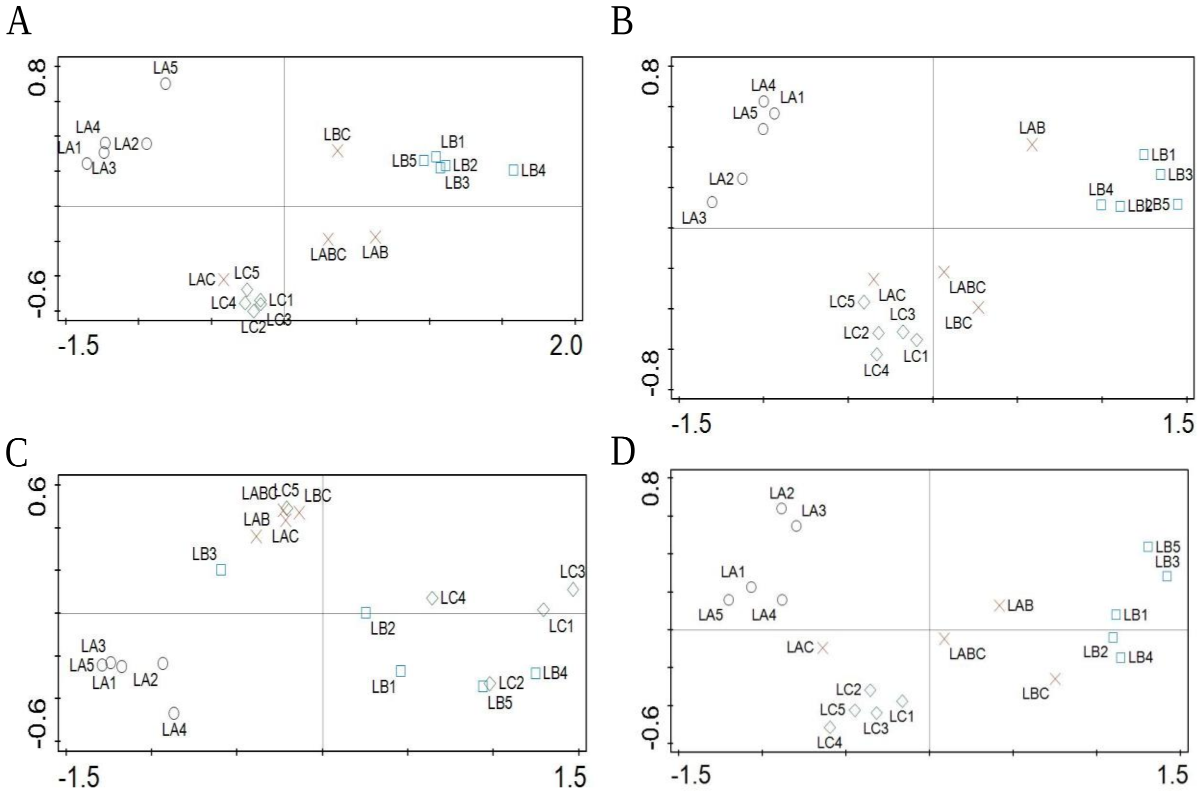


Figure 8.20: PCA biplot for single source and mixed source sample reduced element data determined by XRF for the London sample collections (A - October, B - January, C - April, D - July)

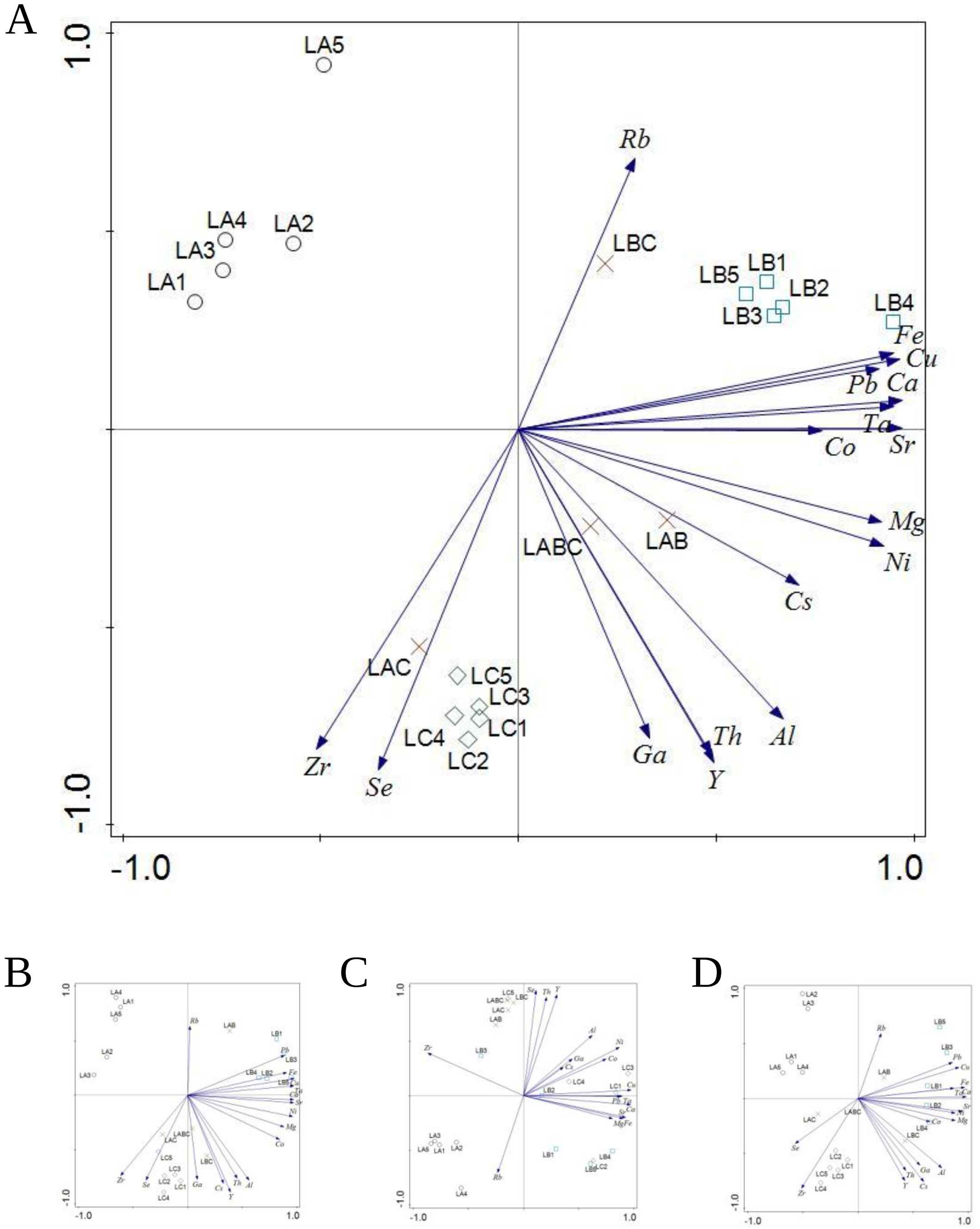


Figure 8.21: Elements responsible for the variation between sites and mixtures for the XRF reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

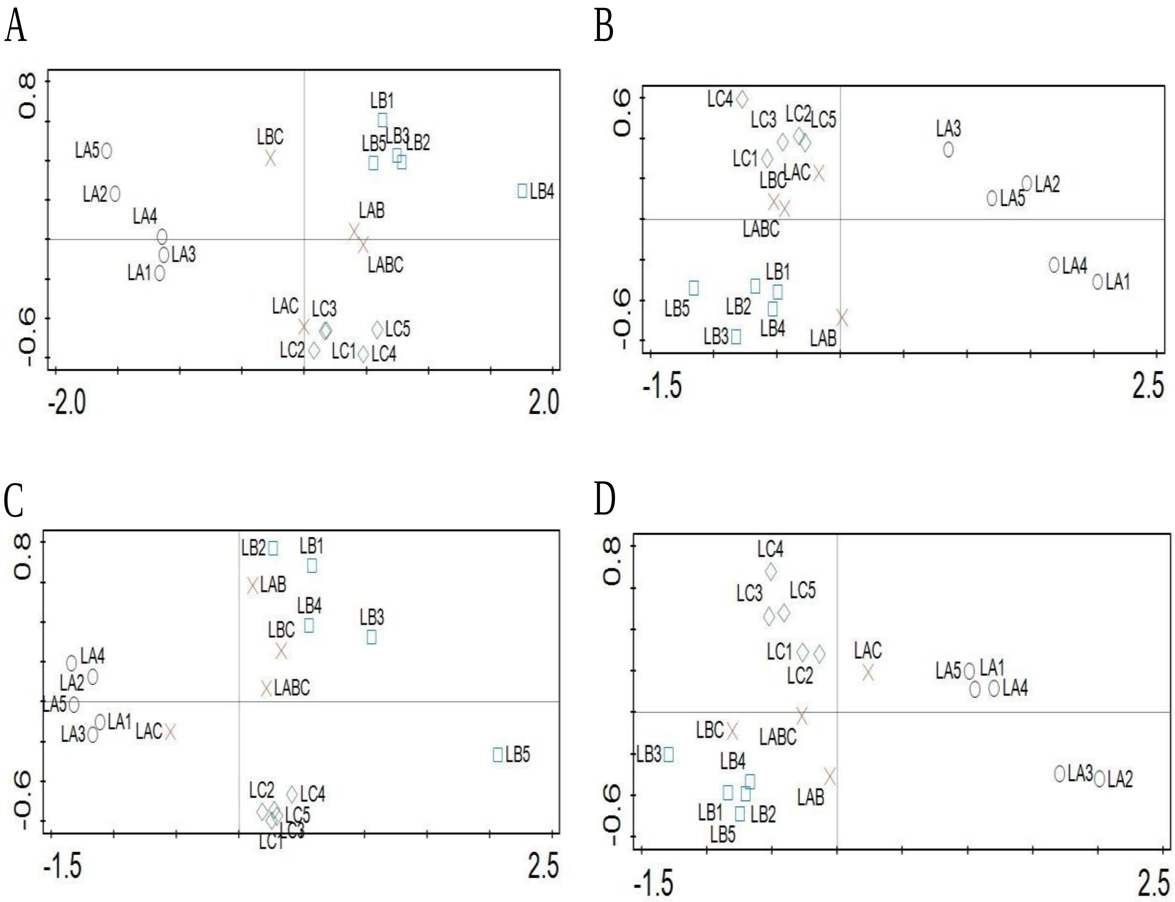


Figure 8.22: PCA biplot for single source and mixed source sample reduced element data determined by ICP-MS for the London sample collections (A - October, B - January, C - April, D - July)

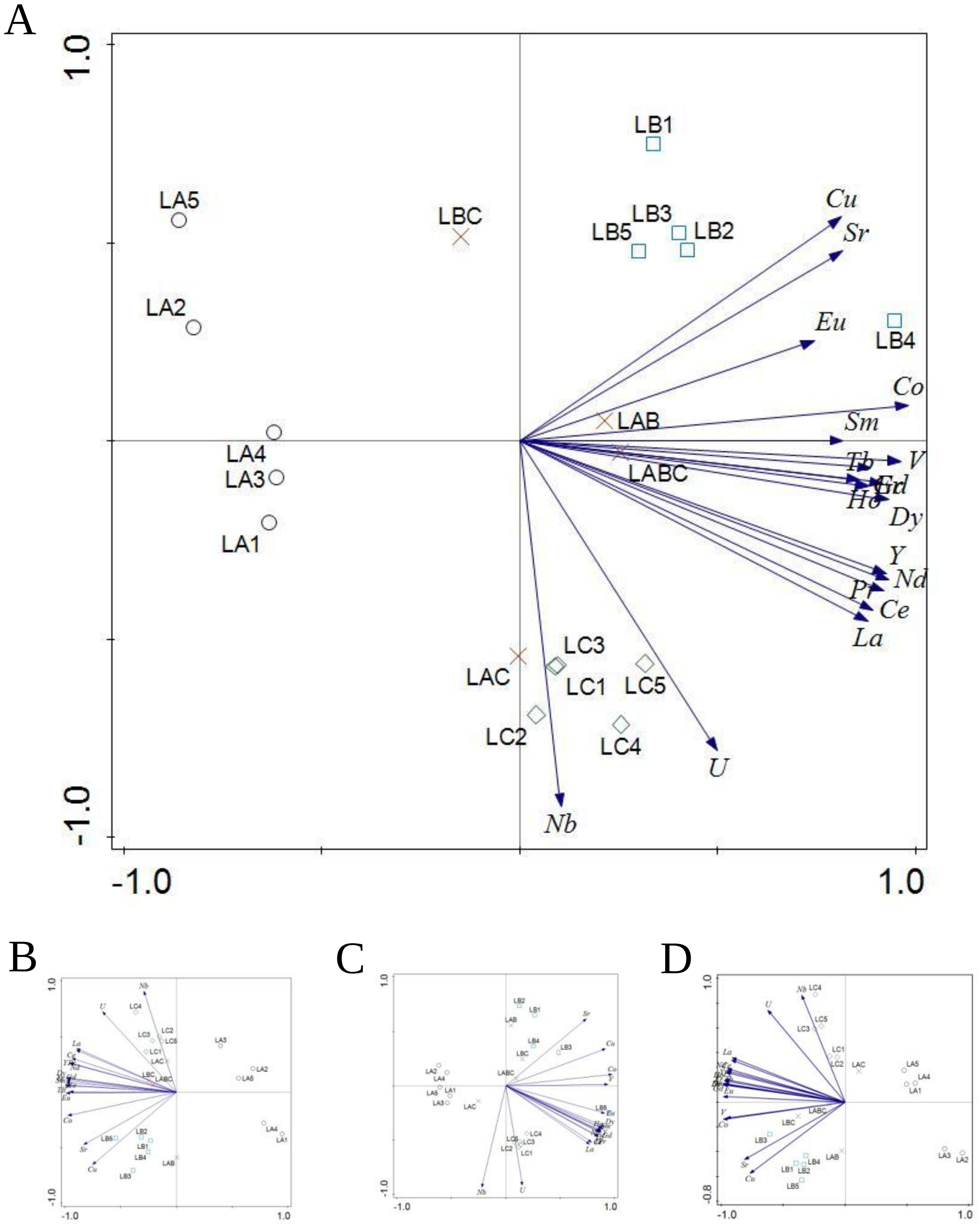


Figure 8.23: Elements responsible for the variation between sites and mixtures for the ICP-MS reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

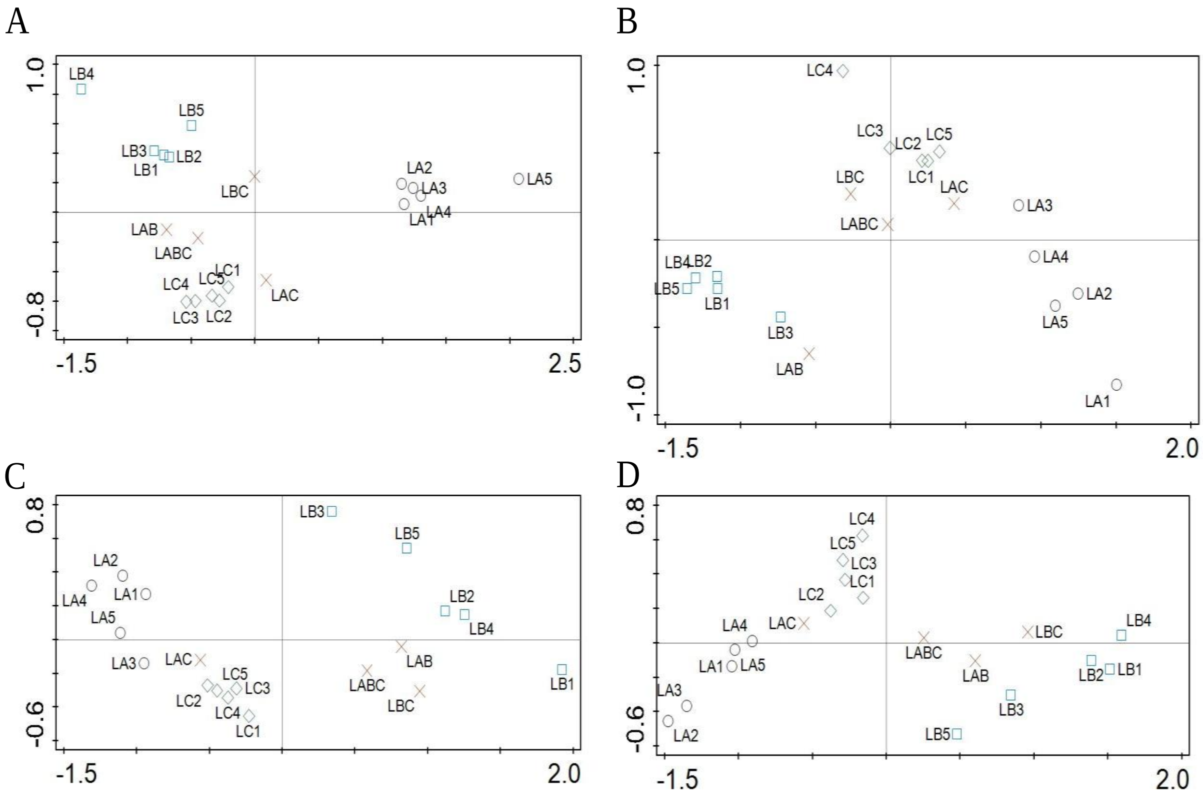


Figure 8.24: PCA biplot for single source and mixed source sample reduced element data determined by ICP-AES for the London sample collections (A - October, B - January, C - April, D - July)

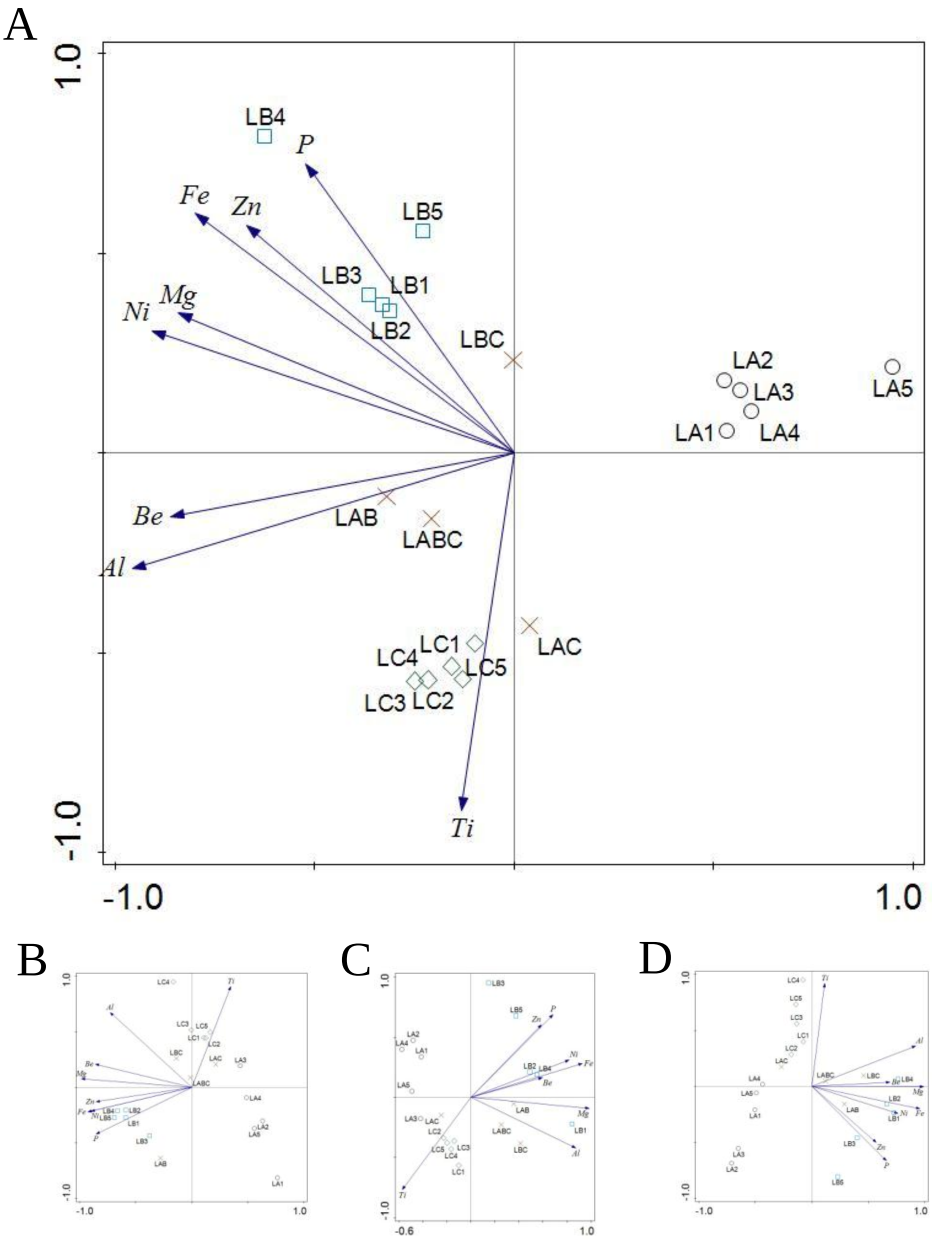


Figure 8.25: Elements responsible for the variation between sites and mixtures for the ICP-AES reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

Table 8.22: PCA eigenvalues for the **common reduced element** data for the Nottingham sample collection

Technique	Axes	XRF		ICP-MS		ICP-AES		Total Variance
		Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	
OCTOBER	1	0.7519	75.19	0.8334	83.34	0.9112	91.12	1.000
	2	0.2063	95.82	0.1616	99.50	0.0472	95.84	
	3	0.0276	98.58	0.0020	99.70	0.0372	99.56	
	4	0.0076	99.34	0.0011	99.81	0.0028	99.84	
JANUARY	1	0.6558	65.58	0.9968	99.68	0.8233	82.33	1.000
	2	0.2830	93.89	0.0028	99.96	0.1412	96.45	
	3	0.0453	98.42	0.0002	99.98	0.0215	98.60	
	4	0.0096	99.38	0.0001	99.99	0.0069	99.29	
APRIL	1	0.8179	81.79	0.9600	96.00	0.9476	94.76	1.000
	2	0.1339	95.18	0.0321	99.21	0.0354	98.30	
	3	0.0299	98.17	0.0022	99.43	0.0073	99.03	
	4	0.0071	98.88	0.0018	99.61	0.0062	99.65	
JULY	1	0.7656	76.56	0.8316	83.16	0.9346	93.46	1.000
	2	0.1803	94.59	0.1466	97.81	0.0556	99.02	
	3	0.0376	98.34	0.0074	98.55	0.0052	99.54	
	4	0.0092	99.26	0.0061	99.16	0.0031	99.85	

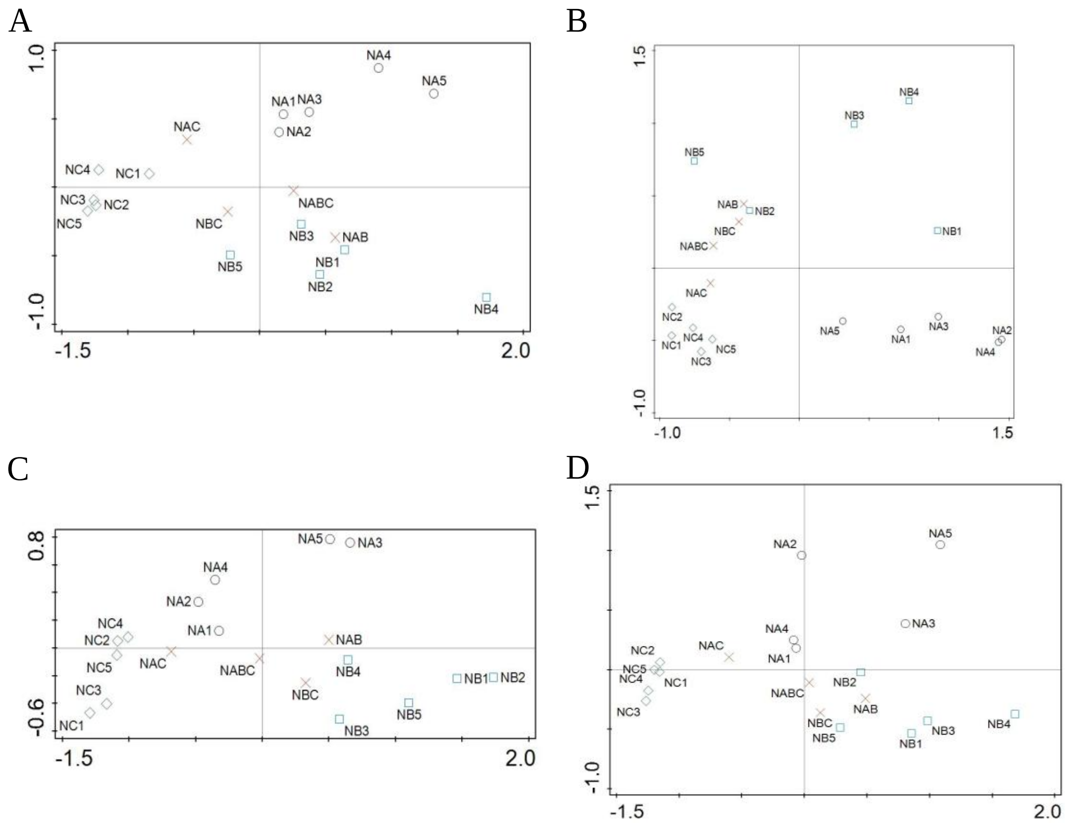


Figure 8.26: PCA biplot for single source and mixed source sample common reduced element data determined by XRF for the Nottingham sample collections (A - October, B - January, C - April, D - July)

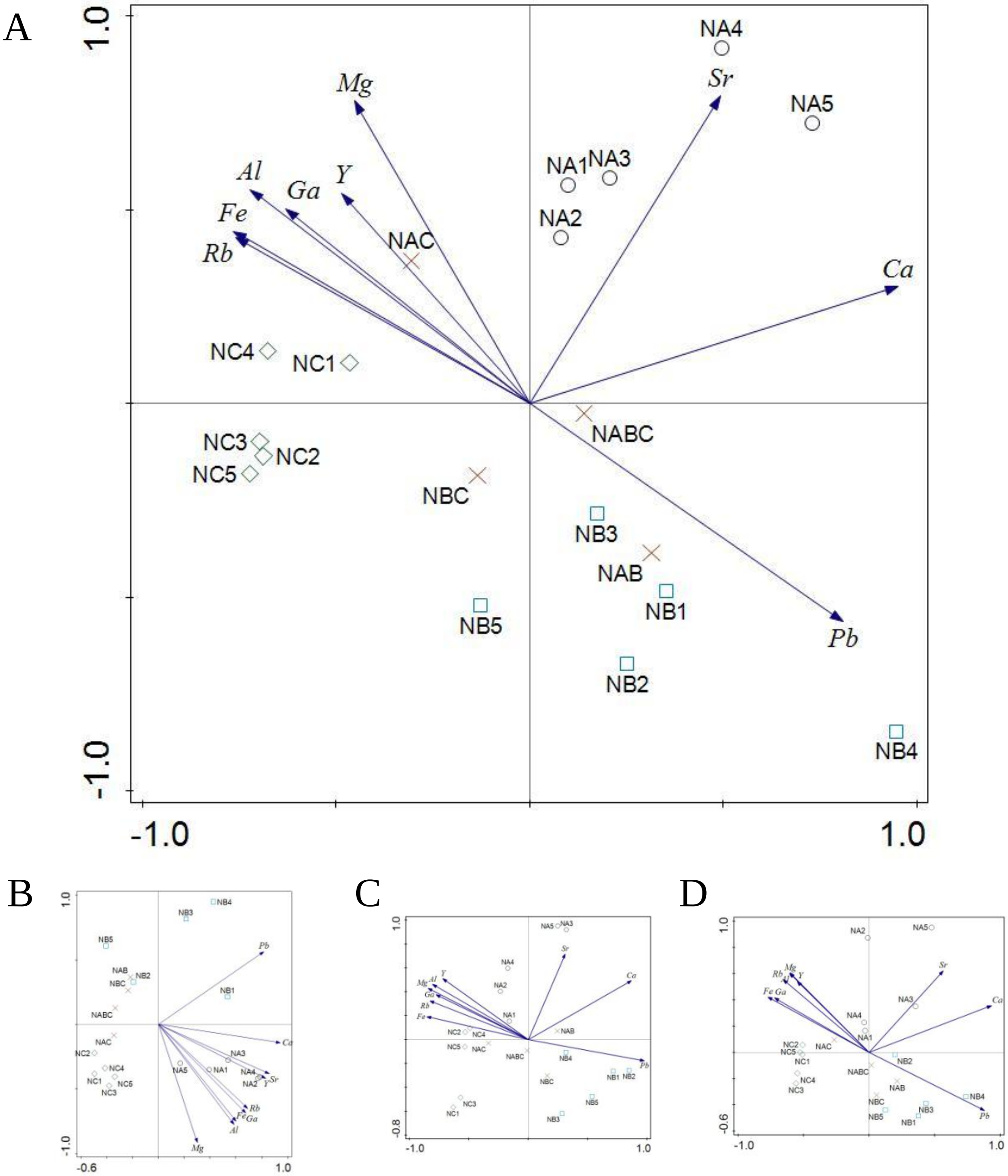


Figure 8.27: Elements responsible for the variation between sites and mixtures for the XRF common reduced element data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA

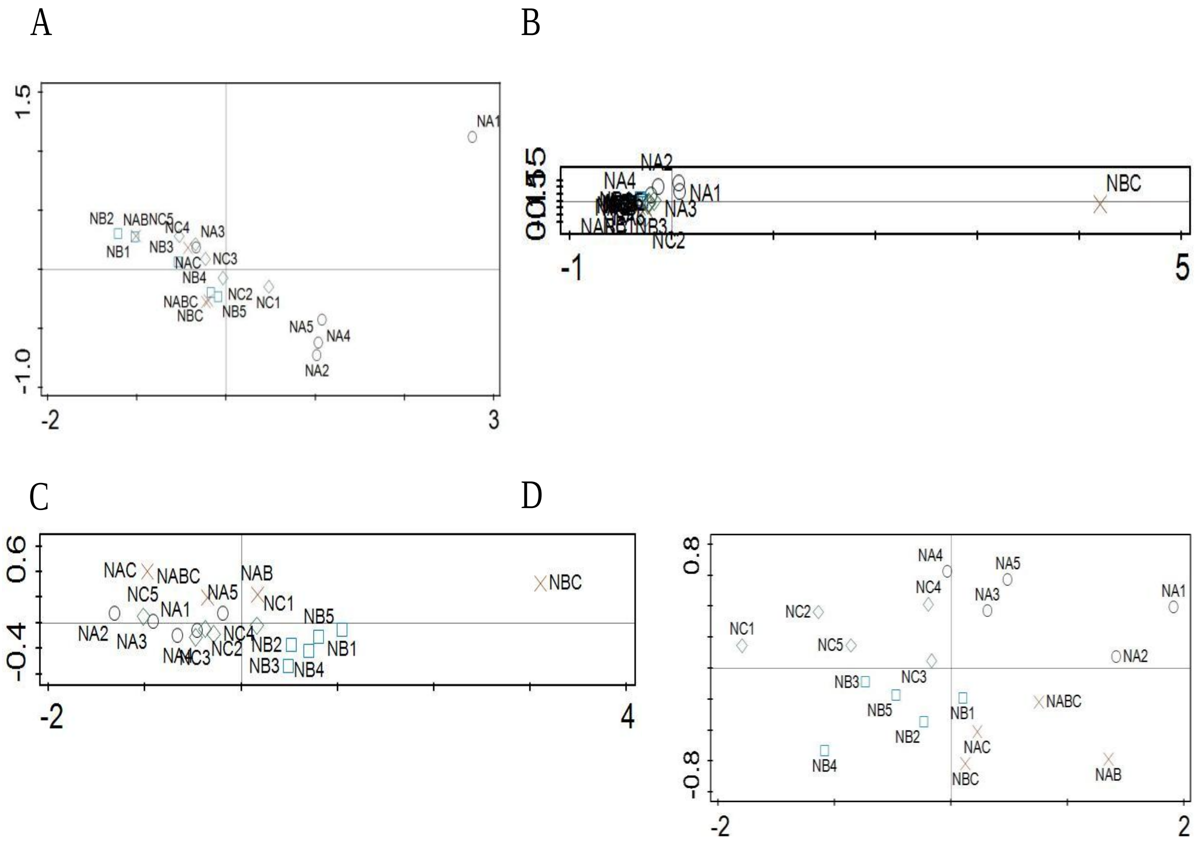


Figure 8.28: PCA biplot for single source and mixed source sample common reduced element data determined by ICP-MS for the Nottingham sample collections (A - October, B - January, C - April, D - July)

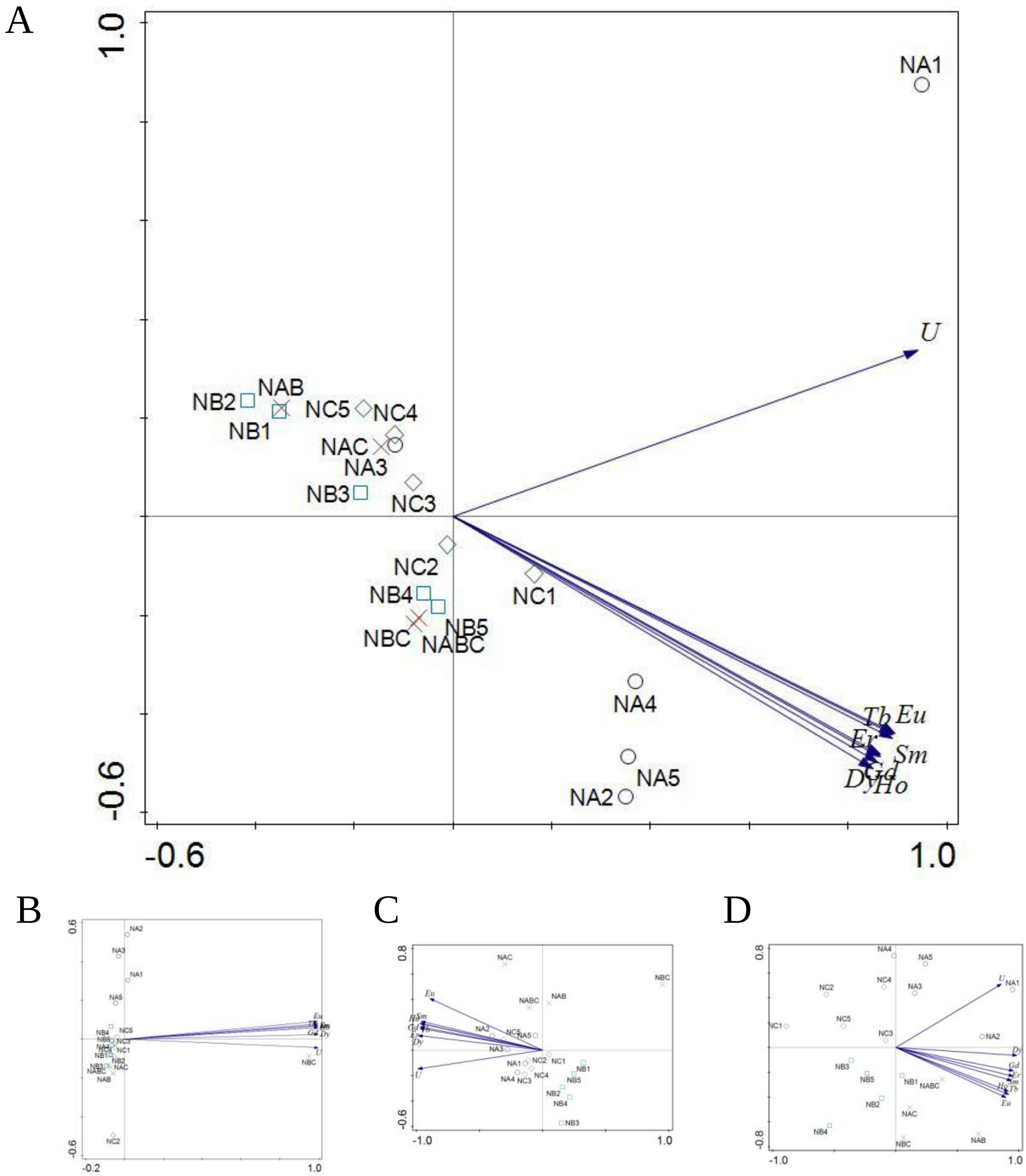


Figure 8.29: Elements responsible for the variation between sites and mixtures for the ICP-MS common reduced element data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA

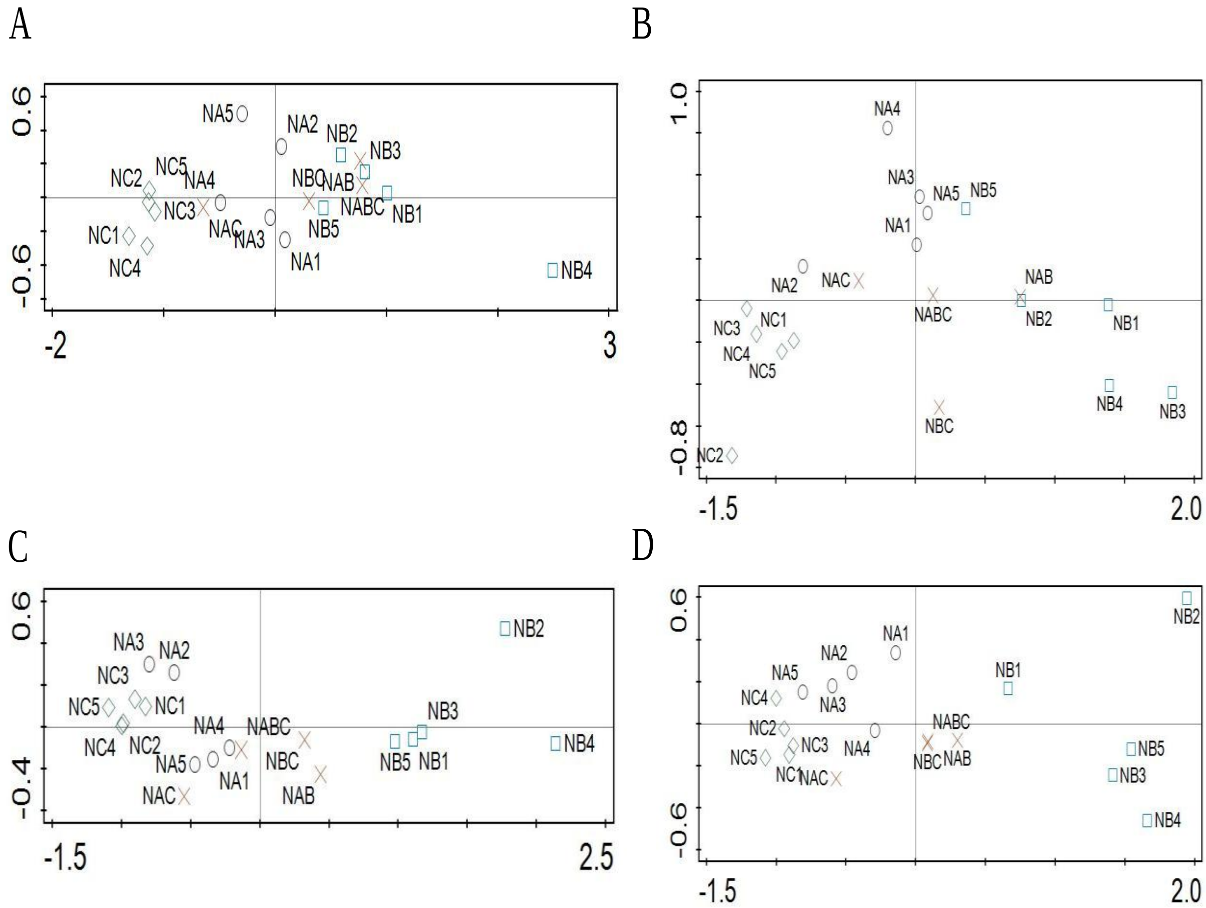


Figure 8.30: PCA biplot for single source and mixed source sample common reduced element data determined by ICP-AES for the Nottingham sample collections (A - October, B - January, C - April, D - July)

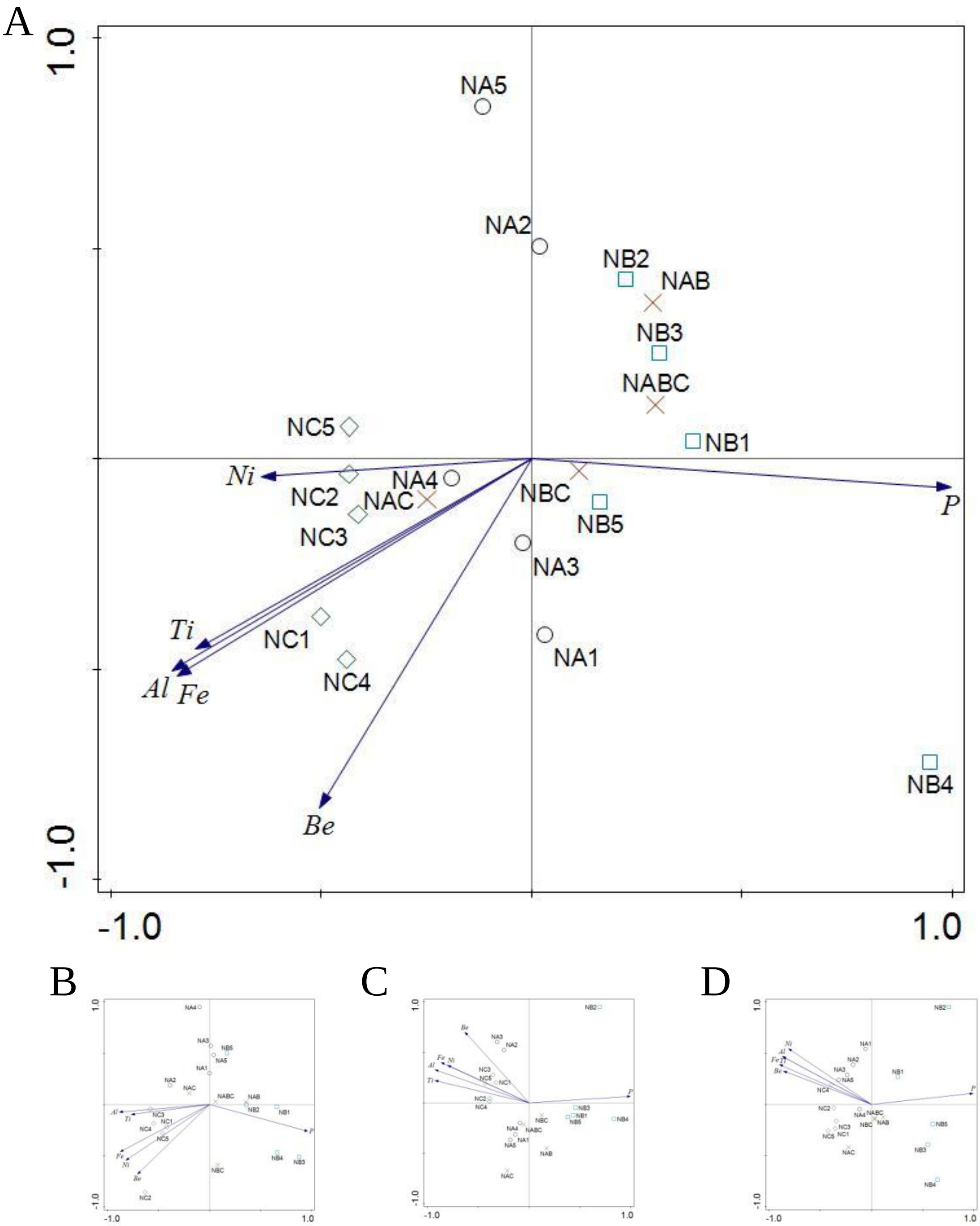


Figure 8.31: Elements responsible for the variation between sites and mixtures for the ICP-AES common reduced element data for the Nottingham sample collections (A - October, B - January, C-April, D - July) as determined by PCA

Table 8.23: PCA eigenvalues for the **common reduced element** data for the London sample collection

Technique	Axes	XRF		ICP-MS		ICP-AES		Total Variance
		Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	Eigenvalues	Cumulative Percentage of variance	
OCTOBER	1	0.8134	81.34	0.8078	80.78	0.8090	80.90	1.000
	2	0.1180	93.13	0.1753	98.31	0.1892	99.82	
	3	0.0463	97.77	0.0097	99.28	0.0016	99.98	
	4	0.0133	99.10	0.0024	99.51	0.0002	100.0	
JANUARY	1	0.7997	79.97	0.8858	88.58	0.6382	63.82	1.000
	2	0.1353	93.49	0.1096	99.54	0.3105	94.88	
	3	0.0390	97.40	0.0017	99.71	0.0390	98.77	
	4	0.0166	99.06	0.0012	99.83	0.0117	99.95	
APRIL	1	0.8061	80.61	0.8683	86.83	0.7720	77.20	1.000
	2	0.0981	90.41	0.1230	99.14	0.2003	97.22	
	3	0.0567	96.09	0.0049	99.63	0.0204	99.26	
	4	0.0313	99.22	0.0013	99.76	0.0063	99.89	
JULY	1	0.8310	83.10	0.8931	89.31	0.7953	79.53	1.000
	2	0.0968	92.78	0.1006	99.37	0.1761	97.14	
	3	0.0500	97.78	0.0026	99.64	0.0182	98.96	
	4	0.0143	99.21	0.0014	99.77	0.0092	99.88	

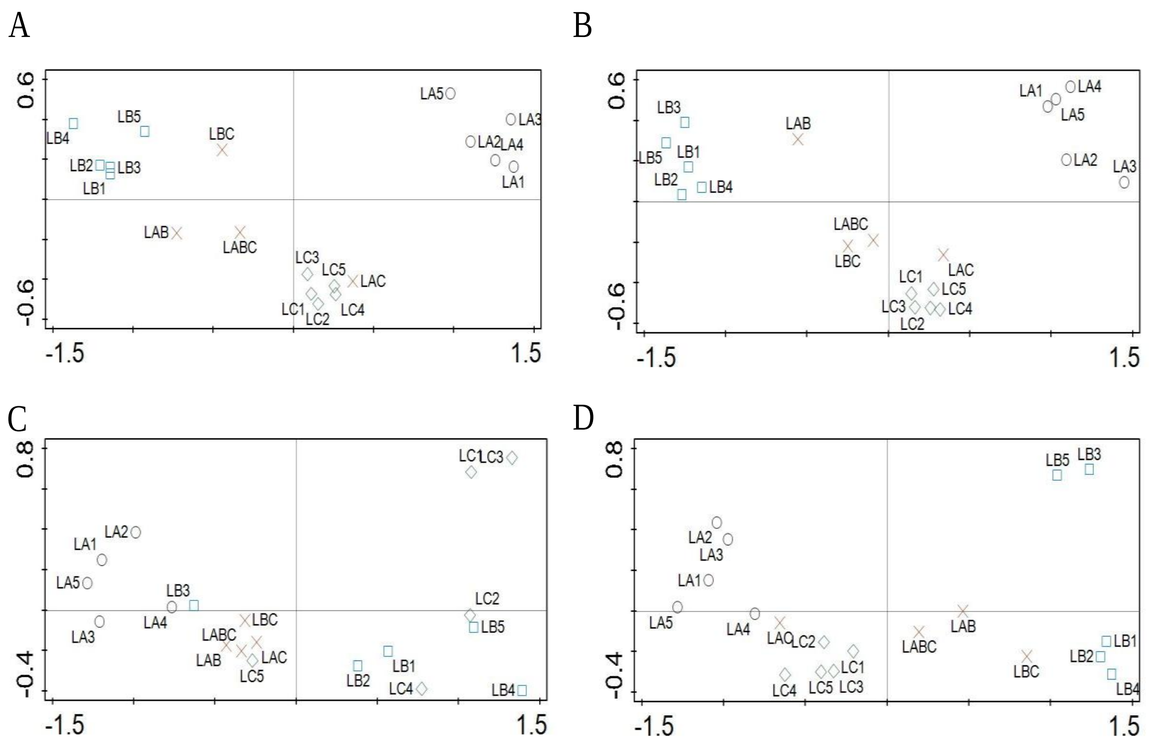


Figure 8.32: PCA biplot for single source and mixed source sample common reduced element data determined by XRF for the London sample collections (A - October, B - January, C - April, D - July)

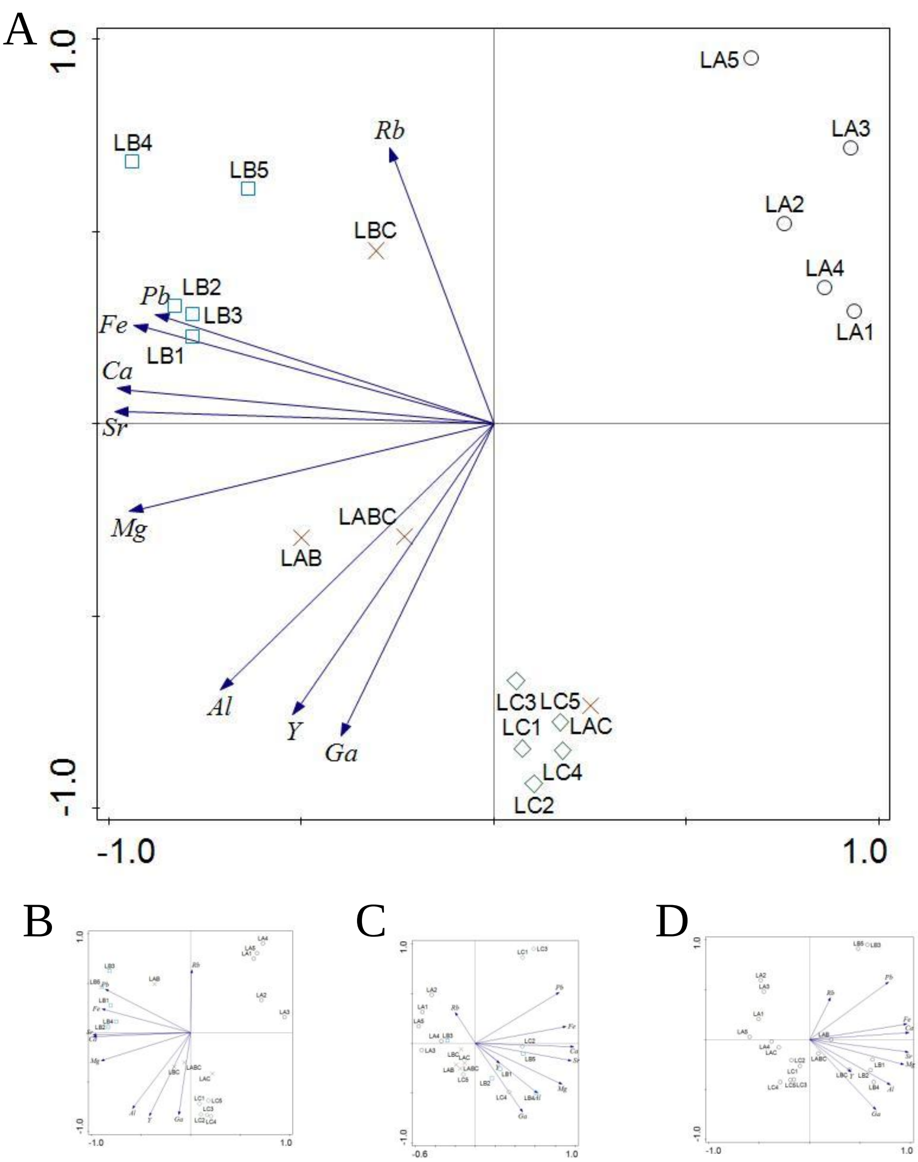


Figure 8.33: Elements responsible for the variation between sites and mixtures for the XRF common reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

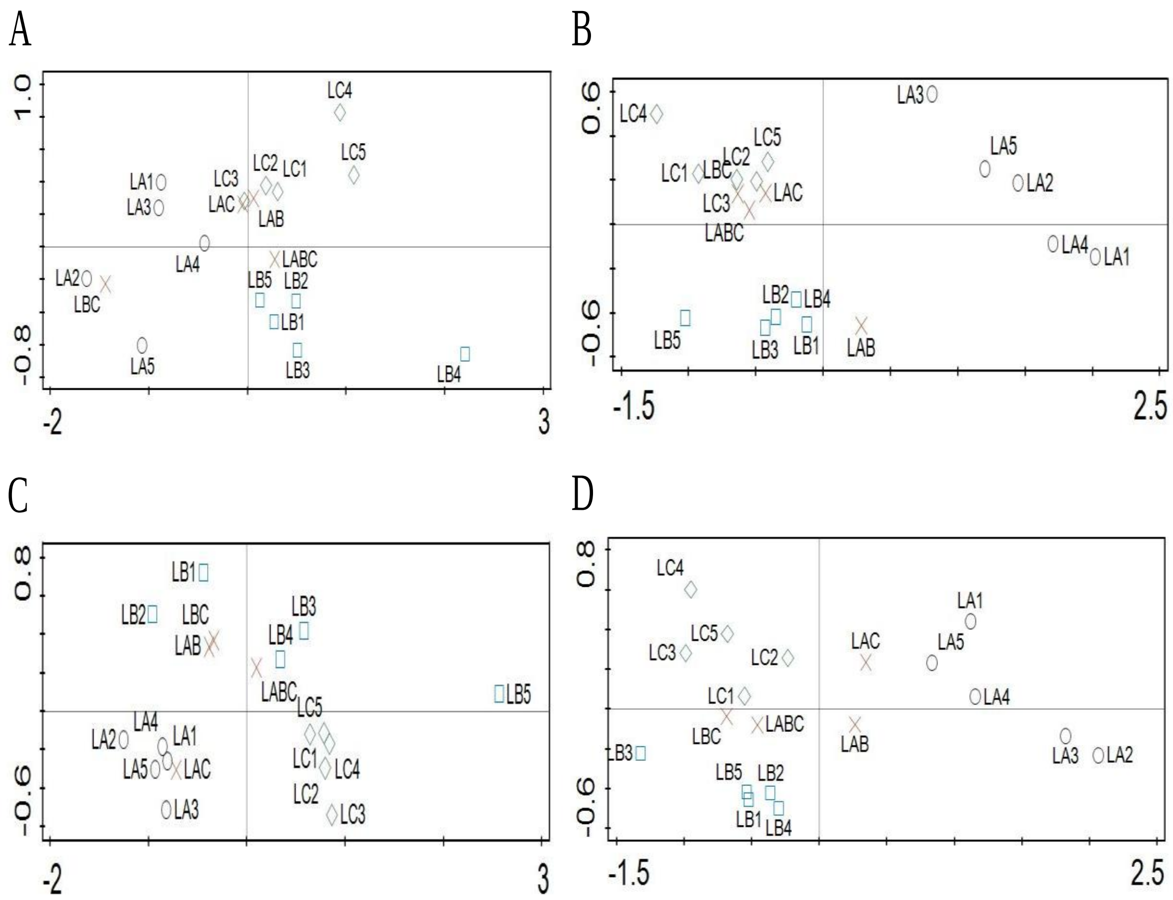


Figure 8.34: PCA biplot for single source and mixed source sample common reduced element data determined by ICP-MS for the London sample collections (A - October, B - January, C - April, D - July)

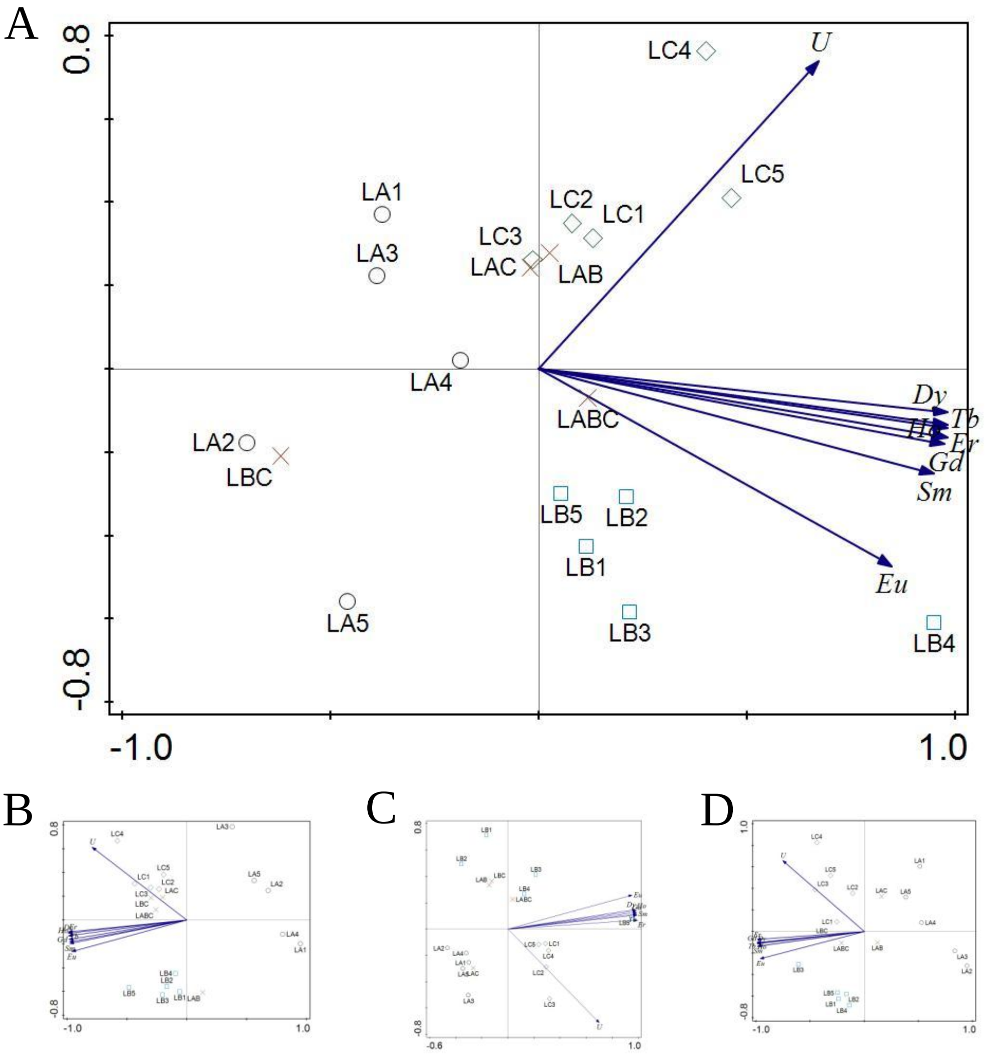


Figure 8.35: Elements responsible for the variation between sites and mixtures for the ICP-MS common reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

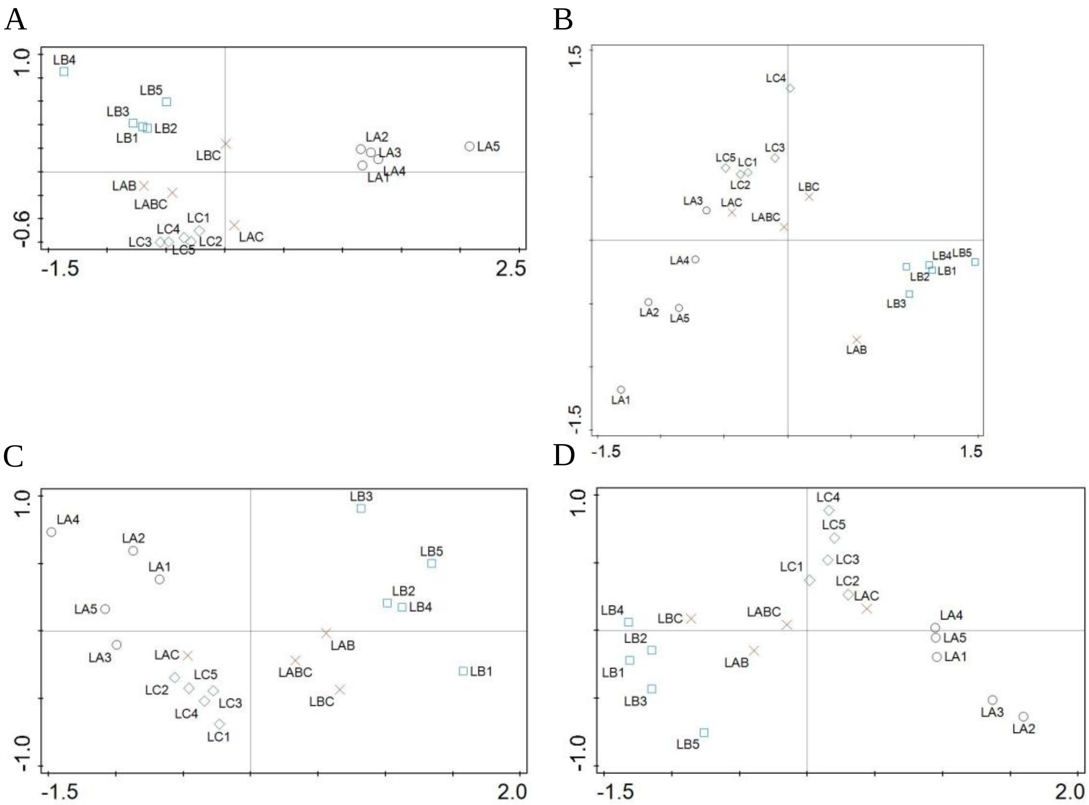


Figure 8.36: PCA biplot for single source and mixed source sample common reduced element data determined by ICP-AES for the London sample collections (A - October, B - January, C - April, D - July)

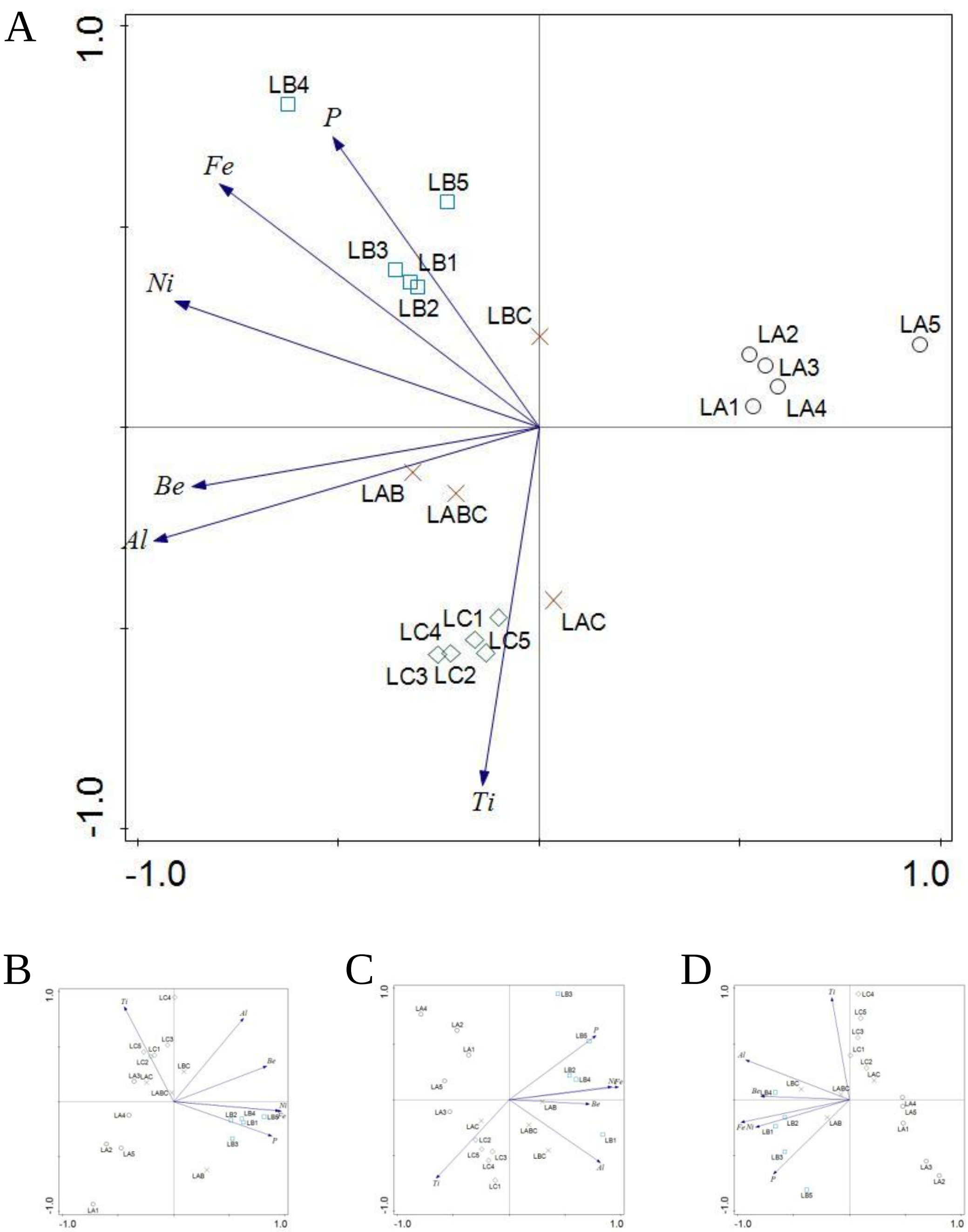


Figure 8.37: Elements responsible for the variation between sites and mixtures for the ICP-AES common reduced element data for the London sample collections (A - October, B - January, C-April, D - July) as determined by PCA

8.3.3 End-Member Modelling

EMM was unsuccessful for the element subsets (table 8.24) identified from the statistical findings in chapter 5.3. For instance, for ICP-AES, sites B and C are well separated in both locations, as are sites B and A for London only (appendix 8.50). However, the mixture data points are not observed between the sites, but instead for Nottingham the data points cluster around site A (appendix 8.49), and for London mixtures overlap sites A and C. In order for

EMM to be successful at identifying sites involved and ratios present within a mixture a good separation of the sites is required from the plotted data. Other element pairs were identified for Nottingham (XRF and ICP-AES only) and London from examining the entire data set and plotting the concentration of each element against concentration of the other elements determined. Figures 8.38 to 8.42 illustrate the most effective end-member pairs identified by EMM to discriminate between single source sites and mixed source samples and tables 8.25 and 8.26 detail the end member values.

Table 8.24: Elements subjected to EMM for the Nottingham and London sample sites

	XRF	ICP-MS	ICP-AES
Nottingham	Al, Fe, Mg, Rb, Y	Eu, Dy, Gd, Sm, U	Al, Fe, Ni, P, Ti
London	Cu, Mg, Y, Zn	Co, Eu, Gd, La, Y	Fe, Mn, Ni, Ti, Zn

For Nottingham end members Ca-S (XRF, figure 8.38) and Ca-Mg (ICP-AES, figure 8.39) were identified. However, none could be successfully identified for the ICP-MS data, due to the distinct clustering of all single source sites and mixtures (see appendix 8.51). In some cases, a near even split of the single source samples within a mixture is identified e.g. XRF assessment of July mixture ABC where 0.3014 from site A, 0.3692 from site B and 0.3294 from site C. However, in other cases, EMM identifies an uneven split between sites involved, and that the mixture is part explained by sites that are not composed of that site e.g. October mixture AB where over half is explained by site B (0.5439) and only 0.1888 explained by site A in comparison to 0.2673 explained by site C (table 8.25). These inconsistencies could be a result of the EMM however, it is also possible that it is due to the elements themselves based on the measurement errors identified for Ca in chapter 5 (table 5.6)

Table 8.25: End-member values for the Nottingham sample sites and mixtures

Nottingham Collection	Sample	XRF (Ca, S)			ICP-AES (Ca, Mg)		
		A	B	C	A	B	C
October	AB	0.2754	0.4918	0.2328	0.1888	0.5439	0.2673
	AC	0.3052	0.2321	0.4627	0.3331	0.2803	0.3866
	BC	0.2539	0.3819	0.3643	0.2312	0.4496	0.3192
	ABC	0.2169	0.5679	0.2151	0.2542	0.4599	0.2859
January	AB	0.2010	0.1247	0.6743	0.2516	0.4878	0.2605
	AC	0.1721	0.1278	0.7001	0.4217	0.2109	0.3674
	BC	0.2189	0.1436	0.6375	0.4321	0.2234	0.3444
	ABC	0.1803	0.1271	0.6926	0.4054	0.2781	0.3165
April	AB	0.2408	0.5839	0.1753	0.2359	0.5223	0.2418
	AC	0.3230	0.2844	0.3926	0.3542	0.2874	0.3584
	BC	0.2236	0.5692	0.2072	0.3300	0.3896	0.2804
	ABC	0.3214	0.4518	0.2268	0.3860	0.3009	0.3131
July	AB	0.3137	0.4661	0.2202	0.2229	0.5100	0.2671
	AC	0.2925	0.2675	0.4400	0.2736	0.3680	0.3584
	BC	0.3237	0.3624	0.3138	0.2389	0.4501	0.3110
	ABC	0.3014	0.3692	0.3294	0.2796	0.4182	0.3022

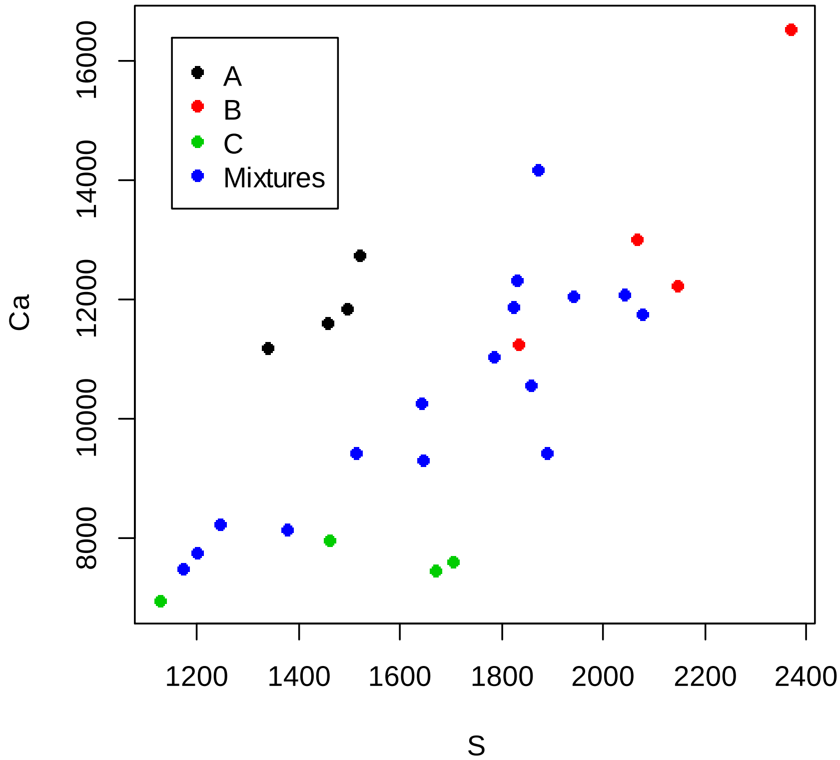


Figure 8.38: EMM chart for Nottingham Ca-S element pairs determined by XRF (axis units ppm)

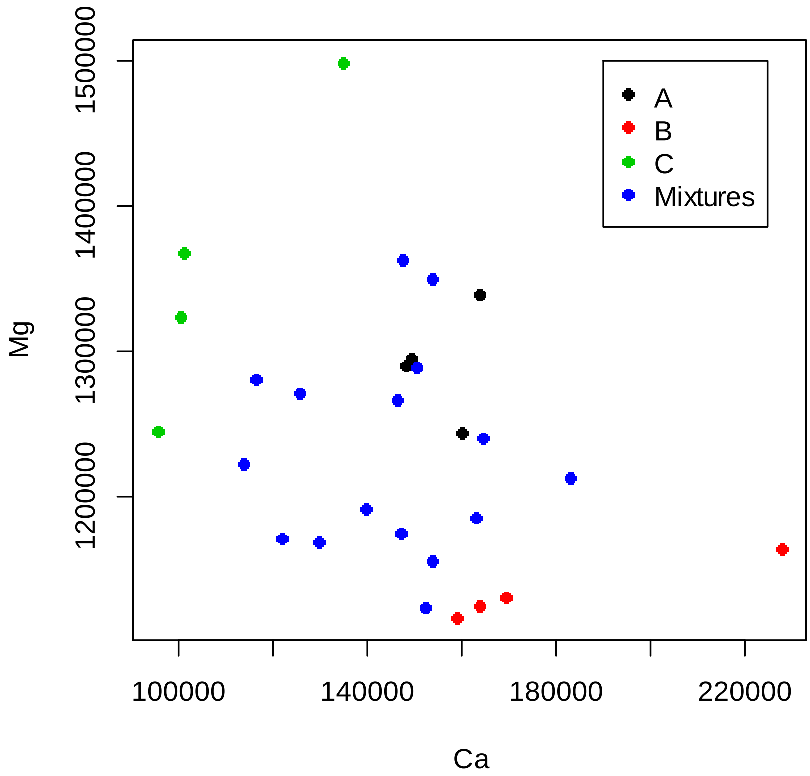


Figure 8.39: EMM chart for Nottingham Ca-Mg determined pairs determined by ICP-AES (axis units ppm)

For London, end-members Hf-Y (XRF, figure 8.40), Sr-Y (ICP-MS, figure 8.41) and Be-Ca (ICP-AES, figure 8.42) were identified. Similar patterns to the Nottingham samples can be observed for the London samples; for instance, the even split of single source samples within a mixture e.g. April ABC by ICP-AES 0.3208 explained by site A, 0.3409 site B, and 0.3384 site C. For January mixture AB by ICP-MS, where 0.4264 explained by site B, and only 0.2212 by site A, compared to 0.3524 by site C; or October mixture BC by XRF, where the majority of the mixture was explained by site A (0.5275), compared to 0.4099 by site B, and 0.0627 by site C. Again this could be a result of element measure errors effecting the performance of the model; though Y measured well with a percentage error of -2.2 %, Hf was significantly higher with 15.1% (table 5.6).

Table 8.26: End-member values for the London sample sites and mixtures

London Collection	Sample	XRF (Hf, Y)			ICP-MS (Sr, Y)			ICP-AES (Be, Ca)		
		A	B	C	A	B	C	A	B	C
October	AB	0.1246	0.4667	0.4087	0.2212	0.4264	0.3524	0.1684	0.6017	0.2299
	AC	0.1298	0.1703	0.6999	0.3365	0.2698	0.3937	0.3106	0.1051	0.5843
	BC	0.5275	0.4099	0.0627	0.3266	0.3861	0.2873	0.2574	0.5527	0.1899
	ABC	0.1749	0.1376	0.6875	0.2157	0.4040	0.3802	0.2184	0.4058	0.3758
January	AB	0.4684	0.4747	0.0568	0.4445	0.2540	0.3016	0.3459	0.4297	0.2244
	AC	0.1408	0.0934	0.7658	0.3686	0.2513	0.3801	0.2566	0.0896	0.6538
	BC	0.0690	0.0426	0.8884	0.2331	0.2953	0.4716	0.1418	0.2136	0.6446
	ABC	0.1537	0.1498	0.6965	0.2697	0.2900	0.4403	0.2214	0.1705	0.6081
April	AB	0.0381	0.0286	0.9333	0.2193	0.5370	0.2438	0.3682	0.4140	0.2178
	AC	0.0499	0.0533	0.8968	0.3587	0.2626	0.3787	0.5008	0.0752	0.4240
	BC	0.0472	0.0459	0.9069	0.1397	0.5609	0.2993	0.1938	0.5156	0.2907
	ABC	0.0383	0.0397	0.9219	0.1831	0.5020	0.3149	0.3208	0.3409	0.3384
July	AB	0.4618	0.4938	0.0444	0.2227	0.5325	0.2448	0.3484	0.4528	0.1988
	AC	0.3958	0.1508	0.4534	0.4368	0.2080	0.3552	0.5576	0.0916	0.3508
	BC	0.1396	0.5038	0.3566	0.1180	0.6180	0.2640	0.1597	0.6093	0.2310
	ABC	0.3665	0.3190	0.3144	0.2788	0.4089	0.3123	0.4052	0.2969	0.2979

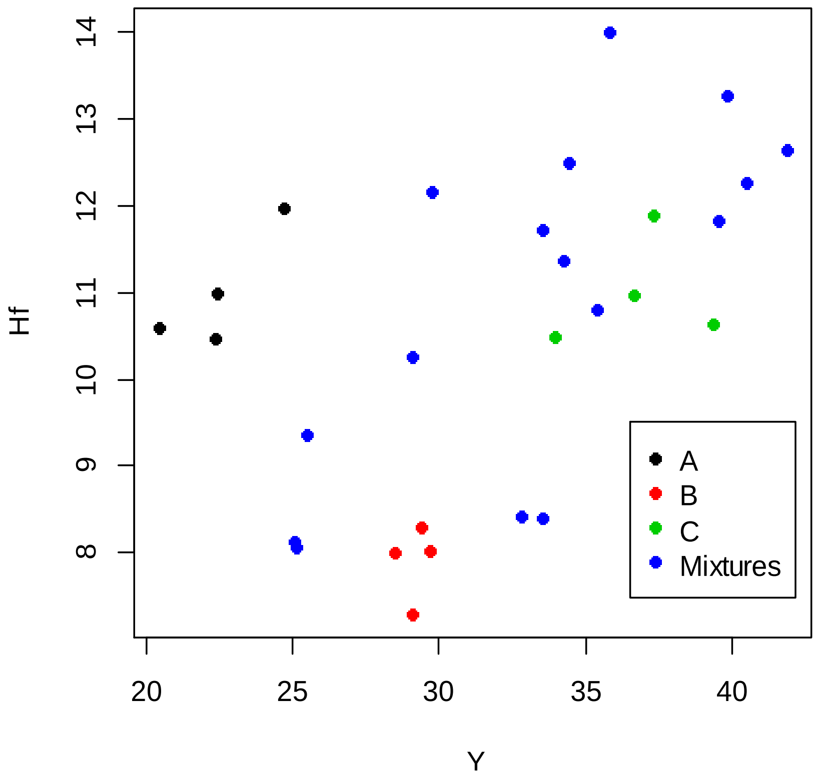


Figure 8.40: EMM chart for London Hf-Y element pairs determined by XRF (axis units ppm)

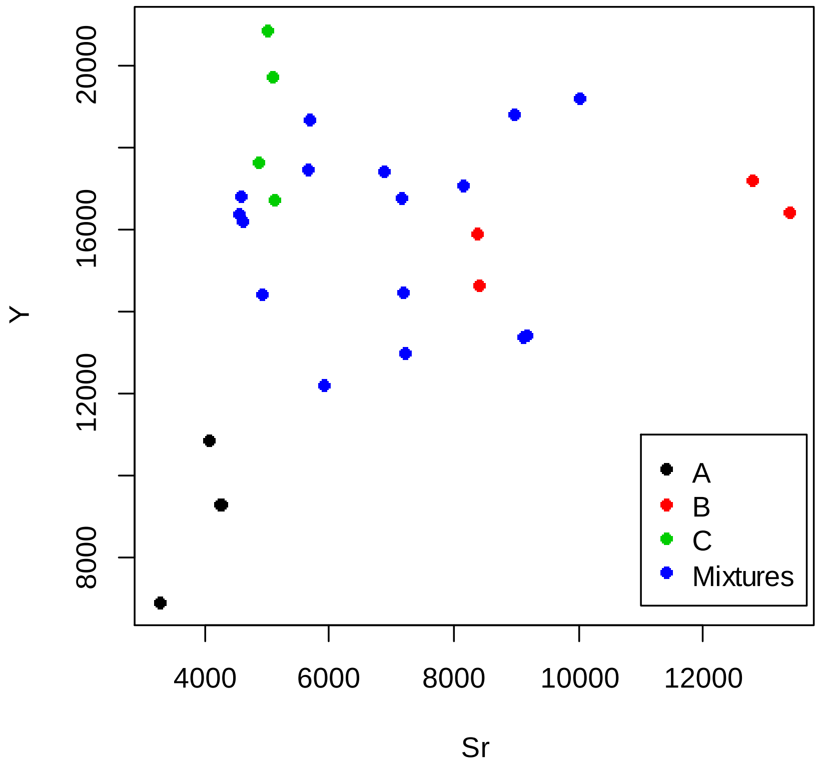


Figure 8.41: EMM chart for London Sr-Y element pairs determined by ICP-MS (axis units ppb)

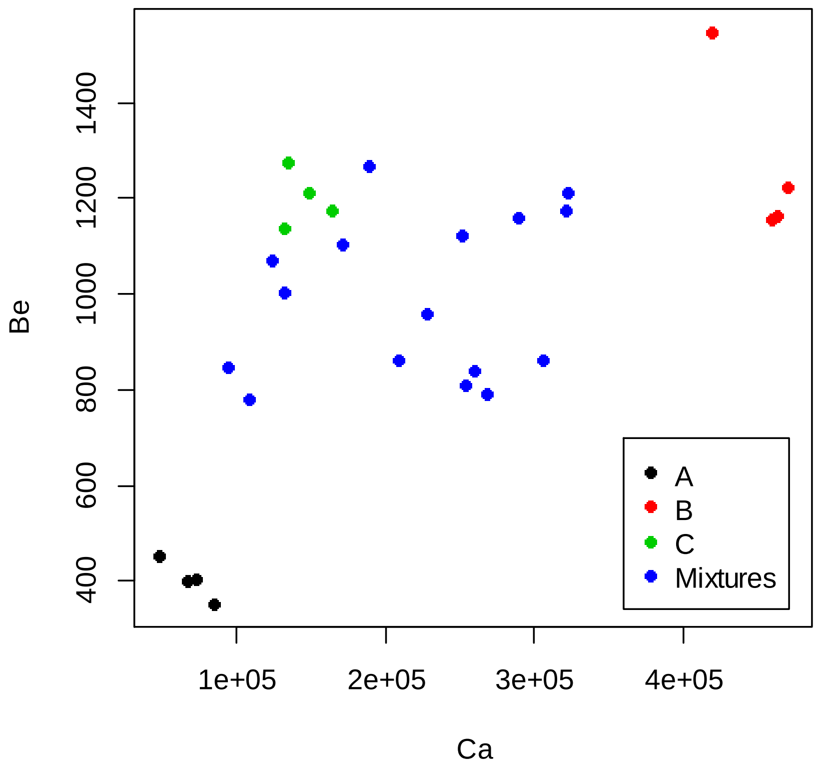


Figure 8.42: EMM chart for London Be-Ca element pairs determined by ICP-AES (axis units ppm)

8.4 Discussion

8.4.1 Critical Elements

From this study, it is apparent that reducing the number of elements assessed is not as simple as it might first appear. The ANOVA (tables 8.2 and 8.3) and CDFA outputs (tables 8.4 to 8.16 and figures 8.2-8.14) indicate that it possible to a certain extent to reduce the number of elements analysed, and still able to discriminate between sites. For ANOVA of the reduced element sets, $p = 0.000 - 0.042 < 0.05$ (Nottingham) and $p = 0.000 - 0.046 < 0.05$ (London). The following exceptions were identified for the Nottingham sample sites: Cl (July $p = 0.315$) determined by XRF; Yb and Lu (July $p = 0.65$ and 0.62 respectively) determined by ICP-MS; and Be (October $p = 0.059$), and Ti (January $p = 0.76$), determined by ICP-AES. This is an unusual finding, as when looking at the original set of elements, these elements were found to be significantly different between sites. CDFA found a significant difference between sites in the majority of cases, with the exception of ICP-MS data for Nottingham sample sites (April only $p = 0.933 > 0.05$) and ICP-AES (October only $p = 0.216 > 0.05$). These findings contradict theories articulated in the literature (e.g. Rawlins and Cave, 2004; Pye *et al.*, 2006b), that the larger the set of elements examined, the greater the power of discrimination, and are therefore, more in line with the findings of Jarvis *et al.* (2004).

However, complications arise when further reducing the number of elements assessed i.e. the elements responsible for discrimination common to both Nottingham sample sites and London sample sites. CDFA of Nottingham ICP-MS data (table 8.11) identified no significant difference between sites based on this common reduced element set, where $p = 0.107$ to $0.211 > 0.05$ (functions 1 - 2 which account for 86.4 to 94.0 % of the variance between groups). Additionally, no significant difference was found between London sites (table 8.14) in April based on the common reduced element set determined by XRF, where $p = 0.835$ (function 2 only). This suggests that although the elements assessed may be reduced, the particular elements in question appear to be site specific. Therefore, a comprehensive reference database of soil elemental compositions would be necessary to enable an analyst to make an informed selection of the appropriate elements to analyse for the sample in question. A database of such micro-scale information is not currently available (Morgan and Bull, 2007c).

Once again the vast complexities of discriminating single and mixed source samples have been demonstrated. Paired t-tests identified no significant difference between single and mixed source samples for the majority of cases when assessing the reduced element set; for Nottingham (XRF 48/48, ICP-MS 46/48 and ICP-AES 48/48) and for London (XRF 48/48, ICP-MS 20/48 and ICP-AES 48/48). This is true for both single source sites that have contributed to the mixtures and for those sites that did not contribute to the mixtures. In general, the common elements data set also found no significant difference between single and mixed source samples; for Nottingham (XRF 47/48 pairs, ICP-MS 20/48 and ICP-AES 48/48) and for London (XRF 48/48 pairs, ICP-MS 18/48 pairs and ICP-AES 48/48), although it is apparent that the further reduction of elements alters the findings of the ICP-MS data, and more of the pairs are identified as being significantly different from one another. The complexities are further demonstrated with the PCA outputs, where significant clustering of data points for all sites and mixtures can be observed (e.g. figures 8.16B, 8.28B and 8.28C). There is also evidence of some overlapping of sites (figure 8.20C), outliers (e.g. NA4 and NB5 in figure 8.14A), and again, certain mixtures associating more with one of the sites contributing to the mixture than the other e.g. Nottingham AB with site A (figure 8.16C) and London AC with site A (figure 8.37). These phenomena are difficult to decipher without *a priori* knowledge to inform decisions of site discrimination and the absence or presence of a relationship between these sites and mixed provenance evidence. It is also observed that axis one accounts for the majority of the variation for all techniques now, not just ICP-MS as witnessed in section 5.3.2. It is possible that the majority of the elements removed from the analysis in this chapter are those elements that previously contributed to axis 2, therefore altering the percentage variance explained by PC1 relative to this.

8.4.2 End-Member Modelling

Given that all the mixtures were created in the laboratory using an equal proportion of single source samples (and therefore of the same elements but in different proportions), it would be expected that with mixtures containing two sources (i.e. AB/AC/BC) an end-member value of 0.5 for each contributing source would be yielded, and for three sources (i.e. ABC) an end-member value of 0.33 for each contributing source would be obtained. From the EMM performed in this study, it was identified that, for some cases, site assignment and ratio within a mixture was correctly identified. For example, XRF assessment of Nottingham ABC mixture in July, where 0.3014 is attributed to site A, 0.3692 to site B and 0.3294 to site C (table 8.25); and ICP-AES assessment of London ABC mixture in April 0.3208 attributed to site A, 0.3409 to site B and 0.3384 to site C (table 8.26). Examples of mixtures containing two sources include London AB assessed by XRF: 0.4684 is explained by site A, 0.4747 explained by site B, and the remaining 0.0568 designated as site C. For ICP-AES assessment of Nottingham AC, 0.3542 is explained by site A and 0.3584 explained by site C. Whilst these are in an equal proportion to one another, it identifies site B as being responsible for the remaining 0.2874, which it cannot be, given that the mixture has not been created using this site. Similarly with ICP-MS assessment of London AC in January, 0.3686 is explained by site A and 0.3801 by site C, with site B explaining the remaining 0.2513. In other cases, the sites responsible for the creation of that mixture are correctly identified, but the ratios were inaccurate e.g. ICP-AES London AC January site A accounting for 0.2566 and site C 0.6538 and again the remainder is attributed to being from site B, despite it not being physically present within the mixture.

However, in the majority of cases, sites that have not contributed to the mixture are identified as a contributor, e.g. London October AB (XRF), A (0.1246), B (0.4667), and C (0.4087). In some cases, the non contributing site is identified as more dominant in the ratio than sites that have contributed. For instance, Nottingham January AB (XRF), 0.6743 of the mixture is explained by site C, whereas only 0.2010 by site A, and 0.1247 site B. For the London samples collected in April, there is evidence of site C accounting for nearly 100 % of the mixture for the XRF data, for example, site C accounts for 0.9333 of mixture AB with only 0.0381 being identified as coming from site A, and 0.0286 coming from site B.

Whilst the modelling clearly succeeds in some cases, there are undoubtedly some inconsistencies that need to be addressed. Applications of EMM within traditional geosciences have effectively discriminated different sources and identified the concentrations and deposition rates of different sediments (e.g. Mulitza *et al.*, 2010; McGee *et al.*, 2013). However, these studies have been applied to samples where there is a higher abundance of material, and on material that has been accumulated from greater distances to one another, not of close proximity like in this study. Christopersen and Hooper (1992) found that PCA facilitated the identification of end-members, and the number of end-members to use. However, it has been demonstrated that this was not effective in this instance. Further replicates may address the issues associated with correct site and ratio assignment, as it would allow for a more comprehensive overview of the sites to enable a more accurate assignment within a mixture (Delsman *et al.*, 2013). As with PCA, the assessment of additional independent parameters (or end-members), such as organic properties, particle size distribution, colour, and pH, in combination with the inorganic elemental data used may illustrate distinctive details that can aid in accurately designating the sources contributing to the mixture (Christophersen and Hooper, 1992; Weltje, 1997; Bezemer *et al.*, 2006). Additionally, different mixture ratios, number of sources within the sample, and the total amount of material, should be explored to determine the criteria necessary for EMM to be performed. EMM has more traditional geoscience applications (e.g. Weltje, 1997; Weltje and Prins, 2003), where more material is available for study and typically performed on sediment cores, where distinct layering from the accumulation of sediment from multiple sources can sometimes be observed by the naked eye. Forensic applications involve less material (0.1 g used for ICP-MS and ICP-AES in this thesis) and visual distinction between the individual sources within a mixture requires assistance from microscopy techniques though even this method provides no guarantee that the individual sources may be distinguished between. It is therefore necessary to establish if the reduced amount of material is a driving factor in the inconsistences observed for the EMM in this study, in order to establish a baseline in which to guide interpretations. This can be achieved by assessing different samples weights, in combination with the number of proxies used for characterising sites, and number of replicates, to identify which of these impact on EMM and to the extent. Once this is established, investigation into the impact of differing mixture ratios on EMM effectiveness can be conducted This is an important factor to consider, as mixtures are not likely to be composed of equal proportions of different source soil/sediment, and it is therefore necessary to ascertain an appropriate means to consistently and effectively interpret these mixtures.

8.5 Conclusion

In this study, the reduction of elements and EMM were explored in order to address the unmixing issue. A reduction of elements analysed was undertaken to establish whether a common set of elements could be identified that enabled the discrimination of sites and mixed source samples whilst reducing time and cost of analysis. Overall, it was found that element reduction proved more successful for London samples than Nottingham samples. However, further reduction of the element sets to obtain a common element set exacerbated problems of single and mixed provenance sample interpretation. This indicates that, although the number of elements may be reduced, the combination of elements appears to be site specific and therefore knowledge of the site location would be necessary to select the appropriate elements to analyse.

EMM was used to identify the sites within the mixture and the proportions of these sites within the mixture. It shows some sign of promise for interpreting the mixtures. However, from the inaccuracies observed in single source site assignment to mixtures (tables 8.25 and

8.26), there is clearly room for improvement. EMM seeks to assign a percentage to each site identified, but does not offer an ‘unknown’ category. This gives rise for a percentage of the contribution potentially being attributed to the remaining site because it is the only other option available. It is therefore necessary to incorporate an ‘unknown’ category so that incorrect sites are not used to explain part of the variance. The findings of this study are indicative of the promise offered by EMM. However, it has only been tested in two locations it therefore requires further exploration in other locations to ascertain if the approach has the ability to assist in mixed source sample discrimination. Additional studies should be conducted regarding the variables previously mentioned (additional replicates, amount of sample material, mixture ratios), to ascertain if any of these factors may address any of the inaccuracies with the EMM experienced in this study. If these issues are resolved, the use of EMM to interpret mixed source samples has potential, particularly if it is possible to introduce an unknown category or clear potential source locations can be identified. This is crucial to the exclusionary approach that should be applied when dealing with any form of trace evidence and ultimately to the establishment of a robust and reliable method in which to interpret geochemical data of mixed provenance soil/sediment evidence.

Chapter 9 Thesis Discussion and Conclusion

9.1 Main Thesis Findings

This thesis set out to identify the feasibility of geochemical analysis to discriminate forensically relevant soil/sediment material and investigate the issues regarding the interpretation of mixed provenance soil/sediment evidence. Throughout the entirety of this thesis the complexities associated with interpreting geochemical data for mixed provenance samples have been demonstrated and examined. The approach of this research has been to address these complexities at each stage of the forensic process, including the role of sample collection and storage, sample analysis and data interpretation, thereby addressing the issue of interpreting geochemical data in a holistic manner as outlined in the conceptual framework (figure 9.1) presented by Morgan and Bull (2007a). From here forward the findings of this thesis will be reflected on in order of appearance in this framework.

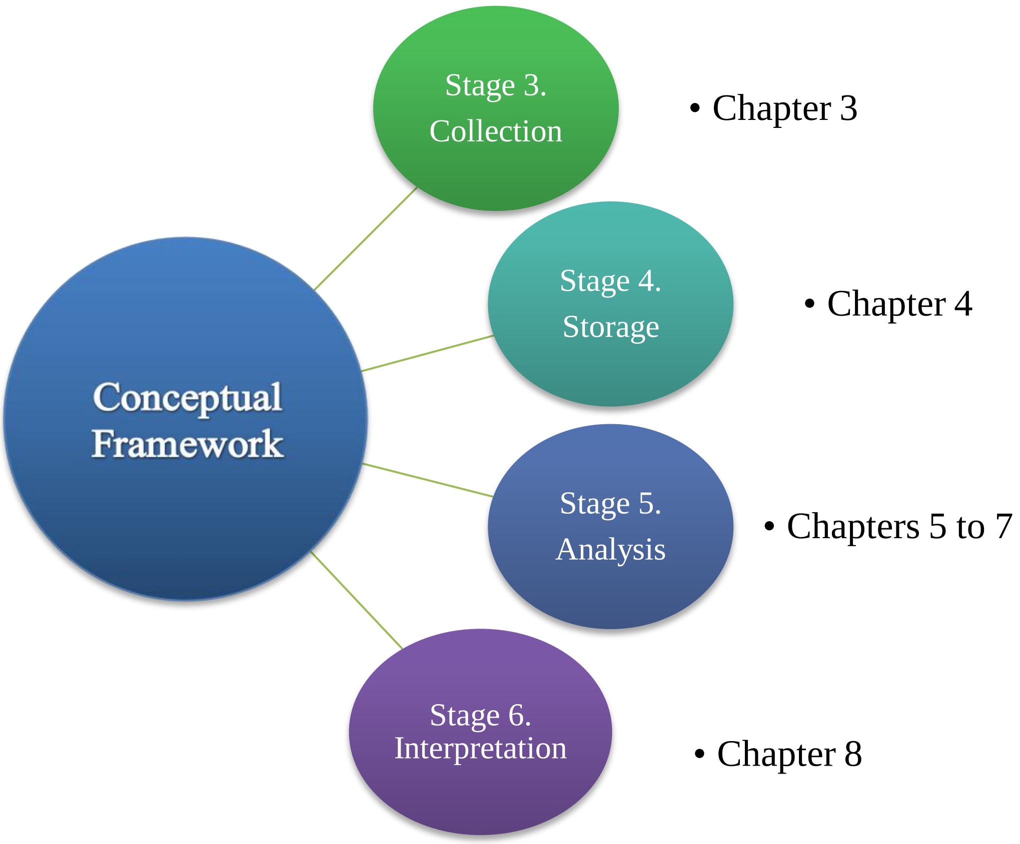


Figure 9.1: Stages of the conceptual framework (figure 2.4; after Morgan and Bull, 2007a) targeted in this thesis

The variations in sample collection methods has not been addressed in this study. The collection procedure undertaken throughout this thesis was to sample from the top 2 cm soils in accordance with Pye *et al.* (2006a) as those samples were assessed with geochemical analytical techniques. Whilst it has more recently been proposed that a sampling depth of 5 cm is necessary (Woods *et al.*, 2016) as opposed to the top 2 cm this is considered to be unusual as it introduces the potential for deeper soil horizons to be incorporated into the sample which are unlikely to be transferred to items of forensic relevance in day to day activity (Dawson and Hiller, 2010). From the work conducted in chapter 4, a range of different plastic bags and storage conditions were tested to identify the optimal storage approach for samples retained in plastic sample bags that maintains sample integrity and allows reproducible data to be obtained. No significant difference was identified between samples stored in different manufactured polypropylene sample bags used ($p = 0.059 - 0.913 > 0.050$ elemental composition; $p = 0.083 - 0.800 > 0.050$ stable isotope ratio) or between samples stored dry at room temperature and samples stored wet at 0 - 4 ^{o}C ($p = 0.051$ to $0.949 > 0.050$ elemental composition; $p = 0.053 - 0.722 > 0.050$ stable isotope ratio) at the 95 % significance level. Additionally, duration of storage was revealed to have no impact upon the findings, at least for the annual period assessed in this thesis, with p values in the range of 0.050 and 0.998 (elemental composition) and 0.082 to 0.605 (stable isotope ratio) for samples stored wet at 0 - 4 ^{o}C and 0.051 to 0.996 (elemental composition) for samples stored dry at room temperature. Combining these findings with assertions in the literature regarding how samples should be stored at room temperature (Fitzpatrick, 2009) and frozen and freeze dried immediately for the preservation of geological evidence for biological and organic assessments (e.g. Mildenall *et al.*, 2006; Dawson and Hillier, 2010) it would be recommended to store samples dry at room temperature in plastic sample bags.

Method development studies (chapter 3 - sections 6.1 and 9.1) allowed for the appropriate sample preparations to be conducted i.e. sample weight, digestion conditions (including reagent volumes, temperature cycle, duration, closed/open vessel), sample dilutions, standard concentration ranges and so forth to ensure optimum state analytical results to be achieved. It is evident that the techniques assessed in chapters 5 to 7 have the capability to distinguish between single source samples from close proximity sites. For elemental assessment a greater number of elements were revealed to be significant between sites tested (table 5.6) in both the Nottingham and London sample locations. CDFA revealed that sites were able to be discriminated ($p = 0.000 < 0.050$) with the exception of the April London collection (p =

0.074 > 0.050). These findings are in agreement with the preliminary study conducted (Cheshire *et al.*, 2016) and demonstrates that geochemical assessment offers effective discrimination of close proximity sites in multiple locations not just in the initial area tested and not just on sites of great distances to one another as demonstrated in other studies (e.g. Croft and Pye, 2004; Pye *et al.*, 2006b; Pye *et al.*, 2007; Pye and Blott, 2009). Stable isotope ratios also displayed successful site discrimination in the Nottingham and London sample locations with ANOVA p values of 0.000 < 0.050 for C and N and for Nottingham p = 0.008 > 0.050 ($\delta^{13}C$) and p = 0.000 > 0.050 ($\delta^{15}N$). Within site variation was greater than that observed in the elemental assessments and could complicate interpretation in casework when a *priori* knowledge of the sites involved is absent. This highlights that discrimination is dependent not only on the technique employed but also the soil/sediment type, the underlying bedrock and the past/current land-use (Pye *et al.*, 2006a).

Sampling was conducted over the period of a year to account for temporal variances in these sites. It was identified for the most part that the temporal variances were non-significant with p values in the range of 0.052 - 0.998 > 0.05 for Nottingham sample location and 0.050 - 0.922 > 0.05 for London sample location at the 95 % significance level. This is to be expected giving the inert nature of the inorganic fraction and the data support that it is not subject to influence by temporal factors make it an effective form of evidence (Pye, 2007; Pirrie *et al.*, 2009).

The techniques implemented are also capable of assessing mixed provenance samples but issues arise when a *priori* knowledge is absent to assist in deciphering the patterns observed. Thus, complicating the correct assignment of provenance(s) and consequently decisions regarding inclusion or exclusion of evidence. Paired t-tests were used to initially assess the relationship between single and mixed source samples. It was identified for elemental analysis that p = 0.052 - 0.969 > 0.050 for Nottingham and 0.051 to 0.986 for London. For stable isotope analysis p = 0.056 - 0.993 > 0.050 for the Nottingham sample location and p = 0.066 - 0.984 > 0.050 for the London sample location. For mineral assessment p = 0.602 - 0.999 for Nottingham and p = 0.881 - 0.983 > 0.05 London. Meaning that the elemental, isotopic and mineralogical composition of the mixed source soil/sediment samples were not distinctively different to single source soil/sediment samples so that they may be discriminated. PCA supports these findings and illustrated the individual site groupings and relation to mixed source samples (figures 5.7 - 5.10, 5.13 - 5.16 and 5.19 - 5.22 for elemental assessment; 6.5 and 6.6 for stable isotope assessment; figures 7.5 and 7.6 for mineral assessment. This is a significant finding as it is contrary to theories articulated the literature that a difference would be identified between single and mixed source samples due to the accumulation of material from multiple sources within the mixture being irrespective of whether the comparator source is present in the mixture. Therefore the discrimination identified is due to a difference in composition rather than being of difference provenance. Further emphasising the complex nature of mixed source sample interpretation that provide justification for concerns raised over in the literature (Morgan and Bull, 2007a).

Chemical analysis should always be used in conjunction with other independent forms of analysis (Morgan *et al.*, 2006; Morgan and Bull, 2007c) such as biological (palynology, diatom, mycology etc) and physical (grain size, colour etc). These approaches examine individual particles within a sample and therefore are not affected by the mixing of sources within a sample in the same way as elemental techniques, which analyse a homogenised sample. Homogenisation involves the further mixing of the sample and therefore the sources within the sample are evenly distributed and even harder to distinguish. Adopting the appropriate technique will depend on the demands of the particular case and the material available for assessment. XRF, IRMS and QEMSCAN require less sample preparation than inductively couple plasma spectroscopic methods, as demonstrated in this thesis (chapter 3 - sections 8.1, 9 and 10 versus sections 8.2 and 8.3), and therefore variances observed are most likely a direct result of the sample itself as opposed to alteration from sample preparation methods. Fewer preparatory stages also reduce the opportunity for contaminants to be introduced or material lost maintaining evidence integrity. However, ICP-MS and ICP-AES require much less sample material (0.1 g used in this study) and still able to provide quantitative data so may be a more suitable option in cases where there is an insufficient amount of material for other analytical techniques. The analysis time is fast (~100 samples a day by ICP-AES/~70 samples a day by ICP-MS) however the preparation for this method is more time consuming in comparison to XRF, IRMS and QEMSCAN and requires more involved treatments (see chapter 3 - sections 5 and 6) and consequently causes greater alteration of the sample.

Finally the means in which we statistically assess the data and the understand these statistics to inform judgements on the evidence comes under scrutiny (chapter 8). Statistical literature is directed towards experts in the field and the language used is not easily translatable making it difficult for non-statistical experts to implement (Curran, 2013). Incorrect statistics may result in erroneous conclusions being drawn and consequently the discrediting of evidence

(Isphording, 2004). This can impact the manner in which other evidence is perceived regardless of whether it is independent of the discredited evidence (Lagnado and Harvey, 2008). Various multivariate statistical methods have been employed in this study including CDFA and PCA to identify differences that can distinguish between sites and single-mixed source discrimination as these techniques are commonly employed on other forms of evidence (Reidy *et al.*, 2013). Interpretations based on these statistical assessments were complex without a *priori* knowledge to assist. Therefore, the number of elements used in the statistical assessment were reduced in order to ascertain whether this would clarify and relationships present (chapter 8 - table 8.1). It has been suggested that a larger number of elements offers greater discriminatory power of samples (Rawlins and Cave, 2004; Pye *et al.*, 2006b) however, a question has been raised regarding the basis for this assertion (Bull *et al.*, 2008). Statistical assessment of reduced element sets in this study revealed single source sample discrimination was achieved and no significant difference was established between single and mixed source samples for the majority of cases ($p = 0.000 - 0.046$ and $p = 0.064 - 0.982$ respectively) which is consistent with assessments of the original data set. This indicates that discriminatory power can still be achieved from using a reduced number of elements which is in agreement with findings of Jarvis *et al.* (2004). However, the study also indicated that the element combinations proved to be discriminatory were location specific and therefore not generalisable across other locations. As a result knowledge of the area where the sample originates would be necessary to select the appropriate elements. A database of such micro-scale details would be beneficial for this and would enable a probabilistic value of the occurrence of these geochemical profiles to be assigned (Morgan and Bull, 2007a). Unfortunately, such a database of micro-scale details is currently unavailable (Morgan and Bull, 2007c) and this would require an exhaustive amount of analysis to ensure all profiles are accounted for and the data obtained reliable which would be a difficult and time consuming task to undertake (MacDonald *et al.*, 2011).

Additional statistical means were sought to address the complications associated with mixed source sample interpretation (chapter 8- section 3.2). This involved exploring the application of end-member modelling to assessing the data as its successful applications in traditional geoscience are well documented (e.g. Tjallingi *et al.* 2008; Mulitza *et al.*, 2010; Négrel *et al.*, 2015) and has also been put to use in forensic science (Linford and Platzman, 2004). The findings for employing this method were variable. In some cases it accurately identified the sites involved in the mixture in the correct proportions e.g. elemental data by XRF for

London sites A and B explain 0.4684 and 0.4747, respectively, of mixture AB with the remaining 0.0568 being attributed to site C. In others the correct sites but incorrect proportions e.g. ICP-AES data for London mixture AC with 0.2566 stemming from site A versus 0.6538 from site C. However, in a vast number of cases it identifies a source that that the mixture is not composed of and occasionally this source attributes for more of the mixture than the sites actually responsible e.g. based on EMM of the XRF data it was determined London site C explains nearly 100 % (0.9333) of mixture AB in the April collection. It is unclear as to whether this is a result of the statistical technique itself, or as the samples involved in the study originate from close proximity sites. These inconsistencies need to addressed in order to determine if EMM can be effectively implemented for routine use in the forensic interpretation of mixed provenance evidence. These may be addressed through the inclusion of additional replicates or parameters (e.g. organics, pH, soil colour, pollen grains etc) to obtain a more representative characterisation of the sites and therefore enable more accurate assignment within a mixture (Christophersen and Hooper, 1992; Weltje, 1997; Bezemer *et al.*, 2006; Delsman *et al.*, 2013). Exploration into different mixture ratios, sample amounts and number of sources contributing to a mixture should be conducted to ascertain the limitations of the technique and identify when most appropriate to apply in forensic case.

In summary, in this thesis it has been established that:

1. Samples being subject to chemical assessment should be freeze-dried and stored at room temperature in plastic sample bags. (Chapter 4)
2. Sample storage duration had no bearing on the data derived from geochemical analysis. (Chapter 4)
3. Temporal variation in the elemental composition at the two study sites was statistically non-significant. (Chapter 5)
4. Single source samples from close proximity sites were able to be distinguished based upon the elemental and stable isotope composition. (Chapter 5 and 6)
5. The potential for single source and mixed source sample discrimination based on the mineral composition and mineral associations has been illustrated. (Chapter 7)
6. Distinction between mixed source and single source samples (both present and not present in the mixtures) were complex particularly where *a priori* knowledge of the sites involved and the proportions of these sources within the mixture is absent to assist in the interpretation. (Chapters 5 to 7)

7. It is possible to reduce the number of elements assessed and still achieve effective discrimination, though the elements are site specific and knowledge of the location is necessary to allow appropriate selection of elements for analysis. (Chapter 8)
8. EMM showed promise due to successful identification of sources and the proportions present within a mixture for some cases and therefore it should be explored further to address the inconsistences to allow its implementation in forensic casework (Chapter 8)

9.2 Implications for Forensic Science

The findings of this research have a number of implications for the implementation of geochemical assessment in forensic investigation. Firstly this study has established that geochemical analysis has the ability to discriminate single source close proximity sites in additional locations supporting findings of the pilot study (Cheshire *et al.*, 2016). This is beneficial to forensic investigation as crime events often occur over short distances and it would therefore be necessary to be able to discriminate between close proximity sites for it to be possible to exclude alibi sites accurately. The speed of chemical analysis allows for these assessments to be conducted in a time efficient manner which can be crucial in a forensic investigation where often required to operate within a restricted time frame. Additionally chemical assessments require a minimal amount of material to provide effective qualitative and quantitative data. This is of benefit in forensic investigation as often only trace amounts of material are available for analysis, sometimes as little as 100 mg (Pirrie *et al.*, 2009).

The temporal variation observed in the geochemical signatures was minimal and statistical tests revealed it to be non-significant which is beneficial as there are often time lapses between the occurrence of crime event(s) and the collection of evidence. Additionally, samples may not be analysed straight away or need to be revisited, e.g. cold cases or appealed cases, and therefore be in storage for long periods of time. Storage duration was deemed to have no statistical significant impact upon the composition of the soil/sediment from the work conducted in chapter 4 and should not impede interpretations made on data from later analyses.

For the majority of cases, single and mixed source samples could not be discriminated based on the paired t-test statistics. PCA indicated in some cases that the techniques assessed in this study could distinguish mixed provenance material though this was not consistent. It was more commonly observed that samples could not be excluded from contributing to a mixture, for example, elemental data determined by ICP-AES for Nottingham mixture AC could not be discriminated from site C for the October collection (chapter 5 - figure 5.19). Where it was possible to distinguish between mixed provenance material was largely due to the *priori* knowledge of the sites and proportions involved providing clarification for the outputs generated from the statistical analyses of the data. Therefore, it may not necessarily be the techniques themselves that are responsible for the difficulty in discriminating mixtures but the understanding of the statistical means employed to assess the data particularly where a *priori* knowledge of the sites and proportions involved are absent. However, until this issue with the interpretation is addressed these geochemical techniques cannot be used to reliably assist in mixed provenance evidence analysis. A *priori* knowledge of all sites involved to aid interpretation is often unavailable in a forensic investigation meaning that false positive or false negative conclusions could be reached. Should such conclusions be drawn it can result in false positive or negative exclusion of a suspect, artefact and/or location, time is wasted pursuing incorrect investigative avenues and/or erroneous court verdicts delivered which can have serious ramifications on the criminal justice system. It would therefore, as it currently stands, be unwise to rely on geochemical analysis alone when dealing with mixed provenance evidence. The implementation of geochemical analysis should be approached with caution and, where sample size allows, used in conjunction with other independent analyses such as biological or physical assessments. The combination of multiple independent techniques can provide an accurate and reliable characterisation of the samples which would enable robust interpretations to be made (e.g. Morrisson *et al.*, 2008).

9.3 Proposed Procedure

While this thesis has not provided a solution to the issues surrounding interpretation of mixed provenance geochemical evidence, it has produced empirical evidence in a systematic way that substantiates these issues for the first time. Previously the issues of mixed provenance sample interpretation have been hypothesised but never systematically demonstrated empirically. This thesis has also provided an evidence base to inform decisions regarding the appropriate manner in which to collect, package, store and analyse the evidence. As a result a procedure outline has been proposed (figure 9.2). This procedure includes details on sample preparations for all analyses, however, not all of these should be performed together as they are not truly independent of one another. Decisions regarding which technique to utilise will depend upon the amount of material available and the nature of the question being asked. Where sample size is small ICP-MS and ICP-AES would prove more beneficial as analyses by these techniques require less sample (0.1 g compared to 4 g by XRF). As a conclusive means of interpreting mixed provenance material has not yet been established it may be beneficial to seek expertise from multiple domains to assist in the interpretation. For example, forensic trace evidence experts, specialised soil/sediment scientists e.g. Woods *et al.*, 2016) and statistical analysis experts. Combining expertise from these domains would facilitate a robust, holistic approach to interpreting evidence to be adopted. This would enable gaps in knowledge of each expert to be addressed and minimise the risk for erroneous conclusions to be drawn. For example, specialised soil/sediment scientists are knowledgeable in soil/sediment properties but not necessarily in forensic applications and forensic trace experts are knowledgeable in the behaviour of trace evidence but not necessarily geological sample properties. Therefore, by combining these expertise the properties of soil/sediment material and how this material behaves in a forensic scenario can be better understood. Then by including statistical analysis experts, it can be ensured that the appropriate method is employed to interpret the data so that the correct conclusions are derived.

Sample Collection

- Surface soil samples taken from the top 2 cm (section 3.1)
- Sterilise collection equipment (trowel or spatula) in-between collecting material to avoid cross-contamination of samples (section 3.1).
- Bags should be sealed immediately and stored separately to other samples to avoid cross-contamination between samples (section 3.1).

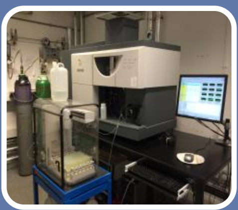
Sample Packaging and Storage

- Samples may be retained in plastic evidence bags such as the tamper proof evidence bags utilised by forensic scene examiners (chapter 4).
- Samples should be frozen, freeze-dried and stored at room temperature at the earliest convenience (chapter 4).

Sample Preparation

- Hand pick plant material (leaves, twigs etc) and bulky man-made materials (e.g. litter) out of the sample instead of sieving to avoid loss of material and/or introduction of contaminants (section 3.5.3).
- Mount sample into a resin and carbon coat for assessment via QemSCAN (section 3.10).
- Homogenise material using agate pestle and mortar (XRF and IRMS, section 3.5.3, 3.8.1 and 3.9)
- Digestion for ICP-MS/ICP-AES (section 3.6) - HF/HNO_3 suitable and avoids issues encountered with HCl_4 when samples are rich in organics.

Sample Analysis



- Reference material should constitute 10 % of the entire run to monitor accuracy (section 3.8)
- Blanks should constitute 10 % of the entire run to monitor contamination (section 3.8).
- XRF (section 3.8.1) - three replicates to account for drift on lighter elements.
- ICP-MS/ICP-AES (section 3.8.2)- five replicates and re-calibration at regular invervals to account for drift; rinse and sample delay to remove residue of previous samples in column.

Interpretation

- Still problematic for close proximity mixed source samples (chapters 5, 6, 7 and 8).
- CDFA for assessment of single source site discrimination (chapters 5, 6 and 8).
- PCA for assessment of single-mixed source site discrimination (chapters 5, 6, 7 and 8).
- Can only conclude that soil/sediment mixtures can or cannot be excluded as coming from a particular source (chapters 5, 6, 7 and 8).

Figure 9.2: Proposed procedure for the management of geological evidence subject to chemical analysis

9.4 Future Work

This thesis empirically demonstrates the issues associated with forensic interpretation of mixed provenance geochemical evidence and provides procedural guidance for the management of geological evidence from an evidence base. The fundamental issues of using geochemical analysis to discriminate single and mixed source sample identified in this thesis require further exploration to establish if it will be possible to implement geochemical analysis for mixed provenance evidence in future.

For instance, in this thesis only two locations (Nottingham and London) have been tested. Whilst the findings are valid for these locations and have provided significant insight they are by no means conclusive. Future research should be directed towards testing geochemical analysis in additional locations before broad conclusions can be drawn that are generalisable across the board.

Additionally the number of sources and the proportions of the sources within a mixture should be investigated to establish what impact these factors have upon interpretation. This thesis has established what patterns and issues are encountered when interpreting geochemical data of mixed provenance samples that are composed of equal proportions of single source material. However, in a real forensic investigation material is unlikely to exist in such idealistic proportions. It is therefore necessary to ascertain how variances in mixture ratios impact upon the geochemical profiles obtained and consequently the interpretations made.

There are a number of statistical methods that may be employed to interpret geological evidence. Effort has been made in this thesis to establish the applicability of end member modelling to forensically relevant geological material. This is an interesting area and represents new territory as it has not been previously investigated. Whilst no definitive conclusions were drawn regarding its implementation, EMM demonstrated signs of promise and should be investigated further. The findings from further investigation of EMM should be compared to those from other multivariate statistical methods that are adopted within forensic science. Bayes modelling for forensic evidence interpretation has been documented in the literature (e.g. Taroni *et al.*, 2010) and could be an additional avenue to explore for geological evidence interpretation. Literature detailing its application to soil for forensic purposes has been limited (e.g. Small *et al.*, 2004) and with regards to other forensic evidence has been done so without an empirical basis. Consequently, its implementation has been hypothetical in nature with probabilities concerning factors such as presence and transfer being estimated. The use of such probabilities and the uncertainties associated within forensic investigation has come under question (Risinger, 2013). Therefore, exploration of this method could be of value not only for forensic geoscience but for other forensic disciplines regarding if and when this method would be suitable for evidence interpretation.

Once a robust evidence base has been derived from exploring the factors outlined above the next stage would then be to reconstruct crime events and conduct strategic sample collection from this reconstruction. This is an important stage for linking any research findings to its practical implementation and has been demonstrated for the transfer and persistence of geological evidence (e.g. Bull *et al.*, 2006b) i.e. stages one and two of the conceptual framework (Morgan and Bull, 2007a). With regards to the development of the research conducted in this thesis it allows for the conditions that could influence mixed provenance sample interpretation to be factored in. This includes the impact of evidence dynamics such as different activity levels during the division or transfer of material (running/walking), the medium from which material is collected on the type/amount of evidence that can be obtained and the subsequent analyses and interpretations made. By exploring these factors the effectiveness of geochemical assessment of mixed provenance samples under crime event conditions could be established and thus a means for its successful implementation in real casework.

It is anticipated that conducting studies in these areas will produce findings that will identify if and where chemical assessment can be reliably used on single and mixed source geological material. This would then facilitate the establishment of a reliable procedure for the chemical analysis and interpretation of geological evidence.

9.5 Synopsis

This thesis sought to answer the following research question:

'To what extent can inorganic geochemical analysis techniques be reliably implemented for the accurate assessment and interpretation of single and mixed provenance soil/sediment samples in forensic investigation'

This was addressed by conducting experimental studies to establish:

1. **Potential factors that can impact sample integrity and consequently the findings of geochemical analysis of soil/sediment samples (chapter 4)**

The findings from the analyses and subsequent interpretations in this thesis indicate that geochemical evidence is not impeded by the time lapse between sample collection and crime event occurring or the duration of storage based on the packaging material and storage conditions tested (addressing objective 1) which can prove fruitful when revisiting older cases.

2. **The geochemical properties of known single source soil/sediment samples through XRF, ICP-MS, ICP-AES, IRMS, QEMSCAN and LOI (Chapters 5, 6 and 7).**

   Geochemical analysis was performed on the samples collected from the two study sites. It was established that these geochemical assessment techniques can distinguish between single source close proximity sites and could therefore contribute useful intelligence to an investigation involving crimes that have unfolded over short distances.

3. **The geochemical properties of known mixed source soil/sediment samples through XRF, ICP-MS, ICP-AES, IRMS, QEMSCAN and LOI (Chapters 5, 6 and 7).**

   Geochemical analysis was performed on the artificial mixtures created in the laboratory using equal proportions of soil/sediment material collected from the two study sites. This data was determined to allow comparisons to be made to single source sample data to investigate interpretation issues associated with mixed provenance geochemical data. This included comparisons between samples that did not contribute to the mixture (e.g. A-BC) in addition to those that were present (e.g. A-AB). Rather interestingly, samples were not discriminated consistently even where single-mixed source sample comparisons were made without common components present.

4. **The feasibility of geochemical analysis techniques to discriminate between known single and mixed source soil/sediment samples (Chapters 5, 6 and 7).**

   The chemical properties for single source (objective 2) and mixed source (objective 3) enabled statistical comparisons to be made to establish if it is possible to discriminate single and mixed source soil/sediment samples from a known location. Comparisons between single and mixed source samples were far more complex and differences between mixed source samples and single source samples could not be identified regardless of whether the source was involved in the mixture or not. This highlights potential for false positive conclusions to be drawn when mixed provenance geochemical evidence is used in a forensic investigation when a *priori* knowledge of the sites involved are unknown.

5. **A time and cost effective protocol that provides reliable geochemical data for the discrimination of forensically relevant soil/sediment samples (Chapter 8).**

   The data sets generated in chapter 5 were refined for further assessment by multivariate statistical analysis in an effort to establish a time and cost effective protocol by reducing the number of elements assessed. It was established that the amount of elements assessed could be reduced and still provide discriminatory value. However, the combination of elements were location specific which may prove difficult to implement in forensic investigation in the absence of comprehensive data bases to support the selection of appropriate elements prior to analysis

6. **The degree to which a reliable statistical method can be identified to address the interpretation issues of mixed provenance soil/sediment evidence (Chapter 8).**

   The refined data sets were also subjected to end-member modelling in an effort to address the issues associated with mixed source sample interpretation. End-member modelling had mixed results; In some cases sites contributing to the mixture and the proportions present were correctly identified, in others the correct sites but incorrect proportions and in the remaining cases identified a site that was not physically present in the mixture as being a key contributor. Therefore, requires further investigation to establish if it can be effectively applied to forensic geochemical data.

Though a definitive means for interpreting mixed provenance evidence has not yet been possible, these studies have produced for the first time a systematic empirical dataset that addresses the issue of mixed and single source sample comparison. Whilst these studies have highlighted significant issues, the data offer a basis upon which to build future research. This will prove crucial to the establishment of a reliable and robust interpretation method for mixed provenance forensic evidence to be employed in forensic casework.

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Chapter 3 Appendix

Appendix 3.1: Laboratory Risk Assessment - Sample Digests

Procedure	Digestion of soils/sediment for ICP analysis

Level of Risk	Medium

Hazard	Risk	Recommended Control
Use of concentrated Nitric Acid	Personal injury - chemical burns, eye injury	• Lab coat, safety glasses and gloves must be worn at all times • Conc. Nitric must be used in the fume cupboard with the window pulled down to the safe working height as indicated • Ensure that all disposable pipettes that have come into contact with the acid are rinsed immediately after use and before disposal.
Use of Hydrofluoric acid	Personal injury - chemical burns, eye injury	• Lab coat, safety glasses/face shield, apron and thick gloves must be worn at all times - the thin disposable gloves are NOT adequate when using HF. • HF must be used in the fume cupboard with the window pulled down to the safe working height as indicated. • Measure out HF using the dispenser provided and always on the tray provided. The tray should be washed and dried before returning to the cupboard. • Wipe down all surfaces in the fume cupboard after use to ensure there are no stray drips of acid. • Wash down apron and gloves before removing and before handling anything else. • Should HF come into contact with skin follow emergency first aid procedure outlined in the guidance leaflet (available from the Lab Supervisor).
Disposal of acid residues	Reaction with other waste materials	• Acid must be neutralised before disposal using Sodium Carbonate. • Test with litmus/universal indicator paper to ensure neutrality.

Appendix 3.2: Assessment of C.O.S.H.H.

Procedure	Digestion of soils etc for ICP analysis

Substance/Procedure	Risk of exposure * L/M/H	HSE Exposure Limits (mg/m^3)	Local controls used	Disposal	Emergency procedures
Nitric Acid	L	5	F/C, PPE, DG,	B, G	1, 5, 6
Hydrofluoric acid	L	2.5 HF	F/C, PPE RG	B, G	1, 5, 6 #See notes on use of HF

#Available from the Lab Supervisor
***** Risk of exposure providing local controls are used
For Key to symbols - see separate table

Declaration

I the undersigned have assessed the activity and the associated risks and declare that the risks will be controlled by the methods listed above. The work will be reassessed whenever there is significant change.

Name **Janet Hope**

Signature

Date **01/05/14**
Review date **01/05/16**

Name	**Signature**	**Date**	**Supervisors initials**
Kelly Cheshire		01/05/14	

KEYS to symbols used on C.O.S.H.H tables

Control Measures

F/C	**Fume cupboard must be used**
PPE	**Personal protective equipment - Safety glasses, lab coat**
DG	**Disposable or rubber gloves**
LG	**Leather gloves**
AP	**Apron must be worn**

Disposal Methods

A	For small quantities - Dilute with copious amounts of water and run to waste in fume cupboard sink with tap running. Leave tap running to flush through.
B	For large quantities - decant into a suitable well-labelled container and dispose of via the college hazardous waste facilities. Do not mix with other waste
C	Decant into bottle labelled **UNCHLORINATED ORGANIC WASTE** and dispose of via the college hazardous waste facilities
D	Decant into bottle labelled **CHLORINATED ORGANIC WASTE** and dispose of via the college hazardous waste facilities
E	Decant into bottle or drum labelled **AQUEOUS ORGANIC WASTE** and dispose of via the college hazardous waste facilities
F	Decant into a suitable well-labelled container and dispose of via the college hazardous waste facilities. Do not mix with other waste
G	Neutralise (test with indicator paper) and flush down the sink with copious amounts of water.

Emergency Procedures

1	**Large spillages** - do not attempt to clear up. Leave the area and inform the Lab Supervisor immediately.
2	**Large Spillages** For large spillages, liquids should be contained with sand or earth and both liquids and solids transferred to salvage containers. Any residue should be treated as for small spillages.
3	**Small Spillages** (volatile substances) ?? Shut off all sources of ignition Wear appropriate protective clothing. Inform others to keep at a safe distance ?? Mop up with plenty of water and run to waste, diluting greatly with running water. Ventilate area to dispel residual vapour.
4	**Small Spillages** ?? Wear appropriate protective clothing. Inform others to keep at a safe distance ?? Mop up with plenty of water and run to waste, diluting greatly with running water. .
5	**Small Spillages** ?? Wear appropriate protective clothing. Inform others to keep at a safe distance ?? Neutralise with Sodium carbonate or bicarbonate. ?? Mop up with plenty of water and run to waste, diluting greatly with running water. .
6	**First Aid** ?? **Eyes --** Irrigate thoroughly with water for at least 10 minutes. SEEK MEDICAL ATTENTION. ?? **Lungs --** Remove from exposure, rest and keep warm. In severe cases, or if exposure has been great, SEEK MEDICAL ATTENTION. ?? **Skin --** Drench the skin thoroughly with water. Remove contaminated clothing and wash before re-use. Unless contact has been slight, SEEK MEDICAL ATTENTION. ?? **Mouth --** Wash out mouth thoroughly with water and give plenty of water to drink. SEEK MEDICAL ATTENTION. ?? **Cuts must receive immediate attention**

7	**Small Spillages** (volatile substances) ?? Shut off all sources of ignition Wear appropriate protective clothing. Inform others to keep at a safe distance ?? Absorb onto Spill granules. ?? Sweep into suitable labelled container ?? Dispose of via College facilities
8	**Small Spillages** ?? Absorb onto Spill granules. ?? Sweep into suitable labelled container ?? Dispose of via College facilities
9	**First Aid – If Phenol comes into contact with skin, swab with glycerol for at least 10 mins. Wash with water for 10mins then seek medical attention.**

Appendix 3.3: Laboratory Risk Assessment - Freeze Drier

Laboratory Risk Assessment

Procedure	Use of the freeze drier
Level of Risk	Medium

Hazard	Risk	Recommended Control
Slips, trips and falls	Personal injury	?? Do not climb onto stools to load the freeze drier - use the step-stool.
Chamber under vacuum	Implosion, personal injury	?? Handle the Perspex flask carefully and check regularly for any abrasions or fractures that might impair the strength of the chamber.
Refrigerated plate inside chamber	Cold bums	?? Do not touch the inside of the refrigeration chamber whilst the fridge is on or immediately afterwards as inside temperatures can be as low as -60°C.

Appendix 3.4: Laboratory Risk Assessment - Loss on ignition

Laboratory Risk Assessment

Procedure	Loss on ignition
Level of Risk	medium

Hazard	Risk	Recommended Control
Furnace at 550°C	Burns to hands and arms;	?? Stand to one side of furnace door when opening ?? Wear Leather gloves provided ?? Use tongs to remove crucibles from furnace or to transfer to desiccator ?? Allow furnace to cool with door slightly open before removing crucibles ?? Ensure that sleeves of lab coat are rolled down and covering arms
Hot crucibles may shatter when in sudden contact with cold air/surfaces	Eye injury	?? Safety glasses must be worn. ?? Allow furnace to cool with door slightly open before removing crucibles
Slips, trips and falls	Personal injury	?? Ensure route from ovens to balance is clear from obstructions

Appendix 3.5: Laboratory Risk Assessment - Percentage carbonate content

Laboratory Risk Assessment

Procedure	Percentage carbonate content

Level of Risk	medium

Hazard	Risk	Recommended Control
Furnace at 925°C	Burns to Face, hands and arms;	?? Switch furnace off and allow to cool to below 550°C before opening the door. ?? Stand to one side of furnace door when opening ?? Wear Leather gloves provided ?? Use tongs to remove crucibles from furnace or to transfer to desiccator ?? Allow furnace to cool with door slightly open before removing crucibles ?? Ensure that sleeves of lab coat are rolled down and covering arms
Hot crucibles may shatter when in sudden contact with cold air/surfaces	Eye injury	?? Safety glasses must be worn. ?? Allow furnace to cool with door slightly open before removing crucibles
Slips, trips and falls	Personal injury	?? Ensure route from ovens to balance is clear from obstructions

Appendix 3.6: CRM Values

smu

Slovak Institute of Metrology
KARLOVESKÁ 63, 842 55 BRATISLAVA 4, SLOVAKIA

Tel./Fax: ++421/55/633 6834

Number of pages: 5

Producer: *pb-anal, Lomená 1, 04001 Košice, Slovakia*
Institute of Radioecology, Komenského 9, 04001 Košice, Slovakia

CERTIFICATE

REFERENCE MATERIAL

ESSENTIAL A TOXIC ELEMENTS IN SOIL RENDZINA S-SP

in accordance with § 7 of the Slovak Act No. 142/2000 Coll.

Registration No: 034/04

Sort of material: *Soil Rendzina S-SP*

Code: *12-1-09*

Certified values of individual element contents with expanded uncertainties (k=2)

Element	Mass fraction μg/g	U μg/g
As	14,0	1,4
Ba	315	22
Cd	0,285	0,059
Co	15,6	1,2
Cr	75,3	3,2
Cu	30,9	1,9
Hg	0,0874	0,0142
Mn	734	34
Ni	37,4	3,3
Pb	41,3	4,4
Sb	2,11	0,08
Sr	274	10
V	89,7	8,7
Zn	119	7

Element	Mass fraction %	U %
Ca	6,34	0,25
Fe	3,73	0,19
K	2,63	0,23

Supplied by:
MBH Analytical Ltd
Holland House, Queens Road
Barnet EN5 4DJ, UK
Tel: +44(0)20 8441 2024
Fax: +44(0)20 8449 0810

Tracebility Interlaboratory comparison by ISO Guide 35: 1989

Expiration period to: December 31, 2013

Minimum sample weight: 200 mg

Batch No: 12-1-09-03404

Packing: 50 g

Authority responsible for preparation and certification : RNDr. Štefan Bartha

Bratislava, 12/02/2004

Ing. Viliam Pätoprstý, PhD.
Director of Chemical Centre

Certification:

Certificate was administered in September 1992 at the meeting of the Commission for Certified Reference Materials (KCRM) of the Slovak Republic. Certified values were stated on the base of inter-laboratory analyses of individual elements under participation of 32 laboratories using 34 different methods of analysis.

Inter-laboratory analysis:

Code number of the abbreviations of methods used for determination:

10 Instrumental Neutron Activation analysis
11 INAA – short irradiation
12 INAA – long irradiation
13 RNAA - NAA with radiochemical separations
14 Another method

20 Atomic Absorption Spectroscopy
21 AAS – with flame atomisation
22 AAS – with electrothermal atomisation
23 AAS – with hydride generation
24 AAS – cold vapour technique
25 Another method

30 Atomic Emission Spectroscopy
31 AES – with flame atomisation
32 AES - ICP
33 AES - CMP
34 Another method

40 X-ray Spectroscopy
41 RFA - energy dispersive
42 RFA - wavelength dispersive
43 PIXE
44 Another method

50 Molecular Spectroscopy
51 Spectrometry UV-VIS
52 Another method

60 Mass Spectroscopy
61 Spark source
62 Another method

70 Electrochemical methods
71 DPP
72 FSDPP
73 ASV
74 Another method

90 Another methods
91 Atomic fluorescence spectroscopy

Participating laboratories:

Reinhaltevestbrend Salzburg, Austria
VITO, Mol, Belgium
China National Environmental Monitoring Centre, Beijing, China
Agronomická fakulta VŠZ, České Budějovice, Czechoslovakia
Bioanalytika, A.S., Hradec Králové, Czechoslovakia
Bioanalytika, E.N., Hradec Králové, Czechoslovakia
Botanický Ústav, ČSAV, Průhonice pri Prahe, Czechoslovakia
Department of Analytical Chemistry Faculty of Natural Sciences Comenius University, Bratislava, Czechoslovakia
District Hygiene Centre, Klatovy, Czechoslovakia
Institute of Hygiene and Epidemiology, Prague, Czechoslovakia
Institute of Landscape Ecology, České Budějovice, Czechoslovakia
Institute of Radioecology and Applied Nuclear Techniques, D.K., Czechoslovakia
Institute of Radioecology and Applied Nuclear Techniques, Š.B., Czechoslovakia
Nuclear Research Institute, J.K., Řež pri Prahe, Czechoslovakia
Nuclear Research Institute, M.B. Řež pri Prahe, Czechoslovakia
Regional Institute of Hygiene, Ostrava, Czechoslovakia
Research Institute of Melioration and Soil Protection, Borkovice, Czechoslovakia
Státní zkušební Ústav lehkého průmyslu, České, Budějovice, Czechoslovakia
VVDVÚ, Košice, Czechoslovakia
Water and Engineering Service, Pardubice, Czechoslovakia
Zemědělské služby, Modřice, Czechoslovakia
Landestalt für Okologie, Recklinghausen, Federal Republic of Germany
National Public Health Institute, Helsinki, Finland
Environmental Survey Laboratory, Taps Colony, India
Nagpur University, Nagpur, India
ENEL-DCO Central Laboratory, Piacenza, Italy
Research Reactor Institute, Kyoto University, Osaka, Japan
Institute of Soil Science and Plant Cultivation, Pulawy, Poland
Institute of Physics and Nuclear Engineering, Bucharest, Romania
All-Union Research Institute of Marine Fisheries and Oceanography, Moscow, Russia
University of Santiago de Compostela, Analytical Chemistry, Spain
Institute of Nuclear Science National Tsing Hua University, Hsinchu, Taiwan

Properties: Powder material, size of particles < 0,16 mm.

Homogeneity: CRM homogeneity is guaranteed for weights > 200 mg.

Storage: Keep in a dark, dry and cool room. After opening it, keep a well closed bottle in refrigerator under the temperature of 3-5° C.

Expected use: Verification of the correctness of analytical procedures employed at the analysis of samples with similar matrixes, validation of measurement methods.

Instruction for use: Prior to each use, the humidity in respective part of the reference material is determined by drying at temperature of 65°C to reach the constant mass. The rest of the reference material is treated according to requirements of the analytical procedures in use (ignition, converting into solution, extraction, briquetting/caking ...).

CERTIFIED VALUES OF THE ELEMENTS:

Element	Unit	Mass fraction x_i	U	No. of labor. averages		Methods of determination
				a	b	
As	µg/g	14,0	1,4	10	8	11,12,22,23
Ba	µg/g	315	22	9	7	12,21,22,32,34
Ca	%	6,34	0,25	12	10	11,12,21,32,34,40,41
Cd	µg/g	0,285	0,059		13	21,22,72,73
Co	µg/g	15,6	1,2	18	16	12,21,22,34,41,74,75
Cr	µg/g	75,3	3,2	23	18	12,21,22,31,34,40,41
Cu	µg/g	30,9	1,9	23	18	21,22,31,32,34,40,73,74
Fe	%	3,73	0,19	20	18	12,21,32,34,40,41
Hg	µg/g	0,0874	0,0142	13	12	21,23,24,25,93
K	%	2,63	0,23	14	12	11,12,21,31,32,40,41
Mn	µg/g	734	34	21	18	11,21,32,34,40,41
Ni	µg/g	37,4	3,3	19	17	21,22,31,34,40,74,75
Pb	µg/g	41,3	4,4	25	22	21,22,31,32,41,72,73,74
Sb	µg/g	2,11	0,08	7	6	12,22,23
Sr	µg/g	274	10	12	9	12,21,22,32,34,40,41
V	µg/g	89,7	8,7	7	7	11,22,32,34,40,41
Zn	µg/g	119	7	31	28	12,21,31,32,34,40,41,73,74,

x_i – value of mass fraction
U – expanded uncertainty
No. of laboratory averages : a – number of all laboratory means
b – number of accepted laboratory means

INFORMATIVE VALUES OF MASS FRACTION OF DIFFERENT ELEMNTS:

Informative values of the mass fraction of individual elements and their uncertainties:

Element	Unit	Mass fraction x_i	U	No. of labor. averages		Methods of determination
				a	b	
Al	%	7,48	0,55	10	7	11,21,32,34,41
Mg	%	1,19	0,17	12	11	21,32,34,40,41

x_i – value of mass fraction
U – expanded uncertainty No. of laboratory averages : *a – number of all laboratory means*
b – number of accepted laboratory means

INFORMATIVE VALUES WITHOUT UNCERTAINTY ESTIMATION:

	Unit	x_i	N	Methods
Ag	µg/g	5	1	21
Al	%	7,48	7	11,21,32,34,41
B	µg/g	70	1	34
Be	µg/g	2	1	22
Br	µg/g	5	3	12
Ce	µg/g	75	2	12
Cs	µg/g	12	3	12
Dy	µg/g	4	1	11
Eu	µg/g	1	2	12
Gd	µg/g	7	1	12
Hf	µg/g	10	2	12
La	µg/g	40	3	12
Li	µg/g	60	2	31,32
Lu	µg/g	0,50	2	12
Na	%	0,45	8	12,21,31,32,40
Nd	µg/g	40	2	12

	Unit	x_i	N	Methods
P	%	0,14	2	12,51
Rb	µg/g	150	3	12
Sc	µg/g	10	3	12
Se	µg/g	0,25	3	12,23,93
Si	%	20	3	34,40,41
Sm	µg/g	5	2	12
Ta	µg/g	1	2	12
Tb	µg/g	1	2	12
Th	µg/g	10	2	12
Ti	%	0,38	3	11,41
Tl	µg/g	<0,2	2	22,73
U	µg/g	4	2	12
W	µg/g	2	1	12
Yb	µg/g	2	2	12
Zr	µg/g	200	1	12

x_i – value of mass fraction
N – number of accepted laboratory means

Recertification: CRM re-certification was performed 12/02/2004, on the base of stability confirmation of previously certified values. This confirmation is based on inter-laboratory analyses (by 3 different labs and 4 different measuring techniques) of one trace and one major element. Commission for Certified Reference Materials (KCRM) of the Slovak Republic on the base of obtained results and in accordance with its Minutes No. 1/2004 from its meeting decided to prolong the expire date of those CRM to 31/12/2013.

Confirmation of certified values stability:

Method of analysis:

AAS - flame,
AAS - graphite furnace,
Polarography - DPP,
X-ray spectroscopy

Participating laboratory:

Geoanalytické laboratória, Markušovská cesta 1, Spišská Nová Ves, SLOVAKIA
pb-anal, Garbiarska 2, Košice, SLOVAKIA
VVDVÚ, Kukučínova 2, Košice, SLOVAKIA

Results of analyses confirmed stability of certified values.

Producer not guarantees certified values in the case of CRM damage caused by user!

Appendix 3.7: Digest Test Weights*

Vessel	**Sample**	**Weight**
Polypropylene tube (Not Acid Washed)	KC01LA1	0.1000
	KC01LB1	0.1002
	KC01NA1	0.1007
Polypropylene tube (Acid Washed)	KC01LA1	0.1009
	KC01LB1	0.1006
	KC01NA1	0.1001
PTFE (Acid Washed)	KC01LA1	0.1007
	KC01LB1	0.1006
	KC01NA1	0.1010

*weight of samples observed to complete dissolution

Chapter 4 Appendix

Appendix 4.1: Garden Sample Site XRF Elemental Data

Element	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu
KCG01a	280	5440	28100	146400	6855	3981	904	11770	29150	2871	69	99	584	26040	23	39	264
KCG01a	240	5870	28240	146800	6862	4015	914	11770	29190	2814	75	96	572	25920	13	40	265
KCG01a	290	5040	28230	146700	6758	3983	898	11900	28960	2837	70	85	561	25900	23	35	260
Average	270	5450	28190	146633	6825	3993	906	11813	29100	2841	71	93	572	25953	20	38	263
KCG02a	290	4360	29490	153800	4902	3710	1008	11920	24750	2599	65	85	598	27790	23	34	243
KCG02a	280	4880	29140	154400	4865	3738	1002	12050	24970	2586	62	83	597	27970	28	35	254
KCG02a	260	5550	29050	154800	4893	3764	1021	11990	24900	2661	55	107	592	27860	21	35	245
Average	277	4930	29227	154333	4887	3737	1010	11987	24873	2615	61	92	596	27873	24	35	247
KCG03a	250	5810	28690	149400	5168	3857	622	11390	28250	2572	56	120	587	25050	15	34	257
KCG03a	260	5960	28610	150700	5114	3840	616	11330	28160	2606	57	108	572	25180	18	35	259
KCG03a	270	5620	28440	151100	5145	3835	621	11300	28340	2556	55	106	567	25250	24	34	267
Average	260	5797	28580	150400	5142	3844	620	11340	28250	2578	56	111	575	25160	19	34	261
KCG04a	230	5820	25940	144500	4097	3916	563	11760	26850	2723	41	103	523	24520	12	33	262
KCG04a	240	5810	25980	145800	4131	3833	565	11840	26670	2759	45	100	524	24530	8	31	266
KCG04a	270	4960	25800	146700	4074	3826	538	11800	26620	2727	64	122	493	24430	27	31	275
Average	247	5530	25907	145667	4101	3858	556	11800	26713	2736	50	108	513	24493	15	31	268
KCG01a	240	5880	26530	145000	6122	3802	888	11410	27640	2667	49	109	534	24340	22	35	245
KCG01a	240	5840	26950	146400	6200	3831	887	11420	27550	2663	58	93	523	24540	26	33	243
KCG01a	250	5820	26750	146800	6142	3834	875	11660	27700	2701	64	95	546	24450	26	32	252
Average	243	5847	26743	146067	6155	3822	883	11497	27630	2677	57	99	534	24443	25	33	247
KCG02a	230	5970	28070	165600	4705	3542	937	11660	22540	2565	59	95	542	27620	27	32	212
KCG02a	270	5460	28260	167000	4798	3593	943	11560	22800	2563	55	94	544	27760	22	32	219
KCG02a	230	5910	28290	167700	4769	3599	969	11780	22790	2608	55	97	561	27810	33	32	222
Average	243	5780	28207	166767	4757	3578	950	11667	22710	2579	56	95	549	27730	28	32	218
KCG03a	240	6180	27500	146200	5068	3748	584	10960	27710	2442	62	105	527	24130	22	31	257
KCG03a	230	6180	27940	146700	5048	3788	601	11040	27690	2493	49	121	551	24300	17	29	260
KCG03a	230	5770	27350	147000	5086	3760	604	10940	27800	2475	64	107	541	24360	20	32	261
Average	233	6043	27597	146633	5067	3765	596	10980	27733	2470	58	111	539	24263	20	31	259
KCG04a	260	5330	25580	148100	4009	3542	487	11300	25110	2657	44	89	515	23080	25	30	244
KCG04a	230	5780	24940	149600	4007	3581	489	11370	25430	2671	42	90	494	23110	34	28	248
KCG04a	260	5190	25010	150400	3995	3528	478	11400	25160	2697	53	89	490	23270	16	28	248
Average	250	5433	25177	149367	4004	3550	484	11357	25233	2675	46	89	500	23153	25	29	247
KCG01b	240	6510	24250	140300	5157	4390	1039	10820	27520	2373	61	105	505	24830	17	30	231
KCG01b	250	5640	23430	139900	5070	4430	1053	10900	27520	2386	49	105	506	24630	32	30	233
KCG01b	240	6660	24280	141200	5067	4347	1042	10910	27420	2363	40	109	484	24560	30	27	222
Average	243	6270	23987	140467	5098	4389	1045	10877	27487	2374	50	106	499	24673	26	29	229

KCG02b	240	5850	23150	128000	4758	4196	674	9720	30120	2260	62	91	522	26250	10	30	254
KCG02b	240	5860	23460	129900	4697	4289	689	9906	30310	2265	70	88	521	26420	19	30	259
KCG02b	240	5600	23270	128500	4674	4197	688	9710	29830	2239	48	85	510	26090	19	29	254
Average	240	5770	23293	128800	4710	4227	684	9779	30087	2255	60	88	517	26253	16	30	256
KCG03b	310	4850	25700	152500	5383	4388	1470	12040	25810	2426	39	147	443	22890	10	27	329
KCG03b	240	6190	26470	152500	5346	4349	1483	11890	25650	2462	52	146	446	22770	33	29	327
KCG03b	240	6200	25630	154700	5307	4352	1482	12120	25520	2450	59	115	442	22780	36	27	319
Average	263	5747	25933	153233	5345	4363	1478	12017	25660	2446	50	136	444	22813	26	28	325
KCG04b	280	4970	27400	149100	4640	4201	575	11460	26150	2688	65	97	491	24020	24	31	266
KCG04b	280	5490	27660	149100	4621	4210	605	11660	26060	2689	55	108	494	23860	11	31	258
KCG04b	280	5040	27150	150000	4634	4195	597	11500	26000	2687	41	103	492	23830	24	31	263
Average	280	5167	27403	149400	4632	4202	592	11540	26070	2688	54	103	492	23903	20	31	262
KCG01a	250	6020	26340	146900	6083	3858	861	11430	27600	2689	54	90	544	24460	24	31	239
KCG01a	300	4750	26500	149400	6112	3862	892	11550	27990	2740	67	104	534	24680	15	36	244
KCG01a	250	5770	26140	149600	6139	3840	880	11390	27930	2734	45	95	546	24660	9	35	243
Average	267	5513	26327	148633	6111	3853	877	11457	27840	2721	55	96	542	24600	16	34	242
KCG02a	240	5940	28620	168000	4820	3627	935	11940	22900	2638	57	68	535	27820	28	32	225
KCG02a	240	6220	28310	169200	4854	3678	943	11970	22890	2642	57	96	563	27970	37	32	216
KCG02a	230	5960	28220	169800	4813	3663	942	11990	23130	2636	62	109	537	27880	21	33	219
Average	237	6040	28383	169000	4829	3656	940	11967	22973	2639	59	91	545	27890	28	32	220
KCG03a	270	5580	26820	147300	5047	3819	598	11130	27770	2495	66	114	533	24360	12	30	264
KCG03a	280	5210	27390	147500	5025	3853	605	11150	27900	2490	46	103	542	24390	22	29	270
KCG03a	230	6570	27740	148200	5073	3855	614	11110	27860	2492	62	95	546	24380	28	29	262
Average	260	5787	27317	147667	5048	3842	606	11130	27843	2492	58	104	540	24377	20	29	265
KCG04a	230	5950	25190	151200	4085	3562	540	11670	25390	2698	59	81	509	23320	24	31	247
KCG04a	220	5700	25280	152400	4056	3575	489	11520	25320	2739	46	98	500	23380	20	30	248
KCG04a	230	6200	25020	153200	4054	3625	523	11410	25580	2791	34	83	490	23380	41	27	253
Average	227	5950	25163	152267	4065	3587	517	11533	25430	2743	46	87	500	23360	28	30	249
KCG01b	230	6150	24090	141800	5022	4375	1041	10950	27370	2368	51	111	507	24670	32	27	232
KCG01b	250	5390	23400	137900	4904	4261	1021	10620	27360	2372	49	110	508	24500	28	28	232
KCG01b	240	6360	23920	142600	5036	4395	1042	10760	27170	2359	47	94	519	24670	29	28	230
Average	240	5967	23803	140767	4987	4344	1035	10777	27300	2366	49	105	511	24613	29	28	231
KCG02b	240	5530	23210	128400	4613	4236	689	9738	29870	2228	59	66	515	25970	27	29	250
KCG02b	240	5400	22840	127400	4613	4204	725	9577	29780	2250	67	84	529	26130	18	30	257
KCG02b	230	6130	23200	128600	4641	4219	689	9567	29850	2297	61	83	511	26190	25	29	255
Average	237	5687	23083	128133	4622	4220	701	9627	29833	2258	62	78	518	26097	23	29	254
KCG03b	300	5360	25440	155400	5272	4398	1492	11900	25540	2478	53	134	433	22820	13	27	322
KCG03b	250	6120	25470	155400	5293	4389	1467	11790	25540	2491	57	129	443	22790	31	26	326
KCG03b	240	6820	25390	155700	5234	4346	1455	11850	25440	2467	62	133	451	22850	26	30	321

Average	263	6100	25433	155500	5266	4378	1471	11847	25507	2479	57	132	442	22820	23	28	323
KCG04b	230	5820	27070	151600	4626	4123	579	11430	25850	2679	66	84	502	23870	12	30	258
KCG04b	240	5690	26810	150500	4582	4213	591	11480	26170	2730	54	99	512	23890	21	32	267
KCG04b	230	5930	27070	151600	4606	4184	605	11540	26080	2691	41	105	508	23810	23	29	266
Average	233	5813	26983	151233	4605	4173	592	11483	26033	2700	54	96	507	23857	19	30	264
KCG01c	270	5640	27910	151600	5204	4182	1097	12100	25730	2747	56	101	498	24590	19	34	274
KCG01c	240	6110	27800	150500	5008	4117	1078	11980	25540	2708	56	98	485	24420	33	31	273
KCG01c	230	6250	27230	149900	5058	4086	1042	11910	25540	2749	59	106	490	24440	25	29	274
Average	247	6000	27647	150667	5090	4128	1072	11997	25603	2735	57	101	491	24483	26	31	274
KCG02c	280	4880	26250	153100	4439	4117	641	11250	24770	2693	53	97	483	23650	25	27	237
KCG02c	230	6340	25880	154600	4441	4213	666	11180	24990	2715	55	83	466	23620	18	29	237
KCG02c	230	6400	25960	155400	4515	4211	660	11230	25130	2720	51	106	475	23740	20	28	234
Average	247	5873	26030	154367	4465	4180	656	11220	24963	2709	53	95	475	23670	21	28	236
KCG03c	240	6200	27510	155300	4868	3906	638	11110	25140	2647	62	102	493	24820	27	31	248
KCG03c	240	6090	27230	155600	4879	3978	626	10940	25420	2598	55	112	492	24680	28	32	249
KCG03c	230	5950	27010	155100	4873	3983	636	10840	25150	2613	56	113	493	24660	19	31	254
Average	237	6080	27250	155333	4873	3956	634	10963	25237	2619	58	109	493	24720	25	31	250
KCG04c	250	6070	26120	148000	6263	4207	1397	11990	26230	2687	60	89	482	25270	21	28	278
KCG04c	250	6320	26090	147100	6231	4203	1428	11920	26150	2650	53	101	474	25340	12	28	292
KCG04c	250	5910	26270	148100	6256	4244	1410	11900	26100	2637	55	115	475	25270	23	29	295
Average	250	6100	26160	147733	6250	4218	1412	11937	26160	2658	56	101	477	25293	18	28	288
KCG01a	240	4480	23670	145700	5785	3457	748	10980	25370	2632	63	90	486	24170	14	33	228
KCG01a	230	5710	26190	158500	6169	3870	833	11550	26040	2769	64	83	501	24520	21	30	226
KCG01a	240	5360	24240	149100	5721	3568	748	10920	25090	2587	57	72	506	24270	20	32	231
Average	237	5183	24700	151100	5892	3632	776	11150	25500	2663	61	82	497	24320	19	32	228
KCG02a	250	5750	26810	142600	4743	3864	1047	11660	25510	2492	68	101	610	26830	22	34	246
KCG02a	240	6000	27100	145900	4799	3875	1061	11690	25840	2532	69	98	596	26710	28	36	245
KCG02a	240	5440	27380	145100	4723	3953	1071	11730	25890	2445	59	115	598	26940	23	37	255
Average	243	5730	27097	144533	4755	3897	1060	11693	25747	2490	65	105	601	26827	24	35	249
KCG03a	270	5490	27390	134600	4942	3970	656	10890	29090	2497	55	82	572	24020	13	32	269
KCG03a	240	6590	26870	135600	5011	3998	676	11010	29080	2508	68	85	548	23990	27	31	271
KCG03a	250	6400	26860	136700	4940	4004	681	10840	29210	2520	64	109	558	24090	20	33	270
Average	253	6160	27040	135633	4964	3991	671	10913	29127	2508	62	92	560	24033	20	32	270
KCG04a	240	5750	24460	120600	4126	4132	603	11340	29350	2494	57	89	507	22940	22	27	273
KCG04a	250	5680	24160	122000	4026	4179	612	11250	29390	2530	58	114	518	23040	27	31	277
KCG04a	260	5670	24410	122900	4077	4197	626	11490	29570	2590	48	104	512	23210	28	29	276
Average	250	5700	24343	121833	4076	4169	614	11360	29437	2538	54	102	512	23063	25	29	275
KCG01b	280	5200	24370	143100	4688	3847	912	10490	25010	2267	43	86	480	23590	33	26	239
KCG01b	240	5690	24240	144800	4708	3883	928	10880	25130	2281	37	99	497	23660	8	29	241

KCG01b	230	6040	24130	145300	4604	3927	922	10940	25060	2343	61	97	482	23650	8	30	236
Average	250	5643	24247	144400	4667	3886	920	10770	25067	2297	47	94	487	23633	16	29	239
KCG02b	280	5400	24570	143500	4651	3931	927	10340	26000	2270	49	88	450	23950	14	28	271
KCG02b	280	4970	24660	144700	4674	3958	940	10450	25970	2238	42	80	449	23950	22	25	271
KCG02b	240	6200	24880	145300	4667	3994	952	10410	25870	2240	56	91	463	24010	13	25	266
Average	267	5523	24703	144500	4664	3961	940	10400	25947	2249	49	86	454	23970	16	26	269
KCG03b	240	5970	25720	141800	4904	4124	1122	11120	25740	2466	50	96	448	22560	8	28	309
KCG03b	240	6160	25740	144400	4880	4244	1132	11210	25800	2553	54	104	458	22630	17	28	305
KCG03b	240	5660	25850	145200	4903	4191	1157	11070	25890	2552	63	84	467	22610	10	29	308
Average	240	5930	25770	143800	4896	4186	1137	11133	25810	2524	56	95	457	22600	12	28	307
KCG04b	240	5990	26330	141200	4260	3941	576	11080	25520	2655	37	107	514	23110	20	29	252
KCG04b	280	4700	25560	142300	4224	3986	584	11050	25470	2687	53	90	507	23190	11	35	257
KCG04b	230	5730	25480	142300	4319	4082	591	11050	25720	2696	52	95	512	23250	31	32	256
Average	250	5473	25790	141933	4268	4003	584	11060	25570	2679	47	97	511	23183	21	32	255
KCG01c	310	4450	24910	150800	4516	3920	1011	11540	23750	2556	53	114	434	22790	18	28	237
KCG01c	280	5740	25830	157900	4754	4036	1026	11680	24090	2630	51	123	446	23090	23	27	239
KCG01c	250	5470	24430	150700	4535	3762	953	11300	23520	2540	68	110	426	22900	32	29	236
Average	280	5220	25057	153133	4602	3906	997	11507	23787	2575	57	116	435	22927	24	28	238
KCG02c	230	5900	26360	152300	4805	4066	853	11250	24530	2606	47	94	467	23260	23	31	265
KCG02c	290	4930	25710	151100	4720	3960	835	11140	24530	2601	53	103	460	23420	28	28	266
KCG02c	230	5720	26290	151300	4694	3979	838	11170	24590	2599	57	100	458	23330	8	35	265
Average	250	5517	26120	151567	4740	4002	842	11187	24550	2602	52	99	462	23337	20	31	265
KCG03c	280	4610	26470	153500	4510	3715	580	10560	23750	2569	53	93	473	23580	27	27	243
KCG03c	230	6120	26270	155600	4527	3772	598	10830	24180	2558	47	104	470	23710	21	32	239
KCG03c	280	4640	26740	156000	4572	3806	589	10840	24150	2604	58	106	485	23730	24	31	244
Average	263	5123	26493	155033	4536	3764	589	10743	24027	2577	53	101	476	23673	24	30	242
KCG04c	240	5740	25690	149700	5199	3941	996	11370	24120	2471	36	88	435	23870	9	30	251
KCG04c	230	6200	26290	151200	5267	4043	1009	11360	24390	2479	57	93	456	23890	33	26	260
KCG04c	240	5550	25100	152800	5259	4088	1020	11480	24370	2569	40	101	443	23910	16	28	262
Average	237	5830	25693	151233	5242	4024	1008	11403	24293	2506	44	94	445	23890	20	28	258
KCG01d	270	5360	26620	163700	4988	3702	964	11870	24320	2756	47	111	443	24120	25	32	238
KCG01d	240	6040	26960	164300	4949	3691	960	11670	23970	2764	48	115	449	23960	16	32	228
KCG01d	230	6020	27420	166000	4986	3653	957	11740	24260	2840	55	108	447	24110	23	34	234
Average	247	5807	27000	164667	4974	3682	960	11760	24183	2787	50	111	446	24063	21	33	233
KCG02d	260	5790	25120	147000	5198	4274	1396	11970	26170	2636	53	117	456	23020	21	27	290
KCG02d	290	5790	24850	147100	5137	4246	1367	11910	26020	2655	52	121	458	22990	21	30	293
KCG02d	270	5930	24950	148100	5136	4198	1370	11800	25860	2684	53	114	455	22980	19	30	285
Average	273	5837	24973	147400	5157	4239	1378	11893	26017	2658	53	117	456	22997	20	29	289
KCG03d	240	6120	28970	170200	4549	3667	558	11450	22380	2921	47	117	477	25900	21	31	245

KCG03d	240	6280	28820	171800	4655	3661	579	11210	22480	2891	63	105	480	25920	16	31	238
KCG03d	280	5600	28200	171800	4597	3643	564	11470	22190	2838	57	113	461	25750	21	30	243
Average	253	6000	28663	171267	4600	3657	567	11377	22350	2883	56	112	473	25857	19	31	242
KCG04d	230	6140	27180	164100	4109	3799	586	11080	23480	2756	57	119	489	25510	12	34	229
KCG04d	230	6360	26940	165400	4114	3774	558	11210	23450	2777	47	106	462	25440	17	30	235
KCG04d	280	5230	27200	167400	4133	3819	586	11240	23440	2773	52	109	465	25440	21	31	242
Average	247	5910	27107	165633	4119	3797	576	11177	23457	2769	52	111	472	25463	17	32	236
KCG01a	270	6150	26710	129400	6082	4174	1045	11200	30090	2572	67	90	575	24000	24	31	261
KCG01a	260	6310	26580	130900	5999	4206	1027	11370	30180	2537	65	101	574	24120	18	33	264
KCG01a	270	5590	26930	131600	6094	4267	1041	11400	30350	2587	66	89	606	24230	22	33	266
Average	267	6017	26740	130633	6058	4216	1038	11323	30207	2565	66	93	585	24117	21	32	264
KCG02a	260	6000	28520	151000	4702	4000	1058	12010	25080	2556	52	106	567	26590	20	34	229
KCG02a	240	6300	28140	150200	4642	4116	1047	12070	25080	2501	62	80	575	26590	20	34	232
KCG02a	250	5960	28650	152500	4728	4109	1063	12090	25220	2574	62	101	578	26770	31	32	232
Average	250	6087	28437	151233	4691	4075	1056	12057	25127	2544	59	95	573	26650	24	33	231
KCG03a	270	5050	24360	126100	4578	3883	660	10630	28290	2378	62	115	541	23700	11	35	250
KCG03a	260	6270	26500	134600	4884	4068	681	10780	28670	2379	42	125	545	23930	21	32	257
KCG03a	250	5990	27540	140600	5021	4300	718	11140	29330	2500	71	106	557	24140	25	32	254
Average	260	5770	26133	133767	4828	4084	686	10850	28763	2419	58	115	548	23923	19	33	253
KCG04a	270	5220	22690	104000	3832	4191	671	10970	30960	2413	49	98	554	22710	28	30	284
KCG04a	270	5400	23750	105900	3920	4347	697	11020	31210	2428	78	96	588	22760	17	31	286
KCG04a	260	5760	24240	109400	4023	4496	715	11100	31560	2479	62	100	564	22920	21	32	288
Average	267	5460	23560	106433	3925	4345	694	11030	31243	2440	63	98	569	22797	22	31	286
KCG01b	250	5510	23160	119000	4372	4098	988	10360	27070	2137	47	104	467	22410	12	31	264
KCG01b	290	4820	22540	120600	4353	4119	1024	10470	27410	2134	64	85	485	22470	30	27	261
KCG01b	250	5980	23290	123800	4545	4223	1063	10420	27700	2212	56	98	503	22610	14	31	268
Average	263	5437	22997	121133	4423	4147	1025	10417	27393	2161	56	96	485	22497	19	30	264
KCG02b	260	5780	24300	119000	4522	4233	1065	10180	29560	2283	56	108	507	23970	26	28	297
KCG02b	260	5960	24050	120800	4527	4247	1075	10090	29830	2274	47	97	507	24110	19	29	295
KCG02b	260	5770	23980	120900	4514	4195	1055	10260	29540	2276	52	92	493	23940	21	29	298
Average	260	5837	24110	120233	4521	4225	1065	10177	29643	2278	51	99	502	24007	22	28	297
KCG03b	250	5870	24380	138800	4612	4216	1141	10840	24990	2242	50	84	421	21890	10	28	297
KCG03b	260	6060	24170	142700	4639	4198	1150	10830	24900	2299	45	100	417	21980	22	29	298
KCG03b	260	5430	24130	141600	4683	4316	1161	10850	25030	2237	55	95	419	21920	12	28	303
Average	257	5787	24227	141033	4645	4243	1151	10840	24973	2259	50	93	419	21930	14	28	299
KCG04b	260	5850	26490	129200	4291	4283	657	10910	27800	2499	68	93	490	23120	25	29	269
KCG04b	250	5760	26250	130100	4227	4360	684	10970	27710	2500	56	92	510	23230	15	32	262
KCG04b	240	5590	26120	130100	4256	4382	682	11040	28120	2526	57	104	514	23200	13	30	264
Average	250	5733	26287	129800	4258	4342	674	10973	27877	2508	60	96	505	23183	17	30	265

KCG01c	270	5700	24710	121500	4444	4239	1162	11080	28460	2300	55	104	500	23190	34	30	290
KCG01c	270	6220	24280	123400	4465	4246	1157	11030	28440	2304	48	97	505	23330	10	28	283
KCG01c	270	5790	25140	124400	4570	4245	1181	11260	28660	2304	62	110	510	23430	17	34	286
Average	270	5903	24710	123100	4493	4243	1167	11123	28520	2303	55	104	505	23317	20	31	286
KCG02c	250	5870	25910	129300	4649	4347	961	11000	27490	2463	47	81	473	23310	30	27	262
KCG02c	260	5930	24930	131300	4608	4318	964	10880	27340	2448	47	99	480	23390	26	31	266
KCG02c	260	5510	25150	131100	4650	4352	963	10970	27460	2460	66	106	479	23460	24	30	267
Average	257	5770	25330	130567	4636	4339	963	10950	27430	2457	53	95	477	23387	27	29	265
KCG03c	250	5920	25500	131200	4317	3995	650	10250	27150	2421	58	96	502	23870	14	33	267
KCG03c	240	6060	25380	132900	4376	4072	667	10630	27450	2468	63	108	503	24080	15	33	278
KCG03c	240	5930	25480	133100	4401	4154	687	10450	27380	2432	59	95	506	23940	29	32	277
Average	243	5970	25453	132400	4365	4074	668	10443	27327	2440	60	100	504	23963	19	32	274
KCG04c	260	5560	24710	136900	5051	4223	1070	11020	26340	2251	51	116	464	23240	17	26	264
KCG04c	260	6150	24410	139900	5107	4274	1075	11020	26440	2321	48	118	478	23380	16	29	272
KCG04c	260	5950	24300	140300	5038	4272	1106	11090	26550	2262	55	128	466	23440	11	32	272
Average	260	5887	24473	139033	5065	4256	1084	11043	26443	2278	51	121	469	23353	15	29	269
KCG01d	270	5360	24320	114600	4413	4156	1236	10960	30280	2277	55	105	537	22510	21	32	293
KCG01d	270	5380	24430	115500	4438	4205	1245	11020	30240	2284	64	102	528	22580	11	32	300
KCG01d	270	5890	24320	117500	4504	4190	1252	11020	30370	2328	56	99	539	22680	17	30	295
Average	270	5543	24357	115867	4452	4184	1244	11000	30297	2296	58	102	535	22590	16	31	296
KCG02d	270	5670	24020	113700	4682	4348	1555	11200	29860	2365	56	130	485	22080	14	29	327
KCG02d	270	5880	23840	113700	4719	4372	1572	11410	29900	2351	59	129	515	22240	16	30	332
KCG02d	270	5920	23280	114300	4660	4411	1585	11240	29920	2314	65	135	486	22210	26	31	333
Average	270	5823	23713	113900	4687	4377	1571	11283	29893	2343	60	131	495	22177	19	30	331
KCG03d	250	5910	28280	148900	4304	3974	661	10820	24860	2516	57	112	470	25220	25	32	264
KCG03d	240	5790	27660	151900	4357	3948	657	11080	24830	2529	55	96	473	25210	23	31	261
KCG03d	240	6170	27700	152400	4263	3968	656	11170	24840	2543	54	121	472	25330	21	32	262
Average	243	5957	27880	151067	4308	3963	658	11023	24843	2529	55	110	471	25253	23	32	262
KCG04d	250	5820	27100	146400	3944	4030	666	10830	26350	2506	55	92	565	23460	29	30	244
KCG04d	250	5820	26160	147400	3832	3974	659	10800	26350	2552	55	114	557	23460	23	30	246
KCG04d	250	6080	26410	148200	3823	4032	657	10870	26420	2527	50	102	534	23400	19	32	249
Average	250	5907	26557	147333	3866	4012	661	10833	26373	2528	53	103	552	23440	24	30	246
KCG01e	240	6920	29570	163100	5319	4259	1120	12390	25440	2690	63	125	470	24480	27	29	239
KCG01e	240	7010	29220	163800	5211	4327	1128	12340	25120	2682	61	134	467	24440	22	29	239
KCG01e	240	6400	29230	163800	5209	4258	1136	12480	25350	2670	67	123	464	24440	13	31	245
Average	240	6777	29340	163567	5246	4281	1128	12403	25303	2681	64	127	467	24453	21	29	241
KCG02e	250	6180	25620	149800	5203	4212	1463	12090	26830	2556	45	108	469	22510	21	25	269
KCG02e	260	6020	25520	150600	5176	4106	1414	11970	26740	2554	44	122	453	22560	16	27	271
KCG02e	250	6550	25400	152000	5116	4162	1438	12030	26620	2542	44	112	461	22640	23	26	273

Average	253	6250	25513	150800	5165	4160	1438	12030	26730	2551	44	114	461	22570	20	26	271
KCG03e	270	5580	29050	164000	4121	3933	595	11150	24810	2726	54	81	495	25490	13	32	237
KCG03e	240	6260	29100	164100	4098	3953	597	11030	24720	2754	58	79	479	25490	21	32	233
KCG03e	230	5730	28780	165200	4051	3956	597	11150	24900	2754	41	103	490	25440	14	35	238
Average	247	5857	28977	164433	4090	3947	596	11110	24810	2745	51	88	488	25473	16	33	236
KCG04e	250	5790	29120	178500	4013	3544	512	11600	22200	2915	59	97	476	26030	24	31	233
KCG04e	300	5060	28500	179500	4024	3565	500	11700	22200	2927	66	90	474	25990	28	34	235
KCG04e	300	4750	28520	179100	3957	3550	506	11570	21990	2939	46	112	473	26140	25	31	239
Average	283	5200	28713	179033	3998	3553	506	11623	22130	2927	57	100	474	26053	26	32	236
KCG01a	260	6100	25490	120800	6110	4274	1008	10940	30310	2545	50	89	571	23980	22	33	256
KCG01a	270	5760	25460	123200	6156	4285	996	11070	30440	2495	64	84	589	24010	30	32	263
KCG01a	260	5690	25610	123500	6113	4246	987	11000	30400	2496	64	79	595	24070	26	35	260
Average	263	5850	25520	122500	6126	4268	997	11003	30383	2512	60	84	585	24020	26	33	260
KCG02a	250	6000	28630	145300	4808	4019	1062	11710	25380	2549	69	87	566	27050	17	36	241
KCG02a	250	6390	29350	146000	4833	4054	1070	11750	25520	2501	50	108	572	27220	24	33	244
KCG02a	250	6110	29670	148400	4864	3967	1059	11890	25540	2492	72	87	587	27220	35	33	236
Average	250	6167	29217	146567	4835	4013	1064	11783	25480	2514	64	94	575	27163	25	34	240
KCG03a	250	6520	26350	131400	4911	4083	631	10540	29410	2330	48	99	561	23870	12	31	274
KCG03a	250	6180	26220	132800	4930	4108	649	10590	29340	2317	61	101	573	23810	14	34	268
KCG03a	240	6550	26720	133000	4961	4135	667	10710	29290	2404	49	111	545	23810	24	31	268
Average	247	6417	26430	132400	4934	4109	649	10613	29347	2350	53	104	560	23830	17	32	270
KCG04a	250	5930	25040	132200	4076	4087	572	11430	27720	2420	54	94	500	23020	15	30	238
KCG04a	250	6220	25400	134200	4049	4149	572	11540	27840	2459	59	84	489	23150	14	28	236
KCG04a	250	6390	24950	134500	4116	4154	579	11560	27580	2454	60	92	501	23150	17	28	235
Average	250	6180	25130	133633	4080	4130	575	11510	27713	2444	58	90	496	23107	15	29	236
KCG01b	270	5760	23510	116200	4581	4427	1092	10600	29150	2416	50	117	510	23240	14	31	257
KCG01b	260	6010	23820	118500	4615	4435	1082	10590	29460	2457	51	117	501	23240	19	30	258
KCG01b	260	5930	24370	119200	4620	4414	1085	10670	29300	2473	39	94	501	23340	19	31	260
Average	263	5900	23900	117967	4605	4425	1086	10620	29303	2449	47	109	504	23273	17	31	258
KCG02b	270	5940	23770	114800	4568	4362	1101	10030	30470	2209	47	88	481	22930	18	29	302
KCG02b	260	5920	23730	115800	4548	4401	1104	10100	30640	2201	59	77	505	23100	35	28	303
KCG02b	270	6160	24130	116200	4523	4383	1096	10050	30310	2248	51	76	494	23220	13	27	302
Average	267	6007	23877	115600	4546	4382	1100	10060	30473	2219	53	80	493	23083	22	28	303
KCG03b	260	5950	24840	126700	4618	4255	1186	10890	27700	2302	67	108	486	22220	30	28	332
KCG03b	250	5950	24500	128200	4665	4325	1192	11000	27880	2390	61	83	473	22380	10	31	339
KCG03b	250	6420	25100	128800	4706	4356	1194	11000	27810	2352	49	94	484	22310	32	30	340
Average	253	6107	24813	127900	4663	4312	1191	10963	27797	2348	59	95	481	22303	24	30	337
KCG04b	260	6250	26140	145500	4364	4450	632	11080	26600	2443	55	93	470	22600	17	32	223
KCG04b	260	6350	26430	146700	4422	4460	620	11120	26680	2437	58	107	467	22720	13	31	221

KCG04b	260	6250	26630	149000	4429	4413	624	11280	26640	2434	55	94	462	22740	23	32	226
Average	260	6283	26400	147067	4405	4441	626	11160	26640	2438	56	98	466	22687	18	32	223
KCG01c	280	6140	25040	119100	4681	4402	1346	11170	30520	2221	54	97	521	22610	13	29	266
KCG01c	270	6530	25590	120800	4725	4422	1325	11230	30840	2271	58	120	543	22840	8	32	265
KCG01c	290	6450	25910	123700	4813	4436	1301	11250	30580	2298	46	115	541	22840	21	30	267
Average	280	6373	25513	121200	4740	4420	1324	11217	30647	2263	53	110	535	22763	14	31	266
KCG02c	260	5910	24730	138200	4533	4289	924	10850	26320	2331	60	89	447	22260	8	28	243
KCG02c	260	5890	25280	140100	4734	4353	934	10880	26710	2411	42	108	461	22450	29	27	246
KCG02c	250	6120	24960	142900	4730	4353	939	10910	26470	2420	61	98	467	22550	17	30	247
Average	257	5973	24990	140400	4666	4332	932	10880	26500	2387	54	98	458	22420	18	28	246
KCG03c	280	4990	24980	123900	4340	3931	650	9951	27960	2307	66	101	516	23100	30	33	287
KCG03c	240	5600	24980	126000	4396	4004	653	10080	28040	2306	66	101	532	23280	28	29	296
KCG03c	230	5810	24770	127400	4394	4034	651	10070	27710	2310	53	115	523	23290	35	30	293
Average	250	5467	24910	125767	4377	3990	651	10034	27903	2308	61	106	523	23223	31	30	292
KCG04c	270	5850	24790	132200	5185	4351	1162	11140	27660	2368	55	94	458	23160	27	25	278
KCG04c	260	5990	24860	135400	5295	4408	1166	11380	27960	2450	47	83	476	23320	20	27	276
KCG04c	260	5840	25150	136500	5289	4416	1168	11270	27940	2417	45	92	477	23340	8	27	283
Average	263	5893	24933	134700	5256	4392	1165	11263	27853	2412	49	89	470	23273	18	27	279
KCG01d	280	5690	24560	110500	4579	4254	1305	10950	31690	2300	60	104	522	22290	15	30	292
KCG01d	270	5760	24530	112400	4612	4274	1268	11020	31770	2372	64	101	500	22490	13	29	292
KCG01d	270	5950	24450	115000	4613	4303	1288	11010	31750	2350	56	114	517	22360	17	31	283
Average	273	5800	24513	112633	4601	4277	1287	10993	31737	2341	60	106	513	22380	15	30	289
KCG02d	280	5960	23010	103700	4687	4340	1598	10990	30290	2254	47	111	489	21800	12	29	329
KCG02d	270	5900	23190	108000	4748	4463	1593	11290	30270	2233	44	116	473	21840	14	29	330
KCG02d	270	5300	23120	110300	4785	4474	1599	11250	30260	2250	56	119	484	21830	19	30	326
Average	273	5720	23107	107333	4740	4426	1597	11177	30273	2246	49	115	482	21823	15	29	328
KCG03d	260	5670	26810	126700	4148	3950	687	10390	27620	2502	50	102	502	24860	12	38	304
KCG03d	250	6220	27030	128500	4208	3948	693	10560	27740	2515	48	112	516	24990	8	37	307
KCG03d	250	5740	26980	131000	4277	3976	675	10500	27750	2565	65	106	496	25120	19	37	308
Average	253	5877	26940	128733	4211	3958	685	10483	27703	2527	54	107	505	24990	13	37	306
KCG04d	250	5900	25640	128600	3780	4140	697	10180	28400	2318	58	110	535	22980	28	28	262
KCG04d	250	5830	26020	131200	3787	4130	696	10180	28300	2353	53	99	555	23070	10	34	266
KCG04d	260	5810	25890	134400	3827	4140	690	10370	28420	2396	57	115	551	23070	19	31	259
Average	253	5847	25850	131400	3798	4137	694	10243	28373	2356	56	108	547	23040	19	31	262
KCG01e	280	5720	24080	123600	4549	4186	1205	11240	27850	2320	53	113	492	22940	17	30	265
KCG01e	270	6350	24210	125100	4593	4246	1198	11160	28160	2382	59	121	509	22950	15	34	267
KCG01e	260	6430	26360	133000	4822	4406	1257	11540	28530	2428	66	97	513	23100	17	28	263
Average	270	6167	24883	127233	4655	4279	1220	11313	28180	2377	60	110	505	22997	16	31	265
KCG02e	280	5930	22820	119000	4977	4276	1538	11160	29370	2429	44	91	483	21420	16	28	300

KCG02e	280	6380	23160	120500	4909	4308	1538	11280	29520	2448	53	107	484	21650	25	30	299
KCG02e	260	6160	23970	123000	5055	4420	1551	11310	29410	2409	61	119	493	21790	18	27	295
Average	273	6157	23317	120833	4980	4335	1542	11250	29433	2429	53	105	487	21620	20	28	298
KCG03e	240	5840	27740	146700	3813	3837	600	10790	25480	2545	69	96	511	24630	33	33	249
KCG03e	240	5960	28050	148500	3889	3908	603	10800	25860	2541	58	106	525	24640	22	35	255
KCG03e	230	6090	28340	149700	3942	3912	602	10820	26050	2583	67	102	517	24760	25	34	251
Average	237	5963	28043	148300	3881	3886	602	10803	25797	2556	65	101	518	24677	27	34	252
KCG04e	270	6060	27780	139900	3880	3975	650	11030	25960	2616	62	98	508	24990	26	32	267
KCG04e	260	5800	28740	143100	3982	4062	645	11140	26030	2631	65	107	503	25320	16	33	262
KCG04e	250	5690	28190	145300	3936	4013	642	11130	25730	2603	66	101	492	25280	37	29	261
Average	260	5850	28237	142767	3933	4017	646	11100	25907	2617	64	102	501	25197	26	31	263
KCG01f	250	6570	26920	157900	5084	4099	1091	11830	25350	2734	64	92	451	23930	19	29	239
KCG01f	240	6440	27310	158700	5123	4129	1083	11930	25460	2715	59	111	461	24010	30	28	239
KCG01f	240	6800	27910	159300	4960	4130	1062	11900	25230	2744	62	115	448	23930	27	26	236
Average	243	6603	27380	158633	5056	4119	1079	11887	25347	2731	61	106	454	23957	25	28	238
KCG02f	250	6370	25830	141400	5610	4283	1405	12090	27300	2475	39	105	490	22630	38	26	259
KCG02f	300	5490	25860	143100	5586	4363	1408	12060	27430	2507	39	123	476	22650	17	33	270
KCG02f	250	6230	25990	144000	5558	4333	1411	12050	27240	2479	57	111	499	22830	16	32	268
Average	267	6030	25893	142833	5585	4326	1408	12067	27323	2487	45	113	488	22703	24	30	266
KCG03f	290	6480	32930	188200	4479	3653	501	12030	21610	2920	61	112	480	26150	9	34	224
KCG03f	300	5820	33030	189400	4480	3717	488	12180	21470	2979	64	116	476	26080	24	34	229
KCG03f	230	6450	33130	189900	4505	3711	487	12070	21520	2956	63	103	484	26120	14	34	230
Average	273	6250	33030	189167	4488	3694	492	12093	21533	2952	63	110	480	26117	15	34	228
KCG04f	240	6620	28500	171100	4235	3898	578	11440	23260	2780	50	107	493	25550	28	29	228
KCG04f	230	5990	28630	169900	4245	3865	575	11380	23180	2778	58	96	480	25530	8	29	227
KCG04f	300	4680	28420	172800	4278	3892	567	11450	23450	2789	50	122	501	25710	17	30	224
Average	257	5763	28517	171267	4253	3885	573	11423	23297	2782	53	109	491	25597	18	30	226
KCG01a	260	5830	25840	122300	6110	4204	1030	10820	30080	2509	59	59	566	24050	23	33	257
KCG01a	250	5660	25530	124200	6150	4275	990	10890	30330	2500	59	88	576	24200	14	34	258
KCG01a	260	5920	25920	125200	6177	4221	998	10910	30270	2524	51	86	558	24230	31	33	260
Average	257	5803	25763	123900	6146	4233	1006	10873	30227	2511	56	78	567	24160	22	33	258
KCG02a	280	5440	28890	151900	4859	3849	990	11860	25030	2567	57	86	574	27330	16	35	241
KCG02a	240	6340	29460	153400	4879	3900	994	11840	24990	2596	78	97	577	27310	19	35	240
KCG02a	300	4840	28940	154100	4909	3904	997	12160	25220	2593	52	95	588	27340	31	33	243
Average	273	5540	29097	153133	4882	3884	994	11953	25080	2585	62	93	580	27327	22	34	241
KCG03a	280	6150	26360	135100	5015	4057	642	10650	29480	2415	62	110	571	23960	14	35	273
KCG03a	240	5800	26520	135400	4960	4107	654	10700	29260	2372	63	95	564	23960	20	31	277
KCG03a	270	5500	26220	135600	4910	4074	647	10800	29170	2383	49	100	570	23880	19	32	271
Average	263	5817	26367	135367	4962	4079	648	10717	29303	2390	58	102	568	23933	17	33	274

KCG04a	240	5940	24560	131000	4053	4065	555	11230	27310	2373	52	73	490	22930	22	26	236
KCG04a	250	5770	24730	133600	4090	4142	576	11320	27780	2382	49	95	487	22950	17	30	237
KCG04a	250	5390	24880	135500	4039	4113	577	11300	27820	2422	46	87	499	23020	8	30	240
Average	247	5700	24723	133367	4061	4107	569	11283	27637	2392	49	85	492	22967	16	29	237
KCG01b	260	5860	23490	120100	4635	4399	1073	10640	28750	2530	59	95	502	23240	16	29	255
KCG01b	260	5970	24170	120900	4633	4378	1069	10780	29180	2570	52	95	504	23220	15	30	256
KCG01b	260	6120	23570	121200	4630	4353	1054	10650	28900	2557	65	107	533	23350	18	27	251
Average	260	5983	23743	120733	4633	4377	1065	10690	28943	2552	58	99	513	23270	16	28	254
KCG02b	260	5790	24160	116000	4710	4358	1121	10170	30660	2282	50	81	507	23300	18	28	303
KCG02b	250	6010	23720	117100	4656	4388	1108	10090	30560	2242	64	87	492	23260	16	30	303
KCG02b	260	6220	24530	118500	4714	4414	1121	10290	30880	2276	56	88	507	23480	10	33	307
Average	257	6007	24137	117200	4693	4387	1117	10183	30700	2267	57	85	502	23347	15	30	305
KCG03b	250	5610	24550	131600	4625	4296	1154	10940	27450	2330	55	98	476	22390	17	30	330
KCG03b	260	6020	24620	132400	4721	4294	1149	10810	27540	2376	63	101	480	22390	27	30	332
KCG03b	250	5960	25090	133400	4780	4370	1162	10850	27730	2385	58	104	488	22480	24	30	332
Average	253	5863	24753	132467	4709	4320	1155	10867	27573	2364	58	101	481	22420	23	30	331
KCG04b	250	6120	26300	150400	4395	4368	613	11160	26410	2574	45	88	484	22780	12	33	230
KCG04b	270	5550	25800	151400	4417	4280	609	11250	26370	2533	51	81	479	22770	10	33	226
KCG04b	250	6440	26050	152400	4459	4331	609	11510	26430	2543	54	87	471	22870	11	32	234
Average	257	6037	26050	151400	4424	4326	610	11307	26403	2550	50	85	478	22807	11	33	230
KCG01c	260	5530	26090	128200	4753	4320	1266	11380	29770	2275	59	94	522	22800	20	27	267
KCG01c	280	6110	26680	131000	4867	4331	1277	11370	29900	2306	60	92	532	22880	8	32	265
KCG01c	260	6160	26530	131200	4828	4401	1295	11550	29960	2344	47	95	524	22990	12	32	265
Average	267	5933	26433	130133	4816	4351	1279	11433	29877	2308	55	94	526	22890	13	30	265
KCG02c	240	5850	25120	141200	4694	4318	910	11010	26130	2454	51	89	442	22420	31	26	246
KCG02c	250	5850	24970	143500	4785	4327	909	11070	26290	2446	43	79	464	22500	40	25	251
KCG02c	250	6070	25370	144300	4744	4322	915	10990	26310	2442	66	70	460	22640	19	28	245
Average	247	5923	25153	143000	4741	4322	911	11023	26243	2447	53	79	455	22520	30	26	247
KCG03c	240	5890	25220	126900	4348	4050	634	9983	27620	2279	49	98	525	23310	15	32	279
KCG03c	240	5830	25980	128000	4433	3946	636	10270	27820	2309	49	100	517	23420	20	33	286
KCG03c	240	5860	26100	128300	4394	4028	646	10300	28020	2330	47	108	546	23390	19	31	289
Average	240	5860	25767	127733	4392	4008	639	10184	27820	2306	48	102	529	23373	18	32	285
KCG04c	260	5880	24630	139500	5182	4342	1104	11370	27630	2408	52	79	455	23410	20	29	271
KCG04c	260	6110	24580	140700	5256	4351	1135	11390	27870	2409	63	103	454	23500	11	30	274
KCG04c	270	5900	25000	141800	5272	4429	1130	11400	27770	2394	54	93	452	23420	22	31	274
Average	263	5963	24737	140667	5237	4374	1123	11387	27757	2404	56	91	453	23443	17	30	273
KCG01d	260	5570	25070	119500	4712	4164	1237	11180	31190	2307	49	106	514	22620	21	30	287
KCG01d	260	5510	24310	120000	4690	4173	1230	11080	31110	2282	51	102	513	22460	17	33	286
KCG01d	270	6020	24340	120900	4713	4213	1237	11220	31130	2308	59	90	518	22610	10	32	288

Average	263	5700	24573	120133	4705	4183	1235	11160	31143	2299	53	100	515	22563	16	32	287
KCG02d	270	5460	23060	111400	4725	4369	1555	11200	29950	2253	68	115	483	21930	9	29	330
KCG02d	270	5790	23420	112700	4786	4409	1546	11160	30120	2312	59	136	507	22060	12	32	338
KCG02d	270	5660	23660	114000	4865	4374	1526	11080	30240	2353	46	113	481	22100	20	30	335
Average	270	5637	23380	112700	4792	4384	1542	11147	30103	2306	57	121	490	22030	14	30	334
KCG03d	250	5470	26810	132700	4170	3923	667	10730	27250	2596	50	119	502	24910	24	37	307
KCG03d	240	5780	27580	132600	4289	3892	645	10730	27030	2584	66	112	525	25040	27	33	306
KCG03d	250	5740	26950	134600	4262	3991	660	10580	27560	2628	62	111	518	25180	27	36	303
Average	247	5663	27113	133300	4240	3935	657	10680	27280	2603	59	114	515	25043	26	35	305
KCG04d	250	6040	25480	134400	3868	4133	676	10330	28160	2352	55	118	554	23070	22	32	263
KCG04d	240	5910	25890	134200	3833	4201	691	10600	28350	2384	54	116	560	23100	11	31	256
KCG04d	240	5950	25950	135400	3919	4163	690	10120	28360	2405	58	111	559	23120	20	31	270
Average	243	5967	25773	134667	3873	4166	685	10350	28290	2380	56	115	558	23097	18	32	263
KCG01e	260	5330	23940	128700	4534	4075	1157	11220	27400	2407	58	135	487	22990	8	34	266
KCG01e	240	6540	25410	136400	4760	4309	1208	11460	27860	2446	56	130	499	23310	34	28	266
KCG01e	260	6270	26140	138100	4796	4282	1222	11680	27840	2415	61	100	507	23420	20	29	258
Average	253	6047	25163	134400	4697	4222	1196	11453	27700	2423	58	122	498	23240	21	30	264
KCG02e	270	5970	23270	125500	4878	4219	1427	11290	29000	2494	62	118	480	21840	15	32	295
KCG02e	260	6340	24020	128400	4990	4294	1443	11540	29300	2518	52	127	489	22050	8	34	296
KCG02e	250	5790	23720	128000	4990	4313	1454	11370	29020	2543	57	119	488	22110	14	29	300
Average	260	6033	23670	127300	4953	4275	1441	11400	29107	2518	57	121	486	22000	12	32	297
KCG03e	230	5770	28050	147900	4015	3880	607	10760	25910	2602	71	87	510	24780	22	32	254
KCG03e	240	5820	28160	150200	3973	3971	608	10880	26020	2609	69	100	517	24830	19	33	252
KCG03e	240	5650	28380	150000	4026	3907	611	10810	26020	2594	66	92	505	24820	20	35	254
Average	237	5747	28197	149367	4005	3919	608	10817	25983	2602	68	93	511	24810	21	33	253
KCG04e	310	4930	28400	147200	3998	3947	593	10980	25740	2704	63	112	522	25530	28	33	271
KCG04e	250	5670	28410	148300	4029	3968	608	11120	25830	2653	55	91	537	25670	23	33	275
KCG04e	230	6550	28690	149300	4074	3988	626	11330	25950	2698	59	97	527	25660	25	36	271
Average	263	5717	28500	148267	4034	3968	609	11143	25840	2685	59	100	529	25620	25	34	272
KCG01f	290	5360	25690	153000	4800	3930	1026	11550	24330	2593	43	102	437	23220	21	27	233
KCG01f	240	6280	25980	154700	4867	3952	1030	11610	24690	2615	55	120	455	23410	8	29	235
KCG01f	230	5930	25890	155100	4850	3981	1045	11560	24750	2645	62	121	444	23340	17	27	233
Average	253	5857	25853	154267	4839	3954	1034	11573	24590	2618	53	114	445	23323	15	27	234
KCG02f	250	5960	24540	138400	5365	4210	1357	11540	26270	2407	52	101	470	22130	17	28	259
KCG02f	240	5960	24850	138700	5392	4217	1365	11480	26580	2438	50	122	454	22100	17	30	263
KCG02f	290	5080	24800	139800	5446	4225	1366	11710	26600	2429	48	109	472	22250	12	29	260
Average	260	5667	24730	138967	5401	4217	1363	11577	26483	2425	50	111	465	22160	15	29	261
KCG03f	300	5660	31170	181500	4447	3555	528	11640	20870	2872	53	107	479	25650	10	34	221
KCG03f	230	6420	31040	182000	4384	3574	484	12050	20960	2901	49	111	459	25640	29	32	229

KCG03f	300	5140	30630	183000	4473	3538	477	11740	20830	2908	43	98	457	25700	20	28	224
Average	277	5740	30947	182167	4435	3556	496	11810	20887	2894	48	105	465	25663	20	31	224
KCG04f	240	6040	27440	165400	4126	3698	595	11030	22150	2726	58	114	472	24800	8	31	220
KCG04f	290	5310	27490	168000	4177	3717	536	11110	22240	2739	50	111	469	25150	14	29	226
KCG04f	240	6320	27850	170600	4200	3774	552	11340	22520	2765	48	113	468	25190	20	30	219
Average	257	5890	27593	168000	4168	3730	561	11160	22303	2743	52	113	470	25047	14	30	222
KCG01g	260	6140	24090	126800	4715	4318	1174	10950	31970	2331	56	109	610	23840	17	32	257
KCG01g	250	5930	24230	129000	4788	4356	1188	11340	32140	2308	65	111	618	23890	28	31	263
KCG01g	240	6320	23700	128700	4721	4299	1177	11030	31820	2325	74	91	587	23840	26	32	255
Average	250	6130	24007	128167	4741	4324	1180	11107	31977	2321	65	104	605	23857	23	32	258
KCG02g	270	5770	22450	116000	4817	4318	1535	11480	29690	2309	59	107	536	23000	11	31	304
KCG02g	250	5730	22670	117000	4836	4291	1520	11220	29520	2302	62	94	537	22930	21	31	300
KCG02g	270	5490	22210	116500	4816	4262	1519	11200	29430	2325	55	106	506	23010	22	31	302
Average	263	5663	22443	116500	4823	4290	1525	11300	29547	2312	59	102	526	22980	18	31	302
KCG03g	300	4610	28190	157300	3960	3742	585	11040	24210	2750	57	96	555	28020	8	36	247
KCG03g	270	6310	29280	161800	4096	3924	570	11240	24190	2785	48	84	560	28030	29	31	241
KCG03g	240	6290	29420	161200	4102	3786	578	11160	24120	2766	63	80	574	27970	9	37	245
Average	270	5737	28963	160100	4053	3817	578	11147	24173	2767	56	87	563	28007	15	35	245
KCG04g	300	3960	29800	164400	3874	3666	570	11390	22900	2798	68	129	526	27760	26	36	284
KCG04g	300	5050	29610	164800	3945	3690	515	11640	22930	2789	65	118	541	27680	33	36	282
KCG04g	290	4650	29960	164800	3975	3677	560	11420	22780	2878	51	105	537	27690	17	36	287
Average	297	4553	29790	164667	3931	3678	548	11483	22870	2822	61	117	535	27710	25	36	284
	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Y	Zr	Nb	Mo	Ag	Cd	In	Sn	
KCG01a	642	4	7	36	1	37	45	125	22	188	9	5	1	3	0	39	
KCG01a	631	4	8	35	2	38	45	125	22	198	8	5	1	2	1	39	
KCG01a	635	3	7	35	1	39	46	125	22	197	7	5	3	3	1	38	
Average	636	3	7	35	1	38	45	125	22	195	8	5	1	2	0	39	
KCG02a	624	2	6	32	1	38	45	116	23	202	11	5	2	2	1	31	
KCG02a	624	3	7	34	1	38	44	116	23	195	8	7	3	3	1	31	
KCG02a	624	4	7	32	1	38	45	117	23	194	11	5	3	3	1	32	
Average	624	3	7	33	1	38	45	117	23	197	10	6	3	3	1	32	
KCG03a	588	4	7	35	1	38	43	121	21	214	9	6	1	3	1	26	
KCG03a	582	3	7	40	1	37	43	124	22	208	8	5	1	2	0	24	
KCG03a	586	4	7	36	2	37	43	123	21	224	10	7	4	3	1	26	
Average	585	4	7	37	1	37	43	123	21	216	9	6	2	3	1	25	
KCG04a	529	2	6	34	1	40	40	117	20	213	12	5	1	2	0	22	
KCG04a	524	4	5	31	1	40	41	116	19	192	8	5	1	2	0	23	
KCG04a	521	3	6	32	1	40	40	117	20	206	8	3	1	3	1	23	
Average	524	3	6	32	1	40	40	117	19	204	9	5	1	2	0	23	

KCG01a	580	3	7	28	1	36	42	115	22	212	6	5	3	2	0	49
KCG01a	591	2	6	28	1	35	42	116	21	207	2	5	1	2	1	48
KCG01a	594	3	5	29	1	35	41	115	22	216	6	6	1	2	1	47
Average	588	3	6	28	1	35	41	115	21	212	5	5	1	2	0	48
KCG02a	552	3	6	29	1	31	42	105	21	226	8	5	2	2	1	33
KCG02a	545	3	5	30	1	32	42	105	22	226	10	7	1	3	1	33
KCG02a	553	5	6	30	1	32	42	106	22	216	8	8	1	2	1	32
Average	550	4	6	29	1	31	42	105	21	222	9	6	1	2	1	33
KCG03a	582	2	6	35	1	36	41	119	20	206	10	4	2	2	0	30
KCG03a	585	2	7	34	1	36	41	119	20	204	8	6	1	1	0	32
KCG03a	588	2	7	35	1	37	41	119	20	195	6	7	1	2	0	30
Average	585	2	6	35	1	36	41	119	20	201	8	6	1	2	0	30
KCG04a	491	5	5	32	1	38	39	113	20	174	8	4	1	2	0	20
KCG04a	488	4	5	27	2	38	39	112	20	168	9	5	2	2	1	20
KCG04a	495	3	5	32	1	38	39	113	19	173	7	5	1	2	0	20
Average	491	4	5	30	1	38	39	113	19	172	8	5	1	2	1	20
KCG01b	509	2	6	26	1	36	37	108	19	200	10	9	1	6	1	67
KCG01b	504	3	6	29	1	36	36	108	19	200	11	9	1	2	1	68
KCG01b	503	3	4	29	1	36	37	108	19	196	9	8	4	3	1	68
Average	505	3	5	28	1	36	37	108	19	199	10	8	2	4	1	68
KCG02b	523	2	4	36	1	40	37	121	20	166	8	5	1	3	1	48
KCG02b	520	3	6	32	1	41	37	122	20	168	2	6	1	2	1	48
KCG02b	525	3	5	34	1	39	37	121	20	167	8	7	1	2	1	49
Average	522	2	5	34	1	40	37	121	20	167	6	6	1	3	1	49
KCG03b	462	4	5	31	1	37	38	110	20	201	9	7	1	3	1	33
KCG03b	461	3	5	28	1	37	39	110	20	212	9	4	3	2	1	33
KCG03b	460	4	5	28	1	36	39	111	19	205	8	5	2	2	0	31
Average	461	3	5	29	1	37	39	110	20	206	9	6	2	2	0	32
KCG04b	542	2	5	27	2	39	39	112	19	206	7	5	3	2	0	25
KCG04b	542	4	6	28	1	39	40	112	20	206	6	7	1	2	0	26
KCG04b	543	4	5	27	1	39	39	112	20	212	7	6	2	3	0	27
Average	542	3	5	27	1	39	39	112	20	208	7	6	2	2	0	26
KCG01a	590	2	7	31	1	35	42	116	22	207	9	6	1	2	1	44
KCG01a	592	4	7	33	1	35	42	116	22	206	9	4	1	3	1	43
KCG01a	586	3	6	31	1	35	42	116	21	214	9	8	1	2	1	45
Average	589	3	7	32	1	35	42	116	22	209	9	6	1	2	1	44
KCG02a	551	4	5	31	1	33	42	106	21	225	8	10	3	3	1	33
KCG02a	559	3	6	29	1	33	42	106	21	211	9	5	1	2	1	34
KCG02a	558	4	6	29	1	32	42	106	22	225	12	7	1	3	1	35

Average	556	3	6	30	1	33	42	106	21	221	10	7	1	3	1	34
KCG03a	580	3	6	33	1	36	40	119	20	198	9	8	3	2	0	31
KCG03a	583	4	6	32	1	35	41	120	21	204	5	7	1	3	1	30
KCG03a	594	4	5	34	1	36	42	121	20	209	12	6	3	3	1	30
Average	586	3	6	33	1	36	41	120	20	204	8	7	2	3	0	30
KCG04a	499	3	5	33	1	38	39	114	20	175	6	5	2	3	0	21
KCG04a	494	3	5	31	1	39	38	113	20	178	10	5	3	2	0	22
KCG04a	498	3	5	34	1	39	39	114	20	169	8	6	1	3	0	24
Average	497	3	5	33	1	39	39	114	20	174	8	5	2	3	0	22
KCG01b	501	2	4	26	1	36	38	107	20	198	9	6	1	3	1	68
KCG01b	502	4	5	29	1	35	37	108	20	203	12	6	5	4	1	68
KCG01b	502	4	5	30	1	36	37	108	19	195	9	6	1	3	1	71
Average	501	3	5	28	1	36	37	108	20	199	10	6	2	3	1	69
KCG02b	518	3	5	34	1	39	36	121	20	164	10	8	1	3	1	50
KCG02b	520	2	5	32	1	39	36	122	20	171	7	6	1	2	1	48
KCG02b	523	3	5	34	1	39	36	121	20	166	7	6	1	3	1	49
Average	520	3	5	33	1	39	36	121	20	167	8	6	1	2	1	49
KCG03b	460	2	5	31	1	37	39	111	20	211	7	7	1	3	1	32
KCG03b	465	4	5	31	1	37	39	111	19	207	8	5	1	2	1	30
KCG03b	462	4	4	30	1	36	39	110	19	212	2	7	1	2	0	30
Average	462	3	5	31	1	37	39	110	19	210	6	6	1	2	1	31
KCG04b	538	4	5	31	0	39	39	111	20	214	7	4	1	3	0	25
KCG04b	545	4	5	32	1	39	39	113	20	208	7	5	1	3	1	27
KCG04b	542	4	6	31	1	39	40	112	20	211	9	5	1	2	0	27
Average	542	4	5	31	1	39	39	112	20	211	7	5	1	2	0	26
KCG01c	527	2	7	35	1	37	41	116	21	245	9	5	1	2	1	44
KCG01c	521	3	6	33	1	39	42	114	20	245	10	6	1	2	1	42
KCG01c	522	3	5	32	1	37	41	116	21	250	14	9	1	4	1	42
Average	523	3	6	33	1	38	42	115	21	247	11	7	1	3	1	43
KCG02c	480	3	5	28	1	36	39	110	20	240	9	6	1	2	1	49
KCG02c	483	4	4	26	1	36	40	109	19	244	11	4	1	3	1	50
KCG02c	483	3	5	29	1	36	40	109	19	246	13	7	1	4	1	50
Average	482	3	5	28	1	36	39	109	19	243	11	6	1	3	1	49
KCG03c	514	2	6	29	1	35	41	117	21	241	8	4	1	2	1	33
KCG03c	514	4	5	30	1	35	41	117	21	247	9	5	4	3	1	33
KCG03c	504	3	5	30	1	35	41	116	21	254	11	6	4	4	1	33
Average	510	3	5	30	1	35	41	117	21	247	9	5	3	3	1	33
KCG04c	488	3	5	30	1	37	39	114	20	200	10	5	1	2	1	29
KCG04c	484	2	6	30	1	37	40	115	20	204	10	7	1	3	1	30

KCG04c	491	3	5	31	1	38	40	116	20	209	9	7	1	4	1	28
Average	487	2	5	30	1	37	39	115	20	204	10	6	1	3	1	29
KCG01a	550	3	5	29	1	34	41	114	21	242	14	9	1	8	1	41
KCG01a	563	2	6	31	1	35	42	115	22	244	12	9	5	4	1	40
KCG01a	554	1	5	26	1	32	41	115	22	233	12	6	1	3	1	38
Average	556	2	5	29	1	34	42	115	21	240	13	8	2	5	1	40
KCG02a	609	3	6	35	2	35	43	109	21	204	2	6	5	4	1	38
KCG02a	607	6	6	31	1	37	41	109	22	198	10	7	3	3	1	39
KCG02a	612	4	7	36	1	36	43	112	22	205	6	5	1	3	1	39
Average	609	4	6	34	1	36	42	110	22	203	6	6	3	3	1	39
KCG03a	578	4	7	34	1	38	41	119	20	221	8	4	1	3	1	39
KCG03a	570	3	7	37	1	39	40	120	21	223	9	4	1	2	0	38
KCG03a	579	3	7	41	2	40	41	119	21	231	6	4	3	2	0	35
Average	576	3	7	37	1	39	41	119	21	225	7	4	1	2	0	37
KCG04a	534	5	5	30	1	41	38	111	18	199	6	6	1	2	0	23
KCG04a	531	3	4	36	1	40	38	111	19	206	7	4	1	2	0	24
KCG04a	534	3	5	32	1	41	39	113	18	202	5	4	1	2	0	24
Average	533	4	5	32	1	40	38	112	18	202	6	5	1	2	0	24
KCG01b	507	3	5	29	1	37	37	109	20	218	7	6	2	2	0	42
KCG01b	510	2	6	28	1	37	38	110	19	220	6	7	1	2	1	46
KCG01b	505	2	5	31	1	37	38	109	19	228	5	5	1	2	1	44
Average	507	2	5	29	1	37	38	109	19	222	6	6	1	2	1	44
KCG02b	461	3	4	28	1	34	37	108	19	196	6	6	1	2	0	39
KCG02b	455	2	5	29	1	36	36	109	20	193	7	4	3	2	1	41
KCG02b	458	2	5	31	1	35	35	109	19	197	7	5	1	2	1	43
Average	458	2	5	30	1	35	36	109	20	195	7	5	1	2	0	41
KCG03b	470	3	5	28	1	37	38	112	20	201	8	6	1	2	0	34
KCG03b	472	3	5	29	1	37	38	111	20	214	7	3	1	2	1	35
KCG03b	474	3	5	35	1	37	39	112	20	213	3	5	1	2	1	36
Average	472	3	5	31	1	37	38	111	20	209	6	4	1	2	1	35
KCG04b	531	4	6	29	1	38	39	111	19	187	6	6	1	2	0	27
KCG04b	534	4	5	30	1	38	39	112	20	191	4	7	3	2	0	25
KCG04b	529	3	5	29	1	39	39	113	20	193	7	6	3	3	1	27
Average	531	4	6	29	1	39	39	112	20	190	6	6	2	2	0	27
KCG01c	453	4	5	27	1	33	39	105	20	234	10	9	1	3	1	25
KCG01c	467	4	5	29	1	33	39	106	20	230	8	7	1	2	1	25
KCG01c	462	4	5	27	2	33	39	105	20	237	13	7	1	5	1	28
Average	461	4	5	28	1	33	39	105	20	234	10	7	1	3	1	26
KCG02c	500	2	4	29	1	38	39	110	20	203	7	4	2	2	1	38

KCG02c	502	3	5	30	1	40	39	111	20	203	9	4	1	2	2	39
KCG02c	502	4	5	32	1	39	38	111	20	199	2	4	1	3	1	39
Average	501	3	5	30	1	39	39	111	20	201	6	4	1	2	1	38
KCG03c	497	2	6	31	1	34	40	113	20	206	5	4	1	2	0	31
KCG03c	499	2	5	28	1	34	40	113	20	200	2	6	2	2	0	31
KCG03c	499	2	5	26	1	34	40	115	20	213	10	4	1	3	1	33
Average	498	2	5	28	1	34	40	113	20	206	6	5	1	2	0	32
KCG04c	462	2	4	28	1	35	38	110	19	209	8	3	2	2	0	26
KCG04c	460	2	4	31	1	36	38	108	19	214	2	5	1	2	1	26
KCG04c	463	2	5	27	1	36	38	110	20	218	2	6	1	3	1	28
Average	462	2	4	29	1	36	38	109	19	214	4	5	1	2	0	27
KCG01d	484	3	5	30	1	33	41	110	20	228	7	4	1	3	1	26
KCG01d	474	3	6	24	1	33	41	110	21	233	7	3	3	2	0	26
KCG01d	481	4	5	26	1	33	40	112	21	238	10	4	1	3	1	27
Average	480	3	5	26	1	33	41	110	20	233	8	4	1	2	1	27
KCG02d	476	3	4	29	1	39	40	117	19	215	8	6	3	2	0	24
KCG02d	481	4	5	33	1	39	39	117	19	214	8	3	1	2	0	24
KCG02d	484	2	5	32	1	40	39	118	20	203	8	4	1	2	0	24
Average	480	3	5	31	1	40	39	117	19	211	8	4	1	2	0	24
KCG03d	499	4	5	30	1	31	42	111	21	252	10	6	1	3	0	26
KCG03d	496	3	6	33	1	30	43	109	21	254	6	5	1	2	1	27
KCG03d	497	3	6	30	1	31	42	110	21	273	10	7	1	3	1	27
Average	497	3	6	31	1	31	42	110	21	259	8	6	1	2	1	27
KCG04d	505	3	6	27	0	35	40	109	20	275	2	6	1	3	0	30
KCG04d	495	3	5	25	1	36	40	107	21	274	8	5	3	3	1	28
KCG04d	498	2	5	26	1	35	40	109	22	284	8	6	4	3	1	31
Average	499	3	5	26	1	35	40	108	21	277	6	6	3	3	0	29
KCG01a	609	3	8	34	1	36	40	112	21	255	12	4	3	2	1	59
KCG01a	606	4	6	37	1	35	40	112	20	250	8	7	1	3	1	58
KCG01a	606	5	6	33	1	36	41	112	20	258	9	7	1	3	1	63
Average	607	4	7	34	1	36	40	112	20	254	9	6	1	3	1	60
KCG02a	571	3	7	32	1	32	41	104	21	243	9	6	1	2	0	46
KCG02a	565	4	5	33	1	31	41	104	21	261	9	6	1	3	1	46
KCG02a	562	4	6	34	1	32	41	106	20	255	11	7	1	4	2	45
Average	566	3	6	33	1	32	41	105	21	253	10	6	1	3	1	46
KCG03a	543	2	6	34	1	34	40	116	20	260	18	9	1	5	1	34
KCG03a	545	4	6	38	2	34	40	117	21	236	9	5	4	3	1	31
KCG03a	548	4	6	35	2	34	40	118	21	222	10	6	1	2	1	29
Average	545	3	6	36	1	34	40	117	21	239	12	7	2	3	1	31

KCG04a	539	5	6	38	2	43	37	112	19	212	9	5	1	3	1	24
KCG04a	542	4	6	38	1	43	38	113	18	216	10	5	4	3	1	25
KCG04a	546	6	6	36	1	42	38	114	19	221	7	3	4	2	1	23
Average	542	5	6	37	1	42	38	113	18	216	9	4	3	3	1	24
KCG01b	547	2	5	33	1	42	37	112	20	160	7	7	1	3	1	38
KCG01b	539	2	6	36	1	42	38	112	19	163	10	7	1	3	1	37
KCG01b	550	2	6	33	1	42	39	114	19	159	8	6	1	2	0	37
Average	545	2	6	34	1	42	38	113	19	161	9	7	1	3	0	37
KCG02b	499	3	5	36	1	36	36	110	18	170	6	7	1	3	1	37
KCG02b	505	2	6	34	1	38	36	111	18	188	10	6	4	3	2	41
KCG02b	504	3	5	33	1	38	36	110	18	175	2	6	1	2	1	38
Average	503	3	5	34	1	37	36	110	18	178	6	6	2	3	1	39
KCG03b	432	2	5	27	1	35	37	107	20	238	9	8	1	3	1	32
KCG03b	428	2	4	28	1	34	37	106	20	256	11	8	4	4	1	35
KCG03b	431	4	5	29	1	35	37	107	20	268	13	5	1	3	1	34
Average	430	3	5	28	1	35	37	107	20	254	11	7	2	3	1	34
KCG04b	527	4	5	31	1	38	37	105	19	231	10	6	1	3	1	47
KCG04b	534	4	6	33	1	37	38	107	18	231	11	4	1	3	1	42
KCG04b	538	4	6	33	2	37	38	106	18	234	12	8	1	3	1	47
Average	533	4	6	33	1	37	38	106	19	232	11	6	1	3	1	45
KCG01c	516	4	7	39	1	36	39	107	19	243	12	7	4	3	1	24
KCG01c	521	4	6	35	1	36	39	107	19	230	12	7	1	4	2	24
KCG01c	518	4	7	36	1	37	38	107	19	255	11	7	1	4	1	27
Average	518	4	6	37	1	36	39	107	19	243	11	7	2	3	1	25
KCG02c	489	4	5	33	1	36	37	107	18	209	9	8	1	3	1	47
KCG02c	497	5	6	33	1	37	37	107	19	216	11	9	1	3	2	56
KCG02c	499	3	6	35	1	36	37	107	19	217	10	5	1	3	1	58
Average	495	4	5	33	1	36	37	107	19	214	10	7	1	3	1	54
KCG03c	531	3	6	33	1	36	40	112	20	216	6	6	4	3	1	28
KCG03c	539	4	5	37	2	37	40	115	20	219	11	6	4	4	1	29
KCG03c	534	4	6	36	2	37	39	114	19	223	10	7	4	4	1	31
Average	534	4	6	35	2	37	40	114	20	219	9	6	4	4	1	29
KCG04c	476	2	5	32	1	35	37	105	19	215	11	6	1	3	1	34
KCG04c	473	4	5	29	1	37	38	106	19	228	9	9	1	4	1	34
KCG04c	471	4	5	32	1	36	37	107	18	220	12	8	1	4	1	36
Average	473	3	5	31	1	36	37	106	19	221	11	8	1	4	1	35
KCG01d	563	4	6	40	1	40	39	110	19	222	10	6	1	3	1	23
KCG01d	563	3	6	40	2	40	38	110	19	211	11	6	1	4	1	26
KCG01d	562	5	7	38	1	42	38	112	20	211	10	7	4	2	1	25

Average	563	4	6	39	1	41	38	111	19	215	11	6	2	3	1	24
KCG02d	513	4	6	41	1	41	38	111	18	204	8	9	4	3	1	33
KCG02d	520	4	5	41	1	41	38	115	18	199	10	9	1	3	1	32
KCG02d	512	4	5	38	1	42	38	113	18	202	11	6	5	3	1	35
Average	515	4	5	40	1	42	38	113	18	202	10	8	3	3	1	33
KCG03d	500	3	7	31	1	32	41	108	20	219	11	6	1	4	1	24
KCG03d	504	5	7	34	1	32	40	108	20	229	11	5	4	3	1	25
KCG03d	507	4	7	35	1	33	41	109	20	226	11	6	5	3	1	26
Average	504	4	7	33	1	32	41	108	20	225	11	5	3	3	1	25
KCG04d	506	4	5	33	1	33	38	102	19	277	11	4	1	3	1	26
KCG04d	497	4	6	33	1	33	38	103	19	254	9	8	1	3	1	26
KCG04d	503	6	5	36	1	35	38	103	19	269	13	5	1	4	1	26
Average	502	5	5	34	1	34	38	102	19	267	11	6	1	3	1	26
KCG01e	468	4	5	30	1	32	41	109	20	235	10	6	1	2	1	19
KCG01e	468	4	6	32	1	32	42	109	20	237	8	6	1	2	0	18
KCG01e	467	5	5	30	1	34	40	108	21	243	9	4	3	3	1	20
Average	467	4	5	31	1	33	41	109	20	238	9	5	1	2	0	19
KCG02e	476	2	5	37	1	39	39	111	19	173	8	4	1	1	0	21
KCG02e	476	3	5	33	1	38	38	111	19	175	6	5	1	3	0	21
KCG02e	478	3	5	28	1	39	38	112	19	181	6	7	1	2	1	21
Average	476	3	5	33	1	39	38	111	19	176	7	5	1	2	1	21
KCG03e	544	2	7	32	1	32	42	108	21	251	6	4	1	2	1	24
KCG03e	548	2	7	29	1	31	41	108	22	245	8	4	3	3	1	25
KCG03e	541	3	6	32	1	32	42	107	22	245	11	5	1	3	0	25
Average	544	2	6	31	1	32	42	108	22	247	8	4	1	3	0	25
KCG04e	539	3	6	31	1	32	43	108	22	266	6	5	2	2	0	28
KCG04e	534	3	7	34	1	32	42	108	21	278	6	7	1	2	1	30
KCG04e	536	4	6	33	0	31	42	108	22	276	9	6	1	2	1	29
Average	536	3	6	32	1	32	42	108	22	273	7	6	1	2	0	29
KCG01a	618	3	7	29	1	38	40	116	20	199	7	6	3	2	1	48
KCG01a	619	3	7	32	1	38	39	116	20	211	8	3	1	2	1	48
KCG01a	624	3	7	34	1	37	41	116	20	215	9	5	1	2	1	50
Average	620	3	7	32	1	37	40	116	20	208	8	4	1	2	1	49
KCG02a	569	4	7	36	1	32	40	104	21	212	8	5	3	2	1	33
KCG02a	575	4	6	38	2	33	40	104	20	213	6	3	1	2	1	33
KCG02a	583	3	6	37	1	33	40	104	21	226	7	5	1	2	2	34
Average	575	4	7	37	1	33	40	104	21	217	7	4	1	2	1	33
KCG03a	580	3	7	38	1	37	41	119	20	202	7	3	3	2	1	28
KCG03a	582	2	7	42	1	37	40	120	20	206	7	4	1	3	0	30

KCG03a	576	6	6	37	1	37	40	120	20	203	7	6	1	2	1	31
Average	579	3	7	39	1	37	40	120	20	204	7	4	1	2	0	30
KCG04a	471	3	4	32	1	35	37	106	18	192	7	5	1	2	0	20
KCG04a	472	5	4	30	1	35	37	107	18	190	7	4	1	2	0	19
KCG04a	474	4	5	27	1	35	37	107	19	205	8	6	1	2	1	20
Average	472	4	4	29	1	35	37	107	18	196	7	5	1	2	1	20
KCG01b	530	2	5	33	1	37	38	107	18	200	4	4	1	2	1	49
KCG01b	531	2	5	31	1	36	37	108	18	202	7	6	1	2	1	50
KCG01b	529	3	5	35	1	37	36	107	19	204	8	5	1	2	1	49
Average	530	2	5	33	1	37	37	108	18	202	6	5	1	2	1	49
KCG02b	495	4	5	31	1	38	35	110	18	184	6	7	1	2	0	39
KCG02b	499	3	5	32	1	39	36	110	18	182	9	7	1	2	1	42
KCG02b	504	4	4	30	1	37	35	109	19	187	2	5	1	2	1	42
Average	499	4	5	31	1	38	35	110	18	184	6	6	1	2	0	41
KCG03b	500	3	6	34	1	39	38	113	19	196	7	7	2	2	0	33
KCG03b	497	3	5	33	1	39	39	113	20	206	6	5	1	2	1	36
KCG03b	501	2	5	35	1	39	38	114	19	191	7	7	3	3	1	34
Average	499	2	5	34	1	39	38	113	20	198	7	6	2	3	0	34
KCG04b	459	4	5	25	1	31	36	98	19	239	7	6	1	1	1	46
KCG04b	460	2	5	29	1	31	37	99	19	244	6	7	4	3	1	47
KCG04b	460	3	5	25	1	31	36	100	19	244	8	6	1	2	1	47
Average	459	3	5	27	1	31	37	99	19	242	7	6	2	2	1	46
KCG01c	485	3	4	31	1	32	39	103	18	266	9	4	3	2	1	41
KCG01c	489	4	5	34	1	33	38	102	18	262	10	7	1	3	1	44
KCG01c	498	4	6	32	1	33	39	103	19	271	11	8	1	3	1	46
Average	491	4	5	32	1	33	38	103	18	267	10	6	1	3	1	44
KCG02c	451	4	6	32	1	34	37	102	18	178	7	4	1	2	0	41
KCG02c	464	2	5	28	1	35	37	104	18	195	9	6	1	4	1	39
KCG02c	463	3	6	31	1	35	37	103	18	196	7	5	3	2	1	40
Average	459	3	6	30	1	34	37	103	18	190	8	5	1	3	0	40
KCG03c	561	4	6	34	1	40	40	118	19	181	6	4	1	2	0	24
KCG03c	570	4	5	35	1	39	40	119	20	199	5	7	1	4	1	26
KCG03c	573	3	6	41	1	40	40	119	19	196	10	5	1	3	0	27
Average	568	4	5	37	1	40	40	119	19	192	7	5	1	3	0	26
KCG04c	473	2	5	34	1	34	36	104	19	208	5	7	1	2	0	27
KCG04c	479	5	4	31	1	34	37	106	19	223	10	6	1	3	1	27
KCG04c	482	5	5	37	1	35	37	106	18	233	3	7	1	4	1	30
Average	478	4	5	34	1	35	37	105	18	221	6	7	1	3	0	28
KCG01d	546	4	6	35	1	39	37	108	18	201	5	5	1	3	0	24

KCG01d	536	5	6	33	1	38	38	109	18	223	11	6	1	3	1	26
KCG01d	545	5	6	35	2	38	37	108	19	215	12	6	1	4	1	25
Average	542	4	6	34	1	38	37	108	19	213	9	6	1	3	1	25
KCG02d	502	3	5	33	1	43	37	111	17	173	9	5	3	3	0	26
KCG02d	511	3	6	37	2	44	36	112	18	179	9	6	1	3	1	28
KCG02d	512	3	6	33	1	44	37	113	18	189	10	6	1	4	1	29
Average	508	3	6	35	1	43	37	112	18	180	9	6	1	3	0	28
KCG03d	566	3	6	35	1	37	41	113	20	223	9	5	4	2	2	42
KCG03d	575	4	7	39	1	37	42	115	20	227	9	6	4	3	1	41
KCG03d	574	3	7	39	1	38	42	115	21	224	9	7	5	3	1	42
Average	572	3	7	38	1	37	41	114	20	225	9	6	4	3	1	42
KCG04d	529	2	5	32	1	39	37	107	18	208	6	6	1	2	0	23
KCG04d	524	5	6	37	1	38	37	108	18	215	10	7	1	4	2	23
KCG04d	531	4	6	35	1	39	37	108	19	214	12	7	1	4	2	23
Average	528	4	6	35	1	39	37	107	18	213	9	7	1	3	1	23
KCG01e	498	4	6	30	1	35	40	108	18	257	10	5	1	3	1	25
KCG01e	493	4	6	33	2	35	40	109	19	275	21	12	1	7	1	28
KCG01e	496	3	6	32	1	35	39	108	19	265	11	4	3	3	1	26
Average	496	4	6	32	1	35	39	108	19	266	14	7	1	4	1	26
KCG02e	499	4	5	29	1	40	36	108	18	240	10	5	1	2	1	25
KCG02e	502	2	6	32	1	39	37	111	19	243	9	8	1	4	1	29
KCG02e	505	4	5	30	1	40	37	110	18	240	10	3	1	3	0	27
Average	502	3	6	30	1	40	37	110	18	241	9	5	1	3	1	27
KCG03e	570	3	7	33	1	33	42	108	21	247	8	5	1	2	1	25
KCG03e	580	3	6	29	2	33	42	111	20	239	10	6	1	5	1	24
KCG03e	579	3	7	34	1	33	41	110	22	245	11	5	1	3	1	25
Average	576	3	7	32	1	33	42	110	21	244	10	5	1	3	1	25
KCG04e	559	5	6	35	1	32	41	106	21	244	13	4	4	3	1	25
KCG04e	557	5	7	31	1	33	41	107	22	246	11	5	1	5	2	27
KCG04e	557	4	6	35	1	33	41	108	20	246	9	5	1	3	1	27
Average	558	5	6	34	1	33	41	107	21	245	11	5	2	3	1	26
KCG01f	468	3	5	28	1	35	39	109	20	224	10	5	1	4	1	23
KCG01f	471	4	4	29	1	34	40	109	20	227	9	2	1	4	1	23
KCG01f	472	4	5	30	1	34	39	108	20	220	10	7	1	4	1	23
Average	470	3	5	29	1	34	39	109	20	224	9	4	1	4	1	23
KCG02f	500	3	6	32	1	40	39	116	20	197	9	8	1	3	1	29
KCG02f	497	2	5	31	1	39	40	118	20	212	11	4	5	3	1	30
KCG02f	499	2	5	31	1	40	40	118	20	196	10	7	1	3	1	31
Average	498	3	6	31	1	40	39	117	20	202	10	6	2	3	1	30

KCG03f	507	3	7	35	1	27	44	107	23	275	13	7	5	4	1	27
KCG03f	521	4	6	30	1	29	45	107	23	278	12	8	1	4	1	29
KCG03f	512	4	6	31	1	28	44	107	23	274	13	3	1	4	1	29
Average	513	4	6	32	1	28	44	107	23	276	13	6	2	4	1	28
KCG04f	487	3	6	29	1	30	41	105	22	280	11	7	1	4	1	28
KCG04f	488	3	5	30	1	30	42	106	20	300	10	6	1	4	1	28
KCG04f	490	2	6	29	1	31	40	106	21	302	13	7	1	5	1	30
Average	488	3	6	30	1	30	41	105	21	294	11	7	1	4	1	29
KCG01a	621	3	6	37	2	37	41	117	21	198	8	3	1	2	1	56
KCG01a	623	4	7	31	1	39	42	117	21	194	8	6	1	2	1	49
KCG01a	629	3	6	35	1	37	42	116	20	210	7	5	1	2	1	49
Average	624	3	6	34	1	38	41	116	21	200	8	5	1	2	1	52
KCG02a	574	3	5	37	1	32	40	106	22	232	2	3	1	4	1	35
KCG02a	585	5	6	31	1	34	41	106	20	213	7	8	1	2	1	35
KCG02a	585	5	7	39	1	34	42	107	20	219	8	5	1	2	1	38
Average	581	5	6	36	1	33	41	106	21	221	5	5	1	3	1	36
KCG03a	581	3	6	35	1	38	41	119	21	211	6	4	1	3	0	29
KCG03a	586	3	6	37	1	39	40	121	20	214	9	4	3	3	1	30
KCG03a	588	3	6	35	1	37	41	121	19	211	8	5	1	3	1	30
Average	585	3	6	36	1	38	41	120	20	212	8	5	1	3	0	30
KCG04a	475	3	5	27	1	36	37	109	19	197	6	4	1	2	1	24
KCG04a	478	4	5	26	1	37	37	108	19	191	7	2	1	2	0	24
KCG04a	476	3	6	28	1	37	37	108	19	196	7	6	1	2	0	24
Average	476	3	5	27	1	36	37	109	19	195	7	4	1	2	0	24
KCG01b	535	3	6	29	1	37	37	107	19	194	7	3	1	3	1	48
KCG01b	533	2	6	33	2	37	37	107	18	205	10	5	4	2	1	48
KCG01b	530	4	5	33	1	38	38	109	19	189	7	5	1	2	1	49
Average	533	3	6	32	1	37	37	108	18	196	8	4	2	3	1	49
KCG02b	508	3	5	36	1	38	36	112	18	198	6	4	1	2	1	37
KCG02b	509	3	5	31	1	37	36	112	19	194	8	3	1	3	1	37
KCG02b	503	3	5	32	1	38	36	112	18	200	8	4	1	3	1	39
Average	506	3	5	33	1	38	36	112	18	197	7	3	1	3	1	38
KCG03b	502	4	5	34	1	41	38	112	19	199	6	2	4	3	1	33
KCG03b	506	2	5	37	1	39	38	114	19	208	9	5	1	3	1	35
KCG03b	497	3	6	33	1	39	38	112	20	210	8	4	4	3	1	35
Average	502	3	5	35	1	40	38	113	19	206	8	4	3	3	1	34
KCG04b	477	4	5	23	1	33	38	98	18	240	9	2	1	3	1	60
KCG04b	475	3	4	24	1	31	37	101	18	222	9	5	1	3	1	50
KCG04b	472	5	5	26	1	33	38	100	19	228	10	5	1	3	1	49

Average	475	4	5	25	1	32	37	99	19	230	9	4	1	3	1	53
KCG01c	487	5	5	31	1	32	39	102	18	297	9	6	1	4	1	55
KCG01c	488	2	6	34	1	32	39	101	18	288	12	5	3	2	1	55
KCG01c	491	3	6	33	1	33	39	103	18	279	13	6	1	3	1	55
Average	489	3	6	33	1	32	39	102	18	288	11	6	2	3	1	55
KCG02c	457	2	5	31	1	34	37	104	18	196	9	6	1	4	1	41
KCG02c	468	3	5	33	1	35	38	104	19	200	8	6	1	2	1	44
KCG02c	470	5	5	30	1	34	37	104	18	193	7	7	1	2	1	43
Average	465	3	5	31	1	34	37	104	18	196	8	6	1	3	1	43
KCG03c	562	4	5	34	1	40	40	118	20	186	10	3	1	4	1	27
KCG03c	572	2	7	33	1	40	40	120	20	182	7	7	1	3	1	26
KCG03c	570	3	6	34	2	41	40	118	20	186	5	4	1	3	1	26
Average	568	3	6	33	1	41	40	119	20	185	8	5	1	3	1	26
KCG04c	476	6	5	35	1	33	37	105	18	284	9	6	1	4	2	35
KCG04c	476	4	5	35	1	33	36	105	18	295	10	3	1	4	1	33
KCG04c	474	6	5	35	1	34	36	105	18	303	14	5	1	4	1	36
Average	476	5	5	35	1	33	36	105	18	294	11	5	1	4	1	35
KCG01d	539	3	6	35	1	38	38	109	19	203	11	8	1	4	1	23
KCG01d	543	3	6	33	2	38	38	109	18	210	12	7	1	4	1	23
KCG01d	545	4	6	42	1	37	38	110	19	208	12	7	1	4	1	22
Average	542	3	6	36	1	38	38	109	19	207	12	7	1	4	1	23
KCG02d	515	4	6	37	1	45	37	114	18	181	2	2	1	3	2	26
KCG02d	522	3	6	34	1	44	37	114	17	194	9	7	1	4	1	25
KCG02d	515	3	4	36	1	44	37	115	19	190	10	6	1	3	1	26
Average	517	3	5	36	1	44	37	114	18	188	7	5	1	3	1	26
KCG03d	574	2	7	38	2	38	41	115	20	224	11	6	1	3	1	43
KCG03d	576	4	7	39	1	38	42	117	20	234	9	5	1	4	1	45
KCG03d	581	4	6	41	1	39	41	116	20	236	12	8	1	5	1	44
Average	577	3	6	39	1	38	41	116	20	231	11	6	1	4	1	44
KCG04d	525	3	6	34	1	38	37	107	18	215	8	4	1	3	1	25
KCG04d	531	4	5	31	1	38	37	109	18	219	9	7	5	4	1	23
KCG04d	525	4	6	35	1	39	37	108	19	209	14	7	1	4	1	26
Average	527	4	6	33	1	38	37	108	18	215	10	6	2	4	1	24
KCG01e	500	6	6	34	1	35	40	109	19	317	21	6	1	7	1	26
KCG01e	501	5	5	33	1	35	41	109	20	278	10	5	1	3	1	22
KCG01e	501	4	5	29	1	34	39	108	20	283	8	4	1	4	1	21
Average	501	5	5	32	1	34	40	109	19	293	13	5	1	5	1	23
KCG02e	492	4	6	36	2	38	37	109	19	215	13	8	1	5	1	28
KCG02e	502	3	5	31	1	39	37	110	18	193	6	5	1	3	1	26

KCG02e	500	2	5	31	1	38	37	109	18	191	7	4	1	2	0	26
Average	498	3	5	33	1	38	37	109	18	200	9	6	1	4	0	26
KCG03e	565	4	6	36	1	34	41	109	22	258	12	6	1	5	1	28
KCG03e	573	2	7	35	1	34	41	110	21	243	11	9	1	3	1	27
KCG03e	578	3	7	31	1	34	42	109	21	236	8	4	3	2	0	26
Average	572	3	7	34	1	34	41	109	21	246	10	6	1	3	0	27
KCG04e	576	4	7	31	1	34	41	109	21	252	11	7	1	4	1	29
KCG04e	572	4	6	33	1	35	41	108	21	229	5	8	1	2	0	28
KCG04e	579	5	7	36	1	34	41	108	21	244	9	6	3	3	1	29
Average	575	4	7	33	1	34	41	108	21	242	8	7	1	3	1	29
KCG01f	457	3	5	31	1	33	39	107	20	268	3	4	1	4	1	43
KCG01f	465	2	5	30	1	33	39	108	19	258	9	3	1	3	1	39
KCG01f	459	2	5	30	1	34	38	108	20	266	7	5	1	3	1	39
Average	460	2	5	30	1	33	39	107	20	264	6	4	1	3	1	41
KCG02f	487	3	5	32	1	41	39	114	19	211	8	4	1	4	1	27
KCG02f	486	3	5	31	1	40	39	115	20	199	8	5	1	3	1	26
KCG02f	495	3	6	30	1	40	39	116	19	211	10	4	1	3	1	27
Average	489	3	5	31	1	40	39	115	19	207	8	4	1	3	1	27
KCG03f	505	4	6	30	1	28	45	107	23	310	14	4	1	4	1	30
KCG03f	509	2	6	31	1	28	44	106	22	277	10	5	1	4	1	28
KCG03f	511	2	5	30	1	28	44	105	22	288	8	5	1	4	2	29
Average	508	3	6	30	1	28	44	106	22	291	11	5	1	4	1	29
KCG04f	476	5	5	28	1	30	40	104	21	296	11	5	1	5	1	28
KCG04f	481	4	6	27	1	30	40	104	21	280	10	3	1	3	1	29
KCG04f	482	4	5	27	1	30	41	105	22	279	10	4	1	4	2	29
Average	480	4	5	27	1	30	40	104	21	285	10	4	1	4	1	29
KCG01g	596	1	7	34	2	40	38	125	20	188	10	2	1	4	1	27
KCG01g	606	1	5	33	2	41	38	126	19	168	6	5	3	3	1	26
KCG01g	600	2	6	29	1	39	38	123	19	170	2	6	1	3	0	25
Average	600	1	6	32	1	40	38	124	19	175	6	4	1	3	0	26
KCG02g	608	4	6	38	2	51	38	126	19	170	10	4	1	3	1	15
KCG02g	612	2	6	37	2	51	39	126	19	171	8	2	1	3	1	15
KCG02g	610	4	5	38	1	51	39	126	19	172	2	4	1	4	1	15
Average	610	3	6	38	1	51	39	126	19	171	7	3	1	3	1	15
KCG03g	593	4	8	35	2	32	42	111	23	269	13	9	1	6	1	26
KCG03g	589	2	7	33	1	33	42	111	23	257	11	5	1	3	1	25
KCG03g	590	3	7	34	1	33	44	111	22	253	9	9	4	4	1	24
Average	591	3	7	34	1	32	43	111	23	260	11	8	2	4	1	25
KCG04g	640	1	8	33	1	33	47	118	25	251	14	11	1	4	1	22

KCG04g	645	1	8	34	1	33	47	117	24	245	16	7	1	4	1	21
KCG04g	641	1	8	38	1	33	46	117	23	237	10	5	3	3	1	21
Average	642	1	8	35	1	33	47	117	24	244	13	8	2	4	1	21
	Sb	Te	I	Cs	Ba	La	Ce	Hf	Ta	W	Hg	Tl	Pb	Bi	Th	U
KCG01a	5	1	2	2	344	11	13	15	6	4	1	1	857	1	8	6
KCG01a	4	1	3	2	346	12	12	20	6	4	1	1	861	1	8	12
KCG01a	4	1	3	2	345	7	11	22	6	4	1	1	862	1	8	10
Average	5	1	3	2	345	10	12	19	6	4	1	1	860	1	8	9
KCG02a	5	1	1	2	361	11	13	23	6	3	1	1	819	1	10	11
KCG02a	5	1	2	2	352	11	20	14	6	4	1	1	824	1	11	13
KCG02a	5	1	3	2	350	12	6	17	6	3	1	1	821	1	10	11
Average	5	1	2	2	354	11	13	18	6	3	1	1	821	1	10	12
KCG03a	4	1	1	2	448	10	15	21	6	3	1	1	767	1	9	11
KCG03a	4	1	1	2	439	12	9	22	6	3	1	1	767	1	9	12
KCG03a	4	1	2	2	436	4	12	14	6	3	1	1	769	2	7	16
Average	4	1	1	2	441	9	12	19	6	3	1	1	768	1	9	13
KCG04a	5	1	3	2	343	14	16	23	6	3	1	1	691	1	8	5
KCG04a	6	1	2	2	325	11	13	19	6	3	1	1	692	1	7	11
KCG04a	5	1	3	2	338	10	13	20	6	3	1	1	692	2	5	17
Average	5	1	3	2	336	12	14	21	6	3	1	1	692	1	7	11
KCG01a	4	1	4	2	351	8	15	17	6	4	1	1	784	1	8	5
KCG01a	4	1	2	2	354	12	14	17	6	4	1	1	786	1	8	5
KCG01a	3	0	2	2	358	14	20	13	6	4	1	1	791	1	7	5
Average	4	1	3	2	354	11	16	16	6	4	1	1	787	1	7	5
KCG02a	5	1	2	2	366	12	25	16	6	3	0	1	733	1	10	5
KCG02a	5	1	4	2	359	10	17	12	6	4	2	1	733	1	9	4
KCG02a	5	1	4	2	360	10	16	15	6	3	1	1	737	1	9	5
Average	5	1	3	2	362	10	19	14	6	3	1	1	734	1	10	5
KCG03a	5	1	2	2	384	13	13	18	6	4	1	1	724	1	8	5
KCG03a	5	1	1	2	383	9	16	21	6	4	1	1	727	1	6	4
KCG03a	4	1	3	2	383	10	19	20	6	4	1	1	726	1	6	4
Average	5	1	2	2	383	11	16	20	6	4	1	1	726	1	7	4
KCG04a	4	1	2	2	314	11	15	12	6	3	1	1	630	0	8	4
KCG04a	5	1	1	2	322	13	12	14	6	4	1	1	637	1	6	4
KCG04a	5	1	3	2	317	12	13	16	6	3	1	1	641	1	7	5
Average	4	1	2	2	317	12	14	14	6	3	1	1	636	1	7	4
KCG01b	5	1	3	2	326	5	11	17	6	3	1	1	691	1	7	14
KCG01b	4	1	4	2	346	12	16	17	6	3	1	1	682	1	10	18
KCG01b	4	1	2	2	340	16	17	19	6	3	1	1	684	1	9	12

Average	5	1	3	2	337	11	15	18	6	3	1	1	685	1	8	15
KCG02b	5	1	4	2	315	4	13	15	6	3	1	1	679	1	8	8
KCG02b	4	1	3	2	323	4	14	16	6	3	1	1	687	1	7	4
KCG02b	4	1	4	2	321	4	16	18	6	3	1	1	676	1	7	6
Average	4	1	4	2	320	4	14	17	6	3	1	1	681	1	7	6
KCG03b	5	1	1	2	342	6	11	15	7	3	1	1	620	2	5	5
KCG03b	5	1	2	2	356	7	14	19	7	3	1	1	624	1	6	8
KCG03b	4	1	4	2	345	9	14	22	7	3	1	1	615	1	8	5
Average	5	1	2	2	347	7	13	18	7	3	1	1	620	1	6	6
KCG04b	5	1	1	2	339	11	12	13	6	4	1	1	650	1	5	4
KCG04b	5	1	3	2	340	8	14	15	6	3	1	1	652	1	6	7
KCG04b	4	1	2	2	350	7	13	15	6	3	1	1	654	1	7	4
Average	5	1	2	2	343	9	13	15	6	3	1	1	652	1	6	5
KCG01a	4	1	2	2	353	12	17	18	6	4	1	1	784	1	8	4
KCG01a	4	1	3	2	357	6	17	19	6	4	1	1	784	1	8	4
KCG01a	4	1	2	2	359	7	15	16	6	4	1	1	789	1	8	4
Average	4	1	2	2	357	8	16	17	6	4	1	1	786	1	8	4
KCG02a	5	1	2	2	362	11	21	14	6	3	0	1	737	1	9	5
KCG02a	4	1	1	2	361	11	19	17	6	3	1	1	744	1	8	5
KCG02a	4	1	2	2	366	9	22	23	6	4	1	1	740	1	8	5
Average	4	1	1	2	363	10	21	18	6	3	1	1	740	1	8	5
KCG03a	4	1	2	2	387	5	18	17	6	3	1	1	734	1	7	4
KCG03a	3	1	2	2	385	8	11	17	6	4	1	1	734	1	7	4
KCG03a	5	1	3	2	390	10	15	18	6	4	1	1	728	1	9	5
Average	4	1	2	2	387	7	15	17	6	4	1	1	732	1	8	4
KCG04a	4	1	3	2	325	6	12	15	6	3	1	1	638	1	7	4
KCG04a	4	1	2	2	339	10	11	18	6	3	1	1	635	1	5	5
KCG04a	5	1	4	2	328	10	12	15	6	3	1	1	640	1	8	8
Average	4	1	3	2	331	8	12	16	6	3	1	1	638	1	7	5
KCG01b	4	1	2	2	339	5	6	13	6	4	1	1	679	1	8	9
KCG01b	5	1	3	2	340	10	19	12	6	3	1	1	683	2	7	24
KCG01b	5	0	3	2	341	8	18	11	6	3	1	1	682	1	7	16
Average	4	1	2	2	340	7	14	12	6	4	1	1	681	1	7	16
KCG02b	4	1	2	2	322	5	6	18	6	3	1	1	675	1	7	4
KCG02b	5	1	3	2	324	10	11	18	6	3	1	1	683	1	6	7
KCG02b	5	1	5	2	319	10	12	16	6	3	1	1	686	1	6	4
Average	5	1	3	2	322	8	10	17	6	3	1	1	681	1	6	5
KCG03b	5	1	3	2	351	5	11	18	7	3	1	1	619	1	7	5
KCG03b	4	1	3	2	353	11	15	19	7	3	1	1	627	1	7	4

KCG03b	5	1	3	2	357	11	18	17	7	3	1	1	623	1	6	5
Average	5	1	3	2	354	9	15	18	7	3	1	1	623	1	7	4
KCG04b	6	1	3	2	355	13	18	16	6	3	1	1	642	1	7	4
KCG04b	5	1	5	2	349	12	6	17	6	3	0	1	654	1	7	4
KCG04b	6	1	6	2	351	9	15	14	6	3	0	1	655	1	5	5
Average	6	1	4	2	352	11	13	15	6	3	0	1	650	1	6	5
KCG01c	6	1	2	2	387	14	11	19	7	3	1	1	714	1	8	10
KCG01c	5	1	5	2	388	10	25	16	6	3	1	1	712	1	8	8
KCG01c	6	1	2	2	382	14	15	23	6	3	1	1	718	1	8	13
Average	6	1	3	2	386	12	17	19	6	3	1	1	715	1	8	10
KCG02c	6	1	2	3	375	7	16	14	6	3	1	1	618	1	7	9
KCG02c	6	1	5	2	372	12	18	17	6	3	1	1	614	1	5	11
KCG02c	6	1	4	3	371	8	17	16	6	3	1	1	615	1	7	12
Average	6	1	4	2	373	9	17	16	6	3	1	1	616	1	6	11
KCG03c	5	1	1	2	371	11	14	19	6	3	1	1	818	1	8	9
KCG03c	5	1	2	2	375	9	18	16	6	3	1	1	816	1	8	11
KCG03c	5	1	3	2	380	10	21	17	6	3	1	1	825	1	11	11
Average	5	1	2	2	375	10	18	17	6	3	1	1	820	1	9	10
KCG04c	5	1	2	2	351	11	15	19	7	3	1	1	661	1	7	10
KCG04c	5	1	3	2	355	12	15	19	7	4	1	1	672	1	6	6
KCG04c	5	1	2	2	357	13	18	17	7	3	1	1	667	2	6	8
Average	5	1	2	2	354	12	16	18	7	4	1	1	667	1	7	8
KCG01a	5	1	3	2	357	10	15	20	6	3	1	1	769	0	8	9
KCG01a	5	1	3	2	360	12	14	20	6	3	1	1	780	1	8	8
KCG01a	4	1	5	2	341	11	16	20	6	4	1	1	779	1	8	13
Average	5	1	3	2	352	11	15	20	6	3	1	1	776	1	8	10
KCG02a	5	1	3	2	343	12	18	13	6	4	1	1	778	1	8	5
KCG02a	5	1	2	2	352	13	12	14	6	4	1	1	781	1	8	4
KCG02a	5	1	2	2	341	10	13	15	6	4	1	1	785	1	8	5
Average	5	1	3	2	345	12	14	14	6	4	1	1	781	1	8	5
KCG03a	5	1	3	2	409	7	16	18	6	4	1	1	741	1	7	8
KCG03a	4	1	4	2	418	11	16	12	6	4	1	1	738	1	6	4
KCG03a	4	1	3	2	424	8	19	16	6	4	1	1	742	1	7	4
Average	5	1	3	2	417	8	17	16	6	4	1	1	740	1	7	5
KCG04a	5	1	1	2	336	10	10	13	6	3	1	1	642	1	4	4
KCG04a	5	1	1	2	348	11	10	15	6	3	1	1	639	1	6	4
KCG04a	4	1	2	2	338	8	12	14	6	3	1	1	643	1	6	4
Average	5	1	2	2	340	10	10	14	6	3	1	1	641	1	5	4
KCG01b	5	1	2	2	306	10	16	13	6	3	1	1	691	1	6	4

KCG01b	4	1	2	2	313	8	12	13	6	3	1	1	696	1	7	5
KCG01b	4	1	2	2	309	5	14	14	6	3	1	1	691	1	8	4
Average	4	1	2	2	309	8	14	13	6	3	1	1	693	1	7	4
KCG02b	4	0	2	2	307	13	11	19	6	3	1	1	607	1	7	5
KCG02b	4	1	3	2	309	9	9	13	6	3	1	1	611	1	6	5
KCG02b	5	1	1	2	313	7	11	14	6	3	1	1	605	1	7	4
Average	4	1	2	2	310	10	10	15	6	3	1	1	608	1	7	4
KCG03b	4	1	3	2	333	11	12	18	7	3	1	1	640	1	7	3
KCG03b	5	1	2	2	343	13	16	17	7	3	1	1	636	1	8	8
KCG03b	4	0	3	2	340	9	15	24	7	3	1	1	631	1	8	5
Average	4	1	3	2	339	11	15	20	7	3	1	1	636	1	8	5
KCG04b	5	1	4	2	349	10	14	16	6	3	1	1	657	1	8	4
KCG04b	5	1	5	2	353	10	10	17	6	3	1	1	659	2	5	4
KCG04b	5	1	2	2	364	10	10	15	6	3	1	1	661	1	8	5
Average	5	1	4	2	355	10	12	16	6	3	1	1	659	1	7	4
KCG01c	4	1	3	2	358	10	21	15	6	3	1	1	618	1	7	7
KCG01c	4	1	4	2	352	12	15	16	6	3	1	1	628	1	8	13
KCG01c	5	1	4	2	352	9	17	16	6	3	1	1	626	2	7	35
Average	5	1	4	2	354	10	18	16	6	3	1	1	624	1	7	18
KCG02c	4	1	3	2	344	12	17	18	6	3	1	1	659	0	7	11
KCG02c	5	1	2	2	338	8	15	18	6	3	1	1	657	0	7	4
KCG02c	5	1	3	2	333	7	10	16	6	3	1	1	653	1	7	17
Average	5	1	3	2	338	9	14	17	6	3	1	1	656	1	7	11
KCG03c	4	0	1	2	348	6	17	17	6	3	1	1	810	1	11	4
KCG03c	5	1	2	2	352	13	19	23	6	3	1	1	815	1	8	4
KCG03c	5	1	2	2	358	12	13	19	6	3	1	1	829	1	9	11
Average	5	1	2	2	352	10	16	19	6	3	1	1	818	1	9	6
KCG04c	4	1	2	2	326	11	13	19	6	3	1	1	620	1	6	4
KCG04c	5	1	2	2	325	10	25	17	6	3	1	1	624	1	6	4
KCG04c	5	1	3	2	321	9	22	17	6	3	1	1	624	1	7	4
Average	4	1	2	2	324	10	20	17	6	3	1	1	622	1	6	4
KCG01d	4	1	3	2	339	10	30	19	6	3	1	1	666	1	7	6
KCG01d	5	1	1	2	351	9	21	14	6	3	1	1	667	0	7	5
KCG01d	5	1	2	2	342	7	16	17	6	3	1	1	665	1	7	8
Average	5	1	2	2	344	9	22	17	6	3	1	1	666	1	7	6
KCG02d	6	1	3	2	320	9	14	15	7	3	1	1	622	1	7	4
KCG02d	5	1	3	2	316	12	13	15	7	3	1	1	616	1	4	4
KCG02d	5	1	3	2	311	7	11	19	7	3	1	1	615	1	6	7
Average	5	1	3	2	316	9	13	16	7	3	1	1	618	1	6	5

KCG03d	5	1	1	2	370	14	24	13	6	3	1	1	720	1	9	4
KCG03d	5	1	3	2	377	7	19	18	6	3	1	1	711	1	9	4
KCG03d	4	1	2	2	385	11	18	16	6	3	1	1	713	1	7	9
Average	5	1	2	2	377	11	20	16	6	3	1	1	715	1	8	6
KCG04d	5	1	2	2	354	11	19	18	6	3	1	1	654	1	7	6
KCG04d	5	1	3	2	352	9	14	18	6	3	1	1	655	1	8	5
KCG04d	4	1	3	2	357	18	17	15	6	3	1	1	653	1	7	7
Average	5	1	2	2	354	13	16	17	6	3	1	1	654	1	7	6
KCG01a	4	1	2	2	316	10	21	18	6	4	1	1	755	1	8	7
KCG01a	4	1	4	2	321	8	16	16	6	4	1	1	756	1	7	13
KCG01a	4	1	2	2	319	4	17	16	6	4	1	1	762	1	9	12
Average	4	1	2	2	318	7	18	17	6	4	1	1	758	1	8	10
KCG02a	4	1	2	2	330	14	17	15	6	4	1	1	735	1	8	7
KCG02a	4	1	2	2	339	10	27	19	6	4	1	1	729	1	9	13
KCG02a	5	1	3	2	343	8	20	16	6	4	1	1	741	1	9	21
Average	4	1	2	2	337	11	22	17	6	4	1	1	735	1	9	14
KCG03a	4	1	3	2	384	4	18	25	6	4	1	1	710	2	9	36
KCG03a	5	1	2	2	398	7	18	22	6	3	1	1	716	1	9	26
KCG03a	4	1	2	2	406	11	6	20	6	3	1	1	716	1	8	19
Average	4	1	2	2	396	8	14	22	6	3	1	1	714	1	8	27
KCG04a	5	1	2	2	314	12	11	13	6	3	1	1	625	1	5	30
KCG04a	5	1	2	2	335	12	17	19	6	3	1	1	633	1	6	18
KCG04a	5	1	2	2	335	8	13	17	7	3	1	1	634	1	6	17
Average	5	1	2	2	328	11	14	16	6	3	1	1	631	1	6	22
KCG01b	4	1	3	2	284	9	15	16	6	3	1	1	702	1	7	12
KCG01b	5	1	3	2	291	5	11	22	6	3	1	1	704	1	9	17
KCG01b	4	1	3	2	294	12	11	20	6	3	1	1	712	1	8	17
Average	4	1	3	2	290	9	12	19	6	3	1	1	706	1	8	15
KCG02b	4	1	4	2	288	11	11	19	7	4	1	1	628	1	8	16
KCG02b	5	1	2	2	300	9	18	17	7	3	1	1	627	1	6	10
KCG02b	4	1	3	2	299	12	17	16	7	3	1	1	637	1	6	13
Average	4	1	3	2	295	11	15	17	7	3	1	1	631	1	7	13
KCG03b	4	1	4	2	306	12	7	19	7	3	1	1	609	1	8	14
KCG03b	4	1	3	2	318	4	15	20	7	4	0	1	601	1	8	13
KCG03b	4	1	5	2	325	5	11	18	7	3	1	1	604	1	7	18
Average	4	1	4	2	316	7	11	19	7	3	1	1	605	1	8	15
KCG04b	6	1	3	2	335	10	13	19	6	3	1	1	635	1	8	12
KCG04b	5	1	4	2	339	10	20	20	6	3	1	1	643	1	6	15
KCG04b	5	1	2	2	336	5	17	21	6	3	1	1	646	1	7	7

Average	5	1	3	2	337	8	17	20	6	3	1	1	641	1	7	11
KCG01c	4	1	4	2	343	7	20	14	7	3	1	1	641	1	8	18
KCG01c	4	1	3	2	343	4	12	17	7	3	0	1	649	1	7	12
KCG01c	5	1	2	2	359	12	14	16	7	3	1	1	646	1	7	20
Average	5	1	3	2	349	8	16	16	7	3	1	1	645	1	7	17
KCG02c	5	1	2	2	309	9	20	17	6	3	1	1	607	1	6	12
KCG02c	5	1	3	2	333	11	20	14	6	3	1	1	609	1	6	13
KCG02c	6	1	3	2	326	11	15	16	6	3	1	1	611	1	7	23
Average	5	1	3	2	323	10	18	16	6	3	1	1	609	1	6	16
KCG03c	5	1	3	2	333	11	12	21	6	3	1	1	799	1	9	13
KCG03c	5	1	4	2	345	7	6	18	7	3	1	1	798	1	9	14
KCG03c	5	1	2	2	348	4	12	20	6	3	1	1	801	1	10	24
Average	5	1	3	2	342	7	10	20	6	3	1	1	800	1	9	17
KCG04c	5	1	3	2	335	15	22	21	7	3	1	1	592	1	9	16
KCG04c	4	1	4	2	345	9	15	18	6	3	1	1	602	1	6	16
KCG04c	4	1	1	3	352	9	14	15	6	3	1	1	599	1	8	24
Average	4	1	2	2	344	11	17	18	6	3	1	1	598	1	8	19
KCG01d	5	1	3	2	323	10	21	17	7	3	1	1	677	1	8	15
KCG01d	4	1	2	2	329	12	6	17	7	3	1	1	676	1	6	18
KCG01d	5	1	3	2	324	7	15	18	7	3	1	1	682	1	7	25
Average	4	1	3	2	325	10	14	17	7	3	1	1	678	1	7	19
KCG02d	6	1	1	2	310	9	12	20	7	3	1	1	645	1	6	9
KCG02d	4	1	3	2	313	8	14	21	7	3	1	1	654	1	7	18
KCG02d	5	1	3	2	319	10	6	22	7	3	1	1	651	1	6	28
Average	5	1	3	2	314	9	11	21	7	3	1	1	650	1	6	19
KCG03d	3	1	2	2	350	10	13	19	6	3	1	1	702	1	7	20
KCG03d	5	1	3	2	358	9	13	14	6	3	1	1	692	1	8	18
KCG03d	5	1	3	2	357	12	17	14	6	3	1	1	699	1	9	18
Average	4	1	2	2	355	10	14	16	6	3	1	1	697	1	8	19
KCG04d	5	1	4	2	333	11	14	16	6	3	1	1	614	1	7	23
KCG04d	5	1	2	2	332	7	15	15	6	3	1	1	611	1	8	19
KCG04d	5	1	3	2	331	9	22	12	6	3	1	1	617	1	8	24
Average	5	1	3	2	332	9	17	14	6	3	1	1	614	1	7	22
KCG01e	5	1	2	2	365	9	18	15	6	3	1	1	629	1	8	5
KCG01e	4	1	1	2	374	13	14	11	6	3	1	1	636	1	6	5
KCG01e	5	1	2	2	371	14	17	11	6	3	1	1	639	1	4	4
Average	5	1	2	2	370	12	16	12	6	3	1	1	635	1	6	5
KCG02e	5	1	3	2	296	14	15	19	6	3	1	1	597	1	7	4
KCG02e	4	1	2	2	287	11	16	14	6	3	1	1	596	1	7	4

KCG02e	4	1	4	2	289	7	10	13	6	3	1	1	603	1	7	4
Average	4	1	3	2	291	11	14	15	6	3	1	1	599	1	7	4
KCG03e	4	1	3	2	376	10	22	16	6	3	1	1	749	1	9	5
KCG03e	5	1	3	2	369	10	13	22	6	3	1	1	754	1	8	5
KCG03e	4	1	2	2	371	4	25	16	6	4	1	1	749	1	8	5
Average	4	1	3	2	372	8	20	18	6	3	1	1	751	1	9	5
KCG04e	6	1	3	2	373	9	21	19	6	3	1	1	725	1	8	5
KCG04e	4	1	3	2	368	9	17	18	6	3	1	1	726	1	8	4
KCG04e	6	1	1	2	376	6	13	14	6	4	1	1	728	1	7	5
Average	5	1	2	2	373	8	17	17	6	3	1	1	726	1	8	5
KCG01a	4	1	3	2	326	9	18	21	6	4	1	1	787	1	7	4
KCG01a	4	1	3	2	336	11	19	16	6	4	1	1	785	1	9	4
KCG01a	4	1	3	2	338	16	19	15	6	4	1	1	785	1	9	4
Average	4	1	3	2	333	12	19	18	6	4	1	1	786	1	8	4
KCG02a	4	1	3	2	349	16	23	8	6	4	1	1	720	1	8	4
KCG02a	4	1	3	2	343	4	15	16	6	4	1	1	724	1	6	4
KCG02a	5	1	2	2	360	8	22	18	6	4	1	1	722	1	9	4
Average	4	1	3	2	351	10	20	14	6	4	1	1	722	1	8	4
KCG03a	4	1	3	2	414	9	6	16	6	3	1	1	737	1	7	4
KCG03a	4	1	3	2	409	9	17	18	6	4	1	1	735	1	7	4
KCG03a	4	1	2	2	423	14	15	18	6	3	1	1	742	1	8	5
Average	4	1	3	2	416	11	12	17	6	3	1	1	738	1	7	4
KCG04a	5	1	5	2	313	7	17	13	6	3	1	1	569	0	6	4
KCG04a	5	1	1	2	319	10	16	13	6	3	1	1	569	0	5	3
KCG04a	5	0	1	2	330	10	11	16	6	3	1	1	571	1	7	4
Average	5	1	2	2	321	9	15	14	6	3	1	1	569	1	6	4
KCG01b	4	1	3	2	333	7	22	17	6	3	1	1	672	1	7	4
KCG01b	3	1	2	2	340	9	14	18	6	3	1	1	675	1	6	5
KCG01b	4	1	2	2	340	6	14	16	6	3	1	1	674	1	7	5
Average	4	1	3	2	337	7	16	17	6	3	1	1	674	1	6	5
KCG02b	5	1	3	2	305	4	16	14	7	3	1	1	625	1	6	4
KCG02b	5	1	4	2	309	11	20	14	7	3	1	1	625	1	6	5
KCG02b	5	1	3	2	311	12	15	15	7	3	1	1	634	1	7	4
Average	5	1	3	2	308	9	17	14	7	3	1	1	628	1	6	4
KCG03b	5	1	3	2	343	16	28	18	7	3	1	1	652	1	6	4
KCG03b	4	1	3	2	347	13	20	20	7	3	1	1	652	1	6	4
KCG03b	4	1	3	2	335	8	15	16	7	3	1	1	649	2	6	4
Average	4	1	3	2	342	13	21	18	7	3	1	1	651	1	6	4
KCG04b	5	1	2	2	338	7	13	10	6	3	1	1	575	1	5	4

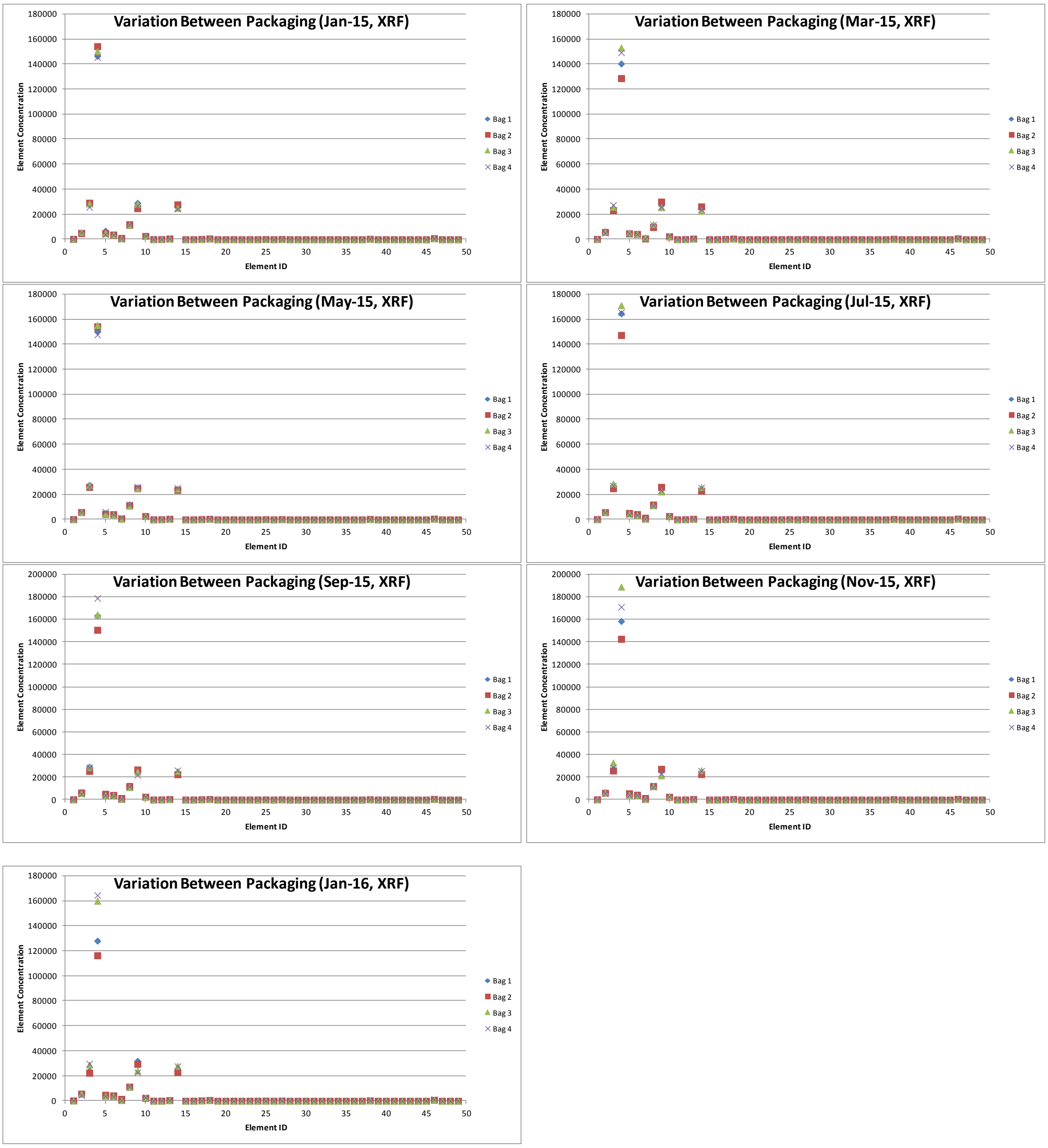
KCG04b	5	1	2	3	349	12	14	18	6	3	1	1	571	1	7	5
KCG04b	5	1	2	3	360	7	22	12	6	3	1	1	577	1	6	5
Average	5	1	2	2	349	9	16	13	6	3	1	1	574	1	6	5
KCG01c	5	1	4	3	392	11	13	13	6	3	1	1	602	1	7	10
KCG01c	5	1	2	3	385	5	25	20	6	3	1	1	610	1	5	15
KCG01c	5	1	3	2	397	9	17	14	6	3	1	1	609	1	7	6
Average	5	1	3	2	391	8	18	16	6	3	1	1	607	1	6	10
KCG02c	5	1	4	2	329	14	12	13	6	3	1	1	583	1	6	4
KCG02c	4	1	4	2	340	11	13	13	6	3	1	1	594	1	6	10
KCG02c	5	1	2	2	336	9	6	13	6	3	1	1	586	1	5	7
Average	5	1	4	2	335	11	10	13	6	3	1	1	587	1	6	7
KCG03c	4	1	3	2	314	7	16	15	6	3	1	1	801	1	8	4
KCG03c	4	1	3	2	329	14	15	15	7	3	1	1	806	2	7	8
KCG03c	4	1	5	2	331	8	12	14	7	3	1	1	805	1	8	10
Average	4	1	3	2	324	10	14	15	6	3	1	1	804	1	8	7
KCG04c	4	1	3	2	325	4	11	16	6	3	1	1	593	1	7	4
KCG04c	4	1	4	2	325	7	6	12	6	3	2	1	598	1	8	10
KCG04c	5	1	1	2	338	8	15	17	6	3	1	1	594	1	6	15
Average	4	1	3	2	329	6	11	15	6	3	1	1	595	1	7	10
KCG01d	5	1	3	2	340	7	10	13	7	4	1	1	631	1	6	4
KCG01d	4	1	2	3	352	9	12	14	7	3	1	1	636	0	6	9
KCG01d	5	1	5	2	351	10	14	17	6	3	1	1	629	0	6	16
Average	5	1	3	2	348	9	12	14	6	3	1	1	632	0	6	10
KCG02d	4	1	2	2	297	7	11	17	7	3	1	1	602	1	6	5
KCG02d	5	1	4	2	298	6	12	17	7	3	1	1	605	0	7	9
KCG02d	5	1	2	2	302	8	13	14	7	3	1	1	606	0	5	13
Average	5	1	3	2	299	7	12	16	7	3	1	1	604	1	6	9
KCG03d	5	1	2	2	351	6	20	18	7	3	1	1	750	1	7	4
KCG03d	5	1	4	2	350	7	12	20	7	4	1	1	757	1	7	10
KCG03d	5	1	2	2	355	10	17	17	7	4	1	1	756	1	8	12
Average	5	1	3	2	352	8	16	18	7	3	1	1	755	1	7	9
KCG04d	5	1	3	2	316	12	13	15	6	3	1	1	623	1	5	4
KCG04d	6	1	2	2	323	5	23	19	6	3	1	1	621	1	8	9
KCG04d	5	1	3	2	324	7	13	16	6	3	1	1	624	1	7	15
Average	5	1	3	2	321	8	16	17	6	3	1	1	623	1	6	9
KCG01e	4	1	2	2	337	13	19	19	6	3	1	1	625	1	7	22
KCG01e	5	1	3	2	329	8	27	23	6	3	1	1	631	2	6	47
KCG01e	5	1	2	2	344	12	17	21	6	4	1	1	635	1	5	27
Average	4	1	2	2	337	11	21	21	6	3	1	1	630	1	6	32

KCG02e	5	1	3	2	295	9	11	12	7	3	1	1	598	1	6	4
KCG02e	5	1	3	2	297	8	11	19	7	3	0	1	605	1	6	24
KCG02e	5	1	4	2	313	9	9	18	7	3	1	1	610	1	6	14
Average	5	1	3	2	302	8	10	17	7	3	1	1	604	1	6	14
KCG03e	4	1	1	2	344	15	18	21	6	4	1	1	777	1	9	12
KCG03e	4	1	2	2	346	6	14	22	6	3	1	1	778	1	7	21
KCG03e	5	1	2	2	353	7	10	20	6	3	1	1	773	1	9	20
Average	4	1	2	2	347	9	14	21	6	3	1	1	776	1	8	18
KCG04e	6	1	3	2	351	13	14	13	6	4	1	1	714	1	5	16
KCG04e	5	1	4	2	341	7	24	19	6	3	1	1	719	1	6	26
KCG04e	5	1	2	2	356	7	14	18	7	4	1	1	722	1	10	22
Average	5	1	3	2	349	9	17	17	6	3	1	1	718	1	7	21
KCG01f	4	1	3	2	342	10	17	20	6	3	1	1	638	1	8	15
KCG01f	4	1	2	2	350	8	22	15	6	3	2	1	639	1	6	24
KCG01f	4	1	3	2	331	9	22	17	6	3	1	1	645	1	9	22
Average	4	1	2	2	341	9	20	17	6	3	1	1	641	1	8	20
KCG02f	5	1	4	2	319	6	11	17	6	3	1	1	627	1	7	12
KCG02f	5	1	4	2	320	13	15	16	6	3	1	1	629	1	6	18
KCG02f	5	1	4	2	322	12	21	16	6	3	1	1	636	1	6	20
Average	5	1	4	2	320	10	16	16	6	3	1	1	631	1	6	17
KCG03f	4	1	3	2	386	8	12	20	6	3	1	1	750	1	9	17
KCG03f	5	1	2	3	397	6	13	17	6	3	1	1	752	1	10	17
KCG03f	5	1	2	2	392	8	17	17	6	3	1	1	753	1	10	22
Average	4	1	2	2	392	7	14	18	6	3	1	1	752	1	9	19
KCG04f	6	1	4	2	367	5	14	19	6	3	1	1	673	1	9	18
KCG04f	5	1	1	3	378	10	15	19	6	3	1	1	677	1	6	19
KCG04f	6	1	1	3	381	11	16	17	6	3	1	1	680	1	7	24
Average	6	1	2	2	376	8	15	18	6	3	1	1	676	1	7	20
KCG01a	5	1	1	2	351	10	17	23	6	4	1	1	784	1	8	4
KCG01a	4	0	4	2	347	9	23	21	6	4	1	1	784	1	7	4
KCG01a	4	1	2	2	343	10	11	22	6	4	1	1	788	1	9	4
Average	4	1	2	2	347	10	17	22	6	4	1	1	786	1	8	4
KCG02a	5	1	1	2	356	15	35	18	6	4	1	1	734	1	10	6
KCG02a	5	1	2	2	352	11	15	16	6	4	1	1	740	1	8	4
KCG02a	6	1	5	2	354	13	17	15	6	4	1	1	738	1	8	4
Average	5	1	2	2	354	13	22	16	6	4	1	1	737	1	9	5
KCG03a	5	1	3	2	411	4	24	19	6	3	1	1	742	1	7	4
KCG03a	5	1	2	2	425	6	15	18	6	3	1	1	745	1	8	5
KCG03a	5	1	3	2	421	6	27	16	6	4	1	1	747	1	8	4

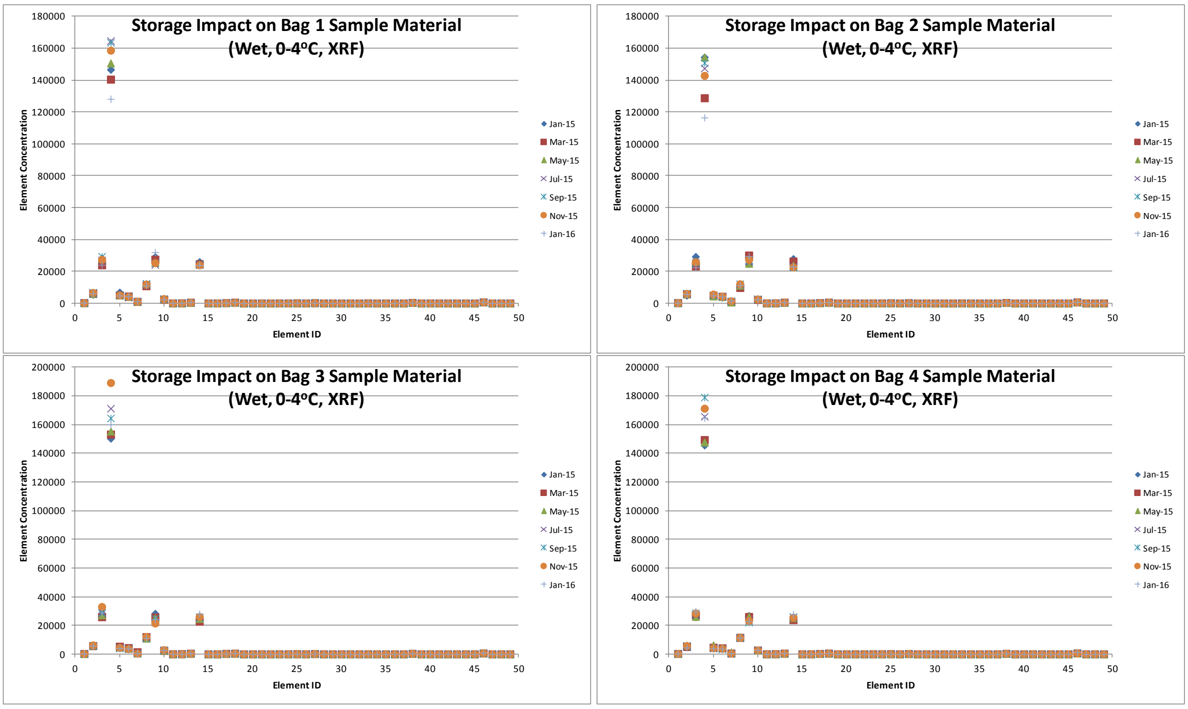
Average	5	1	3	2	419	6	22	17	6	3	1	1	745	1	8	4
KCG04a	5	1	2	2	338	16	17	13	6	3	1	1	580	2	6	5
KCG04a	5	1	4	2	334	10	19	15	6	3	1	1	583	1	6	4
KCG04a	6	1	2	2	335	6	11	15	6	3	1	1	579	1	7	5
Average	5	1	2	2	336	11	16	14	6	3	1	1	581	1	6	4
KCG01b	5	1	3	2	326	8	11	12	6	3	1	1	672	1	5	5
KCG01b	6	1	2	3	325	10	18	17	6	3	1	1	675	1	7	4
KCG01b	4	1	2	2	328	10	12	18	6	3	1	1	673	1	7	5
Average	5	1	2	2	326	9	14	16	6	3	1	1	673	1	6	5
KCG02b	5	1	4	2	316	10	11	15	7	3	1	1	627	1	6	5
KCG02b	5	1	4	2	319	7	6	20	7	3	1	1	632	1	6	4
KCG02b	5	1	3	2	322	13	16	13	7	3	1	1	640	1	6	5
Average	5	1	3	2	319	10	11	16	7	3	1	1	633	1	6	4
KCG03b	4	1	3	2	322	10	17	13	7	3	1	1	658	1	6	5
KCG03b	5	1	2	2	333	8	16	20	7	3	1	1	655	1	7	5
KCG03b	4	1	4	2	324	4	21	17	7	3	1	1	660	1	6	4
Average	4	1	3	2	326	7	18	17	7	3	1	1	658	1	6	5
KCG04b	7	1	2	3	372	10	21	9	6	3	1	1	590	1	7	5
KCG04b	6	1	2	3	359	10	13	18	6	3	0	1	591	2	6	5
KCG04b	7	1	2	3	370	11	19	13	6	3	1	1	592	1	8	5
Average	7	1	2	3	367	10	18	13	6	3	1	1	591	1	7	5
KCG01c	5	1	1	3	422	11	21	13	6	5	1	1	604	1	8	16
KCG01c	4	1	2	3	422	5	25	17	6	3	1	1	608	1	7	12
KCG01c	5	1	2	3	418	11	18	19	6	3	1	1	605	0	7	18
Average	5	1	2	3	421	9	21	16	6	4	1	1	606	1	7	15
KCG02c	4	1	3	2	335	8	12	23	6	3	1	1	592	1	8	8
KCG02c	5	1	2	2	333	6	13	13	6	3	1	1	593	1	7	13
KCG02c	5	1	1	2	334	7	12	14	6	3	1	1	597	1	7	12
Average	5	1	2	2	334	7	12	17	6	3	1	1	594	1	7	11
KCG03c	4	1	1	2	335	10	6	22	6	3	1	1	808	1	7	12
KCG03c	5	1	2	2	333	8	14	24	6	3	1	1	820	1	7	11
KCG03c	4	1	4	2	336	7	18	23	6	3	1	1	820	1	8	23
Average	4	1	2	2	335	8	13	23	6	3	1	1	816	1	7	16
KCG04c	4	1	2	3	370	6	14	14	7	3	1	1	582	2	6	12
KCG04c	4	1	2	3	376	5	13	17	6	3	0	1	584	1	7	13
KCG04c	5	1	4	3	381	8	19	13	6	3	1	1	588	1	7	27
Average	5	1	3	3	376	7	15	15	6	3	1	1	585	1	7	17
KCG01d	5	1	3	2	336	8	18	15	7	3	1	1	646	1	7	7
KCG01d	5	1	3	2	346	5	16	22	7	3	1	1	644	1	6	15

KCG01d	4	1	3	2	345	9	13	18	6	3	1	1	642	1	6	21
Average	5	1	3	2	342	7	16	18	6	3	1	1	644	1	6	14
KCG02d	5	1	4	2	306	10	12	17	7	3	1	1	614	1	6	12
KCG02d	4	1	1	2	312	12	19	19	7	3	1	1	611	1	6	18
KCG02d	5	1	6	2	304	9	12	21	7	5	1	1	615	1	5	20
Average	5	1	4	2	307	10	14	19	7	4	1	1	614	1	6	17
KCG03d	5	1	1	2	365	7	16	21	7	3	1	1	764	1	8	12
KCG03d	6	1	2	2	363	13	16	19	7	3	1	1	772	1	9	16
KCG03d	6	1	3	2	364	5	19	22	7	4	0	1	771	1	7	9
Average	6	1	2	2	364	8	17	21	7	3	1	1	769	1	8	12
KCG04d	6	1	3	2	334	5	11	18	6	3	1	1	623	1	7	20
KCG04d	5	1	6	2	329	14	17	23	6	3	0	1	628	1	5	19
KCG04d	5	1	3	3	326	14	14	10	6	3	1	1	631	1	6	15
Average	5	1	4	2	329	11	14	17	6	3	1	1	627	1	6	18
KCG01e	6	1	3	3	357	9	16	22	6	3	1	1	629	1	6	67
KCG01e	5	1	3	2	364	13	21	17	6	3	1	1	637	1	7	19
KCG01e	4	1	3	2	367	12	21	21	6	3	2	1	637	0	6	13
Average	5	1	3	2	363	11	19	20	6	3	1	1	635	1	6	33
KCG02e	5	1	3	2	321	7	18	19	7	3	1	1	597	1	6	14
KCG02e	5	1	3	2	322	10	21	17	7	3	1	1	604	1	5	8
KCG02e	5	1	1	2	324	8	19	15	7	3	1	1	607	1	8	10
Average	5	1	3	2	323	8	19	17	7	3	1	1	603	1	6	10
KCG03e	5	1	2	2	362	8	17	18	6	3	1	1	778	1	9	23
KCG03e	5	1	3	2	368	7	14	17	6	4	1	1	780	1	6	5
KCG03e	4	1	2	2	373	12	21	19	6	4	1	1	779	1	8	8
Average	5	1	2	2	367	9	17	18	6	3	1	1	779	1	8	12
KCG04e	5	1	1	3	360	8	20	21	7	4	1	1	732	1	9	17
KCG04e	4	1	3	2	361	11	12	17	7	4	1	1	733	2	6	4
KCG04e	5	1	3	2	362	8	17	19	7	4	1	1	734	1	7	5
Average	4	1	3	2	361	9	16	19	7	4	1	1	733	1	7	9
KCG01f	5	1	3	2	346	12	6	19	6	4	1	1	620	1	8	25
KCG01f	4	1	2	3	350	6	10	20	6	3	1	1	624	1	7	7
KCG01f	5	1	3	2	350	11	10	21	6	3	1	1	624	1	8	5
Average	5	1	2	2	349	10	9	20	6	3	1	1	623	1	7	12
KCG02f	5	1	4	2	330	10	9	16	6	3	1	1	610	1	7	23
KCG02f	5	1	2	2	323	12	19	14	6	3	1	1	615	1	7	7
KCG02f	5	1	4	2	335	12	18	17	6	3	1	1	621	1	9	4
Average	5	1	3	2	329	11	15	16	6	3	1	1	615	1	7	11
KCG03f	6	1	2	3	416	10	28	15	6	3	2	1	748	1	9	33

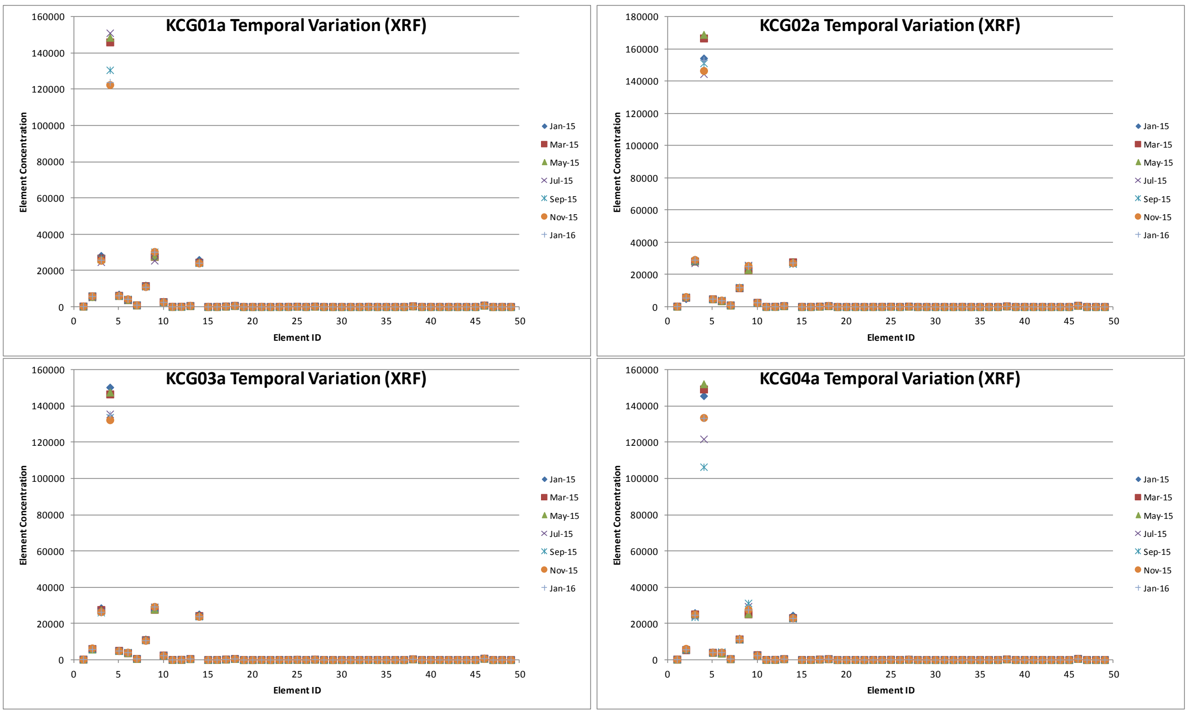
KCG03f	5	1	2	2	414	11	6	20	6	3	1	1	749	1	9	5
KCG03f	5	1	4	3	423	12	18	20	6	3	1	1	749	1	8	8
Average	5	1	2	2	418	11	17	18	6	3	1	1	749	1	9	15
KCG04f	5	1	2	3	403	11	16	24	6	3	1	1	666	1	8	19
KCG04f	4	1	3	3	406	10	16	15	6	3	1	1	673	1	8	5
KCG04f	6	1	4	3	401	17	16	19	6	3	1	1	678	1	8	5
Average	5	1	3	3	403	13	16	19	6	3	1	1	672	1	8	10
KCG01g	6	1	3	2	330	7	16	18	6	4	1	1	778	1	7	22
KCG01g	6	1	2	2	327	11	15	18	6	4	1	1	774	1	7	4
KCG01g	5	1	2	2	330	8	16	21	6	4	1	1	780	1	8	4
Average	6	1	2	2	329	8	15	19	6	4	1	1	778	1	7	10
KCG02g	5	1	5	2	269	5	11	19	7	4	1	1	714	1	8	14
KCG02g	5	1	5	2	271	8	16	21	7	4	1	1	714	1	8	7
KCG02g	4	1	2	2	270	4	16	20	7	4	1	1	719	1	5	3
Average	4	1	4	2	270	6	14	20	7	4	1	1	716	1	7	8
KCG03g	6	1	2	2	366	13	15	26	6	4	1	1	831	1	10	40
KCG03g	5	1	2	2	375	13	17	22	6	3	1	1	833	1	9	16
KCG03g	4	1	4	2	385	15	14	19	6	4	1	1	831	1	9	11
Average	5	1	2	2	375	13	15	22	6	3	1	1	832	1	9	23
KCG04g	5	1	2	2	396	4	6	26	7	4	1	2	1278	1	11	26
KCG04g	5	1	2	2	413	5	20	20	7	4	1	2	1277	1	12	18
KCG04g	5	1	2	2	414	8	16	18	7	4	1	2	1274	1	9	14
Average	5	1	2	2	407	6	14	21	7	4	1	2	1276	1	11	19



Appendix 4.2: XRF Elemental Variance in Garden Soil Samples in Different Manufactured Packaging.



Appendix 4.3: Temporal variance in XRF elemental concentration for garden soil samples stored wet at 0 - 4 oC.



Appendix 4.4: Temporal variance in XRF elemental concentration for garden soil samples stored dry at room temperature.

Appendix 4.5: Park Sample Site XRF Elemental Data

	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu
KCP01a	240	5960	27430	162300	3432	3902	226	13690	24030	2531	74	87	409	21510	7	28	68

KCP01a	270	5920	29810	170800	3611	4100	244	13810	24390	2568	78	81	413	21750	7	27	70
KCP01a	220	6940	30370	171800	3591	4122	226	13900	24640	2573	66	88	413	21710	20	25	68
Average	243	6273	29203	168300	3545	4041	232	13800	24353	2557	73	85	412	21657	12	26	68
KCP02a	210	6370	31120	171100	3426	4089	208	13470	23220	2729	76	85	466	22620	7	27	72
KCP02a	220	6450	31550	173600	3480	4185	210	13240	23480	2727	89	83	464	22620	15	24	75
KCP02a	280	5810	31540	175200	3470	4069	219	13400	23550	2720	79	87	457	22690	11	27	76
Average	237	6210	31403	173300	3459	4114	212	13370	23417	2725	82	85	462	22643	11	26	74
KCP03a	270	6260	31820	175300	3834	3982	228	13750	26590	2702	69	63	471	22790	13	25	73
KCP03a	230	7240	31930	176600	3871	3980	242	13530	26570	2661	72	72	477	22720	18	25	68
KCP03a	220	6830	32090	175600	3778	4037	226	13910	26340	2650	73	53	473	22780	12	27	71
Average	240	6777	31947	175833	3828	4000	232	13730	26500	2671	71	63	474	22763	14	26	71
KCP04a	230	6460	32910	172700	3637	4095	241	13860	25750	2789	100	92	458	22700	12	24	73
KCP04a	220	6720	33070	173100	3614	4153	223	13840	25860	2809	87	70	461	22790	16	25	75
KCP04a	230	6740	32670	173700	3625	4162	257	14010	25580	2833	82	81	462	22730	14	28	74
Average	227	6640	32883	173167	3625	4137	240	13903	25730	2810	90	81	460	22740	14	26	74
KCP01a	230	6640	30270	168100	3494	3978	230	13370	24180	2498	86	70	437	20970	29	24	66
KCP01a	270	6510	30250	169100	3557	3976	223	13610	24180	2528	72	70	424	21260	13	26	61
KCP01a	220	6680	30040	170500	3578	3971	228	13330	24230	2498	71	78	439	21180	26	24	67
Average	240	6610	30187	169233	3543	3975	227	13437	24197	2508	76	73	433	21137	23	25	64
KCP02a	230	6540	32480	172900	3380	3947	204	13390	22500	2799	81	77	462	22310	13	25	72
KCP02a	280	6130	31790	174500	3347	4074	180	13440	22540	2833	86	61	472	22340	18	27	70
KCP02a	230	6730	32090	174500	3437	4014	205	13420	22760	2786	82	66	467	22320	21	25	71
Average	247	6467	32120	173967	3388	4012	196	13417	22600	2806	83	68	467	22323	17	26	71
KCP03a	280	5690	31280	182000	3736	3838	199	13350	24430	2609	79	67	447	21340	23	24	62
KCP03a	280	5290	30740	183500	3844	3924	228	13270	24530	2614	62	77	445	21500	12	24	61
KCP03a	230	6950	30530	183900	3783	3944	230	13410	24510	2530	71	85	458	21390	26	21	58
Average	263	5977	30850	183133	3788	3902	219	13343	24490	2584	71	76	450	21410	20	23	60
KCP04a	270	6500	32570	174900	3528	3924	199	13840	23880	2810	76	82	471	22170	12	26	67
KCP04a	260	6070	32890	174800	3549	3902	201	13780	23940	2806	69	90	462	22280	8	27	68
KCP04a	270	6000	32750	176400	3476	3926	185	13710	23760	2826	83	79	469	22190	14	26	68
Average	267	6190	32737	175367	3518	3917	195	13777	23860	2814	76	84	467	22213	11	26	68
KCP01b	220	7250	33110	196800	3803	3618	193	14230	22170	2721	83	74	436	22090	9	26	64
KCP01b	220	6930	33300	198100	3750	3605	189	14100	22020	2761	80	89	428	22130	21	25	65
KCP01b	210	6590	33610	198500	3764	3653	192	14220	21910	2751	86	76	433	22090	30	21	66
Average	217	6923	33340	197800	3772	3625	191	14183	22033	2744	83	80	433	22103	20	24	65
KCP02b	220	7220	34190	187100	3494	3956	170	13780	22090	2821	93	72	439	22920	9	27	71
KCP02b	220	6860	33900	188400	3525	3910	205	13750	21930	2830	69	79	447	22890	23	30	70
KCP02b	210	6970	33360	189500	3496	3972	193	13780	21930	2862	76	79	444	22740	20	25	71
Average	217	7017	33817	188333	3505	3946	189	13770	21983	2838	79	77	443	22850	17	27	70

KCP03b	220	7100	31750	187700	3630	3691	200	14000	26210	2794	78	80	455	22350	8	26	60
KCP03b	230	6500	31850	187200	3592	3640	203	13870	25830	2809	68	76	442	22180	11	23	66
KCP03b	230	6980	32400	188400	3616	3662	193	13930	26180	2817	85	96	447	22290	25	23	61
Average	227	6860	32000	187767	3613	3664	199	13933	26073	2807	77	84	448	22273	15	24	62
KCP04b	280	5840	31890	176600	3491	3744	210	14110	29010	2840	74	81	505	24110	10	29	73
KCP04b	220	6510	32010	177400	3555	3711	200	13800	28560	2800	83	67	505	24050	15	25	78
KCP04b	290	5770	31230	177900	3567	3750	211	13800	28680	2805	89	73	495	23910	29	26	79
Average	263	6040	31710	177300	3538	3735	207	13903	28750	2815	82	74	501	24023	18	27	77
KCP01a	280	5590	29970	171300	3554	4009	193	13410	24140	2543	87	66	442	21220	7	25	63
KCP01a	260	5820	29820	170200	3567	4022	215	13490	24200	2578	57	83	445	21250	8	27	67
KCP01a	230	6560	30150	171400	3624	4018	235	13560	24320	2558	76	79	434	21260	17	24	64
Average	257	5990	29980	170967	3582	4016	214	13487	24220	2560	73	76	440	21243	10	25	65
KCP02a	220	6410	31980	175500	3392	4043	204	13490	22500	2808	72	70	446	22290	32	25	72
KCP02a	220	6440	32170	175300	3434	4063	202	13500	22790	2806	75	71	451	22520	19	26	75
KCP02a	220	6700	32390	175000	3426	4079	205	13260	22710	2861	67	83	473	22410	20	26	75
Average	220	6517	32180	175267	3417	4062	204	13417	22667	2825	71	75	457	22407	24	26	74
KCP03a	260	6050	30800	185000	3905	3925	229	13280	24630	2575	79	74	449	21540	16	22	62
KCP03a	280	5950	31140	185300	3870	3943	230	13310	24470	2628	73	78	446	21510	7	24	62
KCP03a	260	6010	31040	185700	3899	3942	246	13240	24570	2595	60	78	463	21490	21	22	58
Average	267	6003	30993	185333	3891	3937	235	13277	24557	2599	71	77	453	21513	15	23	61
KCP04a	220	6760	32480	177200	3510	3922	191	13760	24060	2804	86	77	500	22380	11	25	70
KCP04a	270	6380	32280	177300	3565	3903	202	13800	23930	2825	95	77	472	22260	16	25	70
KCP04a	260	6200	32140	177900	3554	3932	201	13870	24040	2864	86	63	481	22340	13	27	69
Average	250	6447	32300	177467	3543	3919	198	13810	24010	2831	89	72	484	22327	13	26	70
KCP01b	220	7120	33370	197300	3690	3698	182	13920	21820	2709	81	78	431	21960	26	23	61
KCP01b	220	6690	32930	197800	3752	3663	189	14160	22010	2771	67	88	419	21980	19	23	60
KCP01b	280	5960	33250	198000	3703	3688	179	13900	22030	2783	71	78	412	22020	35	23	68
Average	240	6590	33183	197700	3715	3683	183	13993	21953	2754	73	81	420	21987	27	23	63
KCP02b	220	7280	33650	190000	3537	3926	204	13650	21900	2857	75	83	452	22780	26	28	69
KCP02b	230	7020	33000	189600	3496	3937	194	13770	21900	2867	77	76	425	22780	8	26	70
KCP02b	220	7080	32730	190600	3517	3918	204	13840	22050	2903	76	75	438	22730	14	27	68
Average	223	7127	33127	190067	3517	3927	201	13753	21950	2876	76	78	438	22763	16	27	69
KCP03b	300	5190	31920	188700	3608	3684	201	13900	26100	2905	69	84	449	22180	13	25	64
KCP03b	240	7000	32010	189300	3590	3685	215	14180	25900	2828	81	69	451	22220	9	25	62
Average	273	5940	31923	188900	3613	3680	206	14010	26097	2869	78	78	451	22207	10	25	62
KCP04b	220	6820	31720	178400	3488	3775	203	13880	28700	2868	61	72	490	23960	10	29	78
KCP04b	230	6490	32130	178900	3538	3751	204	13720	28650	2838	94	94	492	23930	25	27	75
KCP04b	270	6160	31400	180000	3573	3765	209	13710	28770	2832	82	72	496	23980	24	27	77
Average	240	6490	31750	179100	3533	3764	205	13770	28707	2846	79	80	493	23957	20	28	77

KCP01c	290	5530	28260	174100	3229	3792	243	13040	23290	2519	80	59	437	21310	24	23	67
KCP01c	270	5250	28450	176700	3219	3818	235	13130	23200	2612	65	63	448	21400	13	25	65
KCP01c	230	6600	28270	178500	3290	3840	300	13070	23530	2613	72	59	430	21310	17	25	65
Average	263	5793	28327	176433	3246	3817	259	13080	23340	2581	72	61	438	21340	18	24	66
KCP02c	230	6800	33400	189200	3540	3882	195	13520	22970	2695	75	92	445	22140	20	24	65
KCP02c	270	6480	32890	191500	3561	3899	196	13670	22840	2697	87	98	443	22250	10	27	72
KCP02c	280	6270	32640	191400	3521	3896	204	13620	22520	2716	93	97	451	22240	26	25	67
Average	260	6517	32977	190700	3541	3892	198	13603	22777	2703	85	96	446	22210	18	25	68
KCP03c	230	6940	34070	189800	3974	3826	208	14050	24720	2882	74	131	457	22890	24	26	67
KCP03c	300	5790	33600	191300	3933	3838	207	14090	25060	2886	76	94	480	22880	17	27	66
KCP03c	280	6100	33160	191700	3947	3841	209	14320	25080	2893	92	129	493	22850	23	25	63
Average	270	6277	33610	190933	3951	3835	208	14153	24953	2887	81	118	477	22873	21	26	65
KCP04c	290	5820	31170	186200	3432	3890	191	13480	22960	2644	62	59	480	21410	10	24	61
KCP04c	300	5570	30790	187400	3525	3902	213	13220	22620	2621	81	61	470	21340	8	25	63
KCP04c	220	6920	31350	187700	3525	3942	221	13460	22760	2629	77	70	452	21310	15	24	63
Average	270	6103	31103	187100	3494	3911	208	13387	22780	2631	73	63	467	21353	11	25	62
KCP01a	230	6380	29260	165100	3460	3916	203	13220	24150	2477	66	86	422	20490	11	23	63
KCP01a	230	6300	28980	165800	3534	3911	233	13230	24130	2474	75	72	429	20680	25	24	66
KCP01a	270	5240	28720	166400	3549	3965	232	13040	24330	2491	72	70	414	20670	17	24	66
average	243	5973	28987	165767	3514	3931	223	13163	24203	2481	71	76	422	20613	18	24	65
KCP02a	280	4800	29920	167300	3303	4098	225	13120	22420	2735	80	75	440	21460	9	25	73
KCP02a	230	6530	30600	168800	3288	4117	225	13120	22630	2780	77	66	464	21650	20	27	71
KCP02a	220	6170	30530	168300	3302	4092	235	13090	22380	2757	73	81	445	21710	20	26	73
average	243	5833	30350	168133	3298	4102	228	13110	22477	2757	77	74	450	21607	17	26	72
KCP03a	240	6040	30300	169200	3560	3920	197	13150	25520	2533	89	85	471	22100	14	25	70
KCP03a	290	4970	29630	169300	3686	3889	221	13090	25520	2521	71	72	485	22030	15	24	70
KCP03a	230	6900	29470	171500	3657	3955	226	13110	25700	2543	91	76	487	22100	14	29	69
average	253	5970	29800	170000	3634	3921	215	13117	25580	2532	83	78	481	22077	14	26	70
KCP04a	230	6190	31300	164700	3367	4047	236	13620	24330	2765	65	50	488	22550	15	26	77
KCP04a	230	6890	32050	166200	3470	4094	269	13730	24440	2804	82	57	490	22630	18	25	74
KCP04a	220	6520	31560	166600	3455	4082	234	13730	24560	2810	83	56	494	22650	23	25	77
average	227	6533	31637	165833	3431	4074	246	13693	24443	2793	77	54	491	22610	19	25	76
KCP01b	280	6130	31680	188400	3556	3656	210	13600	21620	2691	76	75	424	20790	18	23	65
KCP01b	290	5750	31300	189600	3488	3622	185	13440	21640	2621	85	56	418	20900	30	21	61
KCP01b	220	7190	31410	189700	3572	3650	221	13440	21780	2718	59	73	436	20840	8	22	63
average	263	6357	31463	189233	3539	3643	206	13493	21680	2677	73	68	426	20843	18	22	63
KCP02b	240	7110	32240	172000	3335	3953	231	13260	22850	2648	81	56	454	22050	8	23	68
KCP02b	290	5450	32230	173300	3312	3994	204	13320	22960	2685	71	59	437	22150	11	27	69
KCP02b	230	6590	32410	174000	3393	4008	215	13440	22880	2700	80	82	434	22150	23	25	62

average	253	6383	32293	173100	3347	3985	217	13340	22897	2678	77	66	442	22117	14	25	67
KCP03b	310	6020	31540	160800	3544	3875	233	13680	27130	2660	75	60	474	22390	21	25	63
KCP03b	240	6840	31740	161600	3645	3919	268	13560	27240	2597	83	65	472	22540	8	23	64
KCP03b	240	6920	31530	161900	3651	3976	261	13540	27440	2637	63	80	464	22680	21	26	66
average	263	6593	31603	161433	3613	3923	254	13593	27270	2631	74	68	470	22537	17	24	64
KCP04b	240	6670	31130	160300	3294	3820	213	13660	28030	2707	90	88	508	23010	25	28	76
KCP04b	230	6520	31060	161300	3319	3851	241	13620	28190	2672	74	89	526	23060	18	27	77
KCP04b	270	5700	31000	161300	3276	3792	249	13730	28170	2707	75	84	524	22990	16	28	76
average	247	6297	31063	160967	3296	3821	234	13670	28130	2695	80	87	519	23020	19	27	76
KCP01c	240	5970	27830	172400	3158	3746	252	13060	22410	2522	70	87	435	20960	23	23	65
KCP01c	230	6470	27750	173500	3111	3756	245	13150	22490	2542	67	82	434	21000	19	24	63
KCP01c	240	6610	27860	175800	3166	3835	243	13210	22780	2551	60	95	451	20920	15	23	64
average	237	6350	27813	173900	3145	3779	247	13140	22560	2538	66	88	440	20960	19	24	64
KCP02c	230	6900	30880	173800	3236	3853	250	13110	22370	2647	89	64	498	22300	27	26	69
KCP02c	220	6570	31010	174300	3217	3863	260	13180	22510	2682	78	70	479	22280	20	25	72
KCP02c	290	5770	30740	175500	3277	3866	265	12980	22610	2714	59	83	490	22310	28	24	70
average	247	6413	30877	174533	3243	3861	258	13090	22497	2681	76	72	489	22297	25	25	70
KCP03c	240	6580	31480	164700	3693	3895	259	13370	25920	2592	76	75	483	22510	19	30	71
KCP03c	230	6830	31510	166400	3666	3933	230	13560	26130	2640	76	67	491	22560	14	26	68
KCP03c	240	6430	31650	167900	3756	4016	266	13490	26360	2635	70	60	483	22540	26	23	70
average	237	6613	31547	166333	3705	3948	252	13473	26137	2622	74	67	486	22537	19	26	70
KCP04c	240	6910	30880	162600	3315	4065	223	13140	24230	2569	72	81	465	21770	18	27	70
KCP04c	240	6720	31060	162900	3318	4145	236	13660	24360	2617	85	44	468	21770	10	27	67
KCP04c	290	5460	30740	164200	3422	4167	259	13450	24440	2627	77	73	460	21710	17	24	72
average	257	6363	30893	163233	3352	4126	239	13417	24343	2604	78	66	464	21750	15	26	70
KCP01d	240	6840	31990	181400	3376	3992	205	14090	21430	2688	77	96	413	22250	29	25	65
KCP01d	230	6930	31740	181800	3407	3979	209	14150	21360	2691	76	93	421	22350	13	26	65
KCP01d	290	5830	31900	182500	3366	4029	212	14100	21550	2719	76	104	437	22380	18	22	65
average	253	6533	31877	181900	3383	4000	208	14113	21447	2699	76	98	424	22327	20	25	65
KCP02d	300	5100	31510	201200	3190	3506	160	13600	20510	3033	79	80	432	21900	8	23	66
KCP02d	230	6960	31530	203300	3243	3550	183	13710	20590	3071	78	76	424	21860	14	23	68
KCP02d	210	6940	30950	203900	3304	3567	188	13840	20610	3036	79	67	417	21780	14	26	66
average	247	6333	31330	202800	3246	3541	177	13717	20570	3047	79	74	424	21847	12	24	67
KCP03d	230	7020	29300	177700	3523	3966	246	13100	26140	2626	72	102	460	20870	23	25	64
KCP03d	230	6620	29450	177500	3567	3910	269	13170	26100	2659	64	88	460	20950	17	26	65
KCP03d	230	7020	29080	178100	3578	3884	261	13170	26420	2688	73	95	474	20990	17	25	66
average	230	6887	29277	177767	3556	3920	259	13147	26220	2658	70	95	465	20937	19	25	65
KCP04d	290	5490	31590	181400	3493	3941	223	13660	23260	2717	78	72	446	22400	16	25	71
KCP04d	290	6070	30880	183300	3441	3966	220	13590	23550	2730	75	81	448	22340	27	27	69

KCP04d	290	5320	30870	182900	3482	3990	216	13660	23540	2735	79	81	454	22320	23	25	67
average	290	5627	31113	182533	3472	3966	220	13637	23450	2727	77	78	449	22353	22	26	69
KCP01a	260	5610	27010	150300	3368	3888	207	13030	23690	2483	59	57	410	20550	13	25	65
KCP01a	240	6650	29650	158600	3620	4162	245	13550	24400	2489	72	77	435	20910	7	28	66
KCP01a	290	5990	29590	161600	3556	4200	250	13420	24580	2569	70	70	421	20800	19	23	65
average	263	6083	28750	156833	3515	4083	234	13333	24223	2514	67	68	422	20753	13	25	65
KCP02a	300	5480	31240	162500	3348	4180	230	13240	23140	2620	81	62	466	21800	8	26	70
KCP02a	290	5330	31910	164800	3368	4302	237	13410	23240	2643	88	51	469	21780	17	25	73
KCP02a	240	6220	32020	165700	3435	4340	243	13460	23280	2650	95	75	476	21850	26	25	70
average	277	5677	31723	164333	3384	4274	236	13370	23220	2638	88	63	470	21810	17	25	71
KCP03a	240	6850	31140	162600	3703	4060	218	13360	26070	2621	72	68	471	22220	8	28	69
KCP03a	270	6530	31100	164100	3712	4122	255	13820	26140	2617	88	76	472	22140	17	24	67
KCP03a	240	6760	31980	165600	3754	4052	236	13510	26140	2600	75	75	490	22300	13	28	70
average	250	6713	31407	164100	3723	4078	236	13563	26117	2613	79	73	478	22220	12	27	68
KCP04a	290	5260	32160	173200	3489	4010	223	13550	23830	2681	76	71	453	21710	13	26	67
KCP04a	230	6270	32500	174400	3503	4061	229	13860	24020	2737	83	68	463	21760	15	22	67
KCP04a	230	6470	32710	174800	3426	4023	189	13670	23880	2764	75	62	433	21760	16	25	66
average	250	6000	32457	174133	3473	4031	214	13693	23910	2727	78	67	449	21743	15	24	67
KCP01b	250	6650	32320	153400	3544	3982	198	13820	25290	2595	80	62	494	23280	11	27	70
KCP01b	250	6850	32530	154500	3618	3962	233	13860	25580	2602	89	73	489	23260	17	27	72
KCP01b	250	6920	32010	154900	3574	3980	232	13670	25430	2570	72	68	513	23310	17	28	72
average	250	6807	32287	154267	3579	3975	221	13783	25433	2589	80	68	498	23283	15	27	71
KCP02b	300	5170	32310	162500	3353	4020	231	13480	23330	2663	87	73	441	22730	14	27	66
KCP02b	280	6090	32700	164700	3400	4086	236	13520	23740	2712	84	64	440	22930	19	26	71
KCP02b	240	7010	32490	166800	3362	4082	216	13570	23860	2686	80	73	435	22970	20	25	70
average	273	6090	32500	164667	3372	4063	228	13523	23643	2687	84	70	438	22877	17	26	69
KCP03b	290	5500	31210	162200	3420	3706	266	13280	26670	2645	79	68	454	22190	11	28	70
KCP03b	230	6340	31560	164500	3480	3812	266	13550	26990	2706	68	76	445	22310	9	25	67
KCP03b	240	7260	31330	165300	3517	3849	273	13380	26970	2710	76	63	461	22480	8	27	68
average	253	6367	31367	164000	3472	3789	268	13403	26877	2687	74	69	453	22327	9	26	68
KCP04b	290	5870	31500	156900	3203	3866	235	13640	28550	2758	79	94	485	23030	24	28	73
KCP04b	250	6430	31430	158900	3220	3869	230	13500	28710	2703	90	74	493	23070	14	27	70
KCP04b	250	6190	31430	160200	3282	3947	228	13440	28880	2754	74	69	498	23010	9	25	72
average	263	6163	31453	158667	3235	3894	231	13527	28713	2738	81	79	492	23037	16	27	72
KCP01c	260	6260	28490	144300	3226	4125	280	13320	25740	2415	80	64	462	21760	20	23	66
KCP01c	250	6270	28300	146600	3229	4146	270	13110	25700	2435	73	77	483	21730	10	26	70
KCP01c	260	6680	28960	147800	3247	4215	278	13170	25980	2400	67	53	478	21720	21	27	69
average	257	6403	28583	146233	3234	4162	276	13200	25807	2417	73	65	474	21737	17	25	68
KCP02c	230	6300	32060	169100	3221	3980	184	13380	23050	2682	74	68	437	22680	8	27	66

KCP02c	230	6780	31990	170000	3312	3926	204	13060	23030	2662	82	98	451	22710	8	28	68
KCP02c	280	6260	32410	170900	3338	3978	203	13350	23070	2704	91	86	460	22760	22	25	70
average	247	6447	32153	170000	3290	3961	197	13263	23050	2683	82	84	449	22717	12	27	68
KCP03c	250	6600	31680	172000	3685	3953	284	13490	25410	2642	68	61	478	21860	18	23	64
KCP03c	240	7120	32720	172500	3815	3986	300	13530	25630	2704	73	77	496	21970	14	27	64
KCP03c	240	7120	32210	173300	3751	4005	268	13490	25710	2673	88	74	493	21890	17	25	64
average	243	6947	32203	172600	3750	3981	284	13503	25583	2673	76	71	489	21907	16	25	64
KCP04c	240	6610	30900	160200	3359	3935	251	13310	24520	2597	76	62	463	21950	16	27	70
KCP04c	240	6510	30620	160800	3403	4026	238	13310	24520	2635	59	69	477	22100	10	26	67
KCP04c	300	6020	30790	160500	3291	4117	238	13600	24570	2588	88	85	439	22210	24	27	68
average	260	6380	30770	160500	3351	4026	242	13407	24537	2607	74	72	459	22087	17	27	68
KCP01d	290	5920	30540	160200	3199	3949	213	13610	21960	2529	74	68	425	22400	8	26	70
KCP01d	240	6180	30480	162600	3160	4053	202	13820	21830	2524	72	69	430	22440	13	27	68
KCP01d	240	6590	30630	163300	3148	3997	216	13830	22180	2605	70	69	446	22390	15	27	70
average	257	6230	30550	162033	3169	4000	210	13753	21990	2553	72	68	433	22410	12	26	70
KCP02d	290	5670	30970	174100	3195	3775	224	13500	22640	2640	76	75	446	22370	13	24	65
KCP02d	300	5600	31130	175500	3152	3812	229	13420	22770	2675	61	95	457	22420	7	24	66
KCP02d	280	5810	31190	177900	3243	3875	218	13560	22640	2700	76	80	441	22390	27	24	66
average	290	5693	31097	175833	3197	3821	223	13493	22683	2672	71	83	448	22393	16	24	66
KCP03d	240	6680	29210	152700	3480	4064	256	13020	27420	2454	94	70	475	21570	7	23	69
KCP03d	240	6850	29540	156000	3521	4034	272	12900	27580	2540	81	51	477	21580	13	25	70
KCP03d	290	6050	29090	157300	3586	4090	270	13060	27860	2484	83	59	487	21640	33	24	71
average	257	6527	29280	155333	3529	4063	266	12993	27620	2493	86	60	480	21597	18	24	70
KCP04d	240	6480	31130	159600	3247	4123	219	13370	25110	2533	84	63	482	22520	17	23	69
KCP04d	240	7260	30520	159800	3354	4117	255	13530	25050	2586	83	78	493	22490	21	25	71
KCP04d	240	6700	31040	161500	3398	4199	255	13550	25350	2576	86	70	500	22620	17	26	73
average	240	6813	30897	160300	3333	4146	243	13483	25170	2565	84	70	492	22543	18	25	71
KCP01e	270	5390	28640	185700	3185	3877	228	13190	21120	2457	67	77	419	20350	18	24	60
KCP01e	220	7010	31440	201300	3489	4188	233	13860	22210	2593	68	75	441	20710	23	23	57
KCP01e	300	5470	30120	197300	3358	4016	219	13550	21760	2525	68	85	445	20670	14	23	62
average	263	5957	30067	194767	3344	4027	227	13533	21697	2525	68	79	435	20577	18	23	60
KCP02e	260	6380	33800	182300	3250	3867	181	13930	21860	2830	82	98	439	23920	8	29	76
KCP02e	220	6750	35170	190000	3444	4077	220	14110	22360	2923	81	86	475	24080	28	26	74
KCP02e	250	6430	33670	186200	3295	3946	220	13860	21590	2860	81	85	470	23950	14	30	69
average	243	6520	34213	186167	3330	3963	207	13967	21937	2871	81	90	461	23983	16	28	73
KCP03e	250	6300	28830	173400	3722	3989	229	13350	25790	2581	73	68	487	21480	11	25	67
KCP03e	240	6800	28930	176000	3626	3974	235	13390	26060	2633	76	56	491	21750	27	21	69
KCP03e	270	5790	29680	175900	3616	3966	218	13350	25950	2622	84	81	486	21660	27	26	67
average	253	6297	29147	175100	3655	3976	227	13363	25933	2612	78	68	488	21630	21	24	68

KCP04e	220	6900	32840	194800	3514	3986	168	14100	22590	2795	71	102	457	21340	12	25	65
KCP04e	280	5810	32060	195800	3552	3890	192	14030	22620	2828	79	83	471	21260	24	23	63
KCP04e	290	6230	32390	196100	3496	3956	192	13980	22600	2806	79	105	461	21290	21	23	64
average	263	6313	32430	195567	3521	3944	184	14037	22603	2810	76	97	463	21297	19	24	64
KCP01a	250	6590	27760	146400	3444	4129	263	13120	25370	2362	69	69	443	20910	7	25	67
KCP01a	240	6280	28290	148700	3500	4169	266	13340	25670	2399	74	88	437	20830	16	24	69
KCP01a	240	7020	30240	155300	3498	4303	249	13670	25910	2401	69	89	435	21110	9	24	67
average	243	6630	28763	150133	3481	4200	259	13377	25650	2387	70	82	438	20950	11	24	67
KCP02a	280	5870	30580	159600	3305	4168	222	13100	23100	2621	69	73	467	21760	11	26	72
KCP02a	230	6400	30750	160900	3349	4217	257	13160	23370	2673	74	64	477	21790	14	27	76
KCP02a	230	6650	31580	164200	3406	4260	246	13310	23470	2680	83	61	463	21940	17	27	76
average	247	6307	30970	161567	3353	4215	242	13190	23313	2658	75	66	469	21830	14	27	75
KCP03a	230	7310	30480	167900	3719	4063	236	13260	25900	2528	80	83	454	21740	20	23	67
KCP03a	230	6820	31150	168700	3759	4012	267	13160	25960	2548	94	80	452	21880	7	26	66
KCP03a	290	5760	31520	169400	3726	4023	229	13040	25940	2561	55	71	442	21860	14	25	67
average	250	6630	31050	168667	3735	4033	244	13153	25933	2546	76	78	449	21827	14	24	67
KCP04a	240	6440	32420	157100	3451	4079	227	13560	25600	2806	97	76	484	22980	10	27	73
KCP04a	230	6940	32730	158200	3557	4136	258	13650	25790	2795	92	70	468	23040	12	28	77
KCP04a	270	6130	32260	158500	3519	4095	260	13530	25780	2834	88	71	481	22980	11	29	75
average	247	6503	32470	157933	3509	4103	248	13580	25723	2812	92	72	478	23000	11	28	75
KCP01b	250	7140	32570	161300	3590	3918	228	13780	25130	2618	89	59	478	23230	18	26	72
KCP01b	240	7060	33380	162800	3620	3930	231	13780	25170	2670	71	72	466	23240	12	27	72
KCP01b	240	7530	33030	164000	3616	3894	243	13880	25330	2657	77	58	490	23260	20	27	76
average	243	7243	32993	162700	3609	3914	234	13813	25210	2648	79	63	478	23243	17	27	73
KCP02b	240	6820	32260	167900	3297	3947	194	13000	22780	2638	69	67	431	22050	15	27	65
KCP02b	230	6740	32280	169400	3366	3947	220	13160	23150	2615	78	69	436	22030	18	24	67
KCP02b	230	6920	32630	170000	3363	4001	216	13250	23060	2651	70	64	448	22180	8	27	68
average	233	6827	32390	169100	3342	3965	210	13137	22997	2635	72	67	438	22087	14	26	67
KCP03b	240	7080	32120	159800	3518	3775	244	13470	27110	2661	81	62	470	22310	14	27	70
KCP03b	240	6740	31860	160600	3546	3810	197	13280	27400	2677	69	90	469	22360	16	26	66
KCP03b	250	7110	32470	161800	3627	3847	236	13460	27380	2721	87	74	450	22410	18	25	71
average	243	6977	32150	160733	3564	3811	226	13403	27297	2686	79	76	463	22360	16	26	69
KCP04b	240	6330	30300	169200	3214	3747	205	13110	27460	2625	70	86	482	22390	19	25	69
KCP04b	270	6410	30410	170600	3264	3809	123	13050	27600	2630	71	87	486	22510	21	24	66
KCP04b	240	6460	30330	171100	3210	3791	198	13130	27480	2636	92	72	502	22510	18	26	71
average	250	6400	30347	170300	3229	3782	175	13097	27513	2630	78	82	490	22470	19	25	69
KCP01c	250	6860	28430	148900	3187	4057	273	13430	25540	2513	69	73	480	22430	7	27	76
KCP01c	240	5880	29050	149400	3174	4062	275	13300	25650	2505	80	81	479	22390	12	26	74
KCP01c	240	6600	29050	150400	3127	4068	242	13290	25770	2480	85	61	494	22520	25	26	78

average	243	6447	28843	149567	3163	4062	263	13340	25653	2499	78	71	485	22447	15	26	76
KCP02c	280	5920	32330	173300	3352	3986	207	13520	23020	2665	84	69	462	22210	16	27	69
KCP02c	290	6110	32580	174100	3381	3924	224	13410	22870	2685	76	67	463	22240	18	25	65
KCP02c	290	5880	32260	175000	3353	4012	220	13420	22820	2668	71	70	469	22340	16	25	67
average	287	5970	32390	174133	3362	3974	217	13450	22903	2673	77	68	464	22263	17	26	67
KCP03c	240	6110	28910	167900	3481	3639	219	13170	24200	2501	74	82	484	21530	17	25	67
KCP03c	240	6300	29510	170900	3492	3652	210	13210	24700	2476	80	104	488	21640	11	28	71
KCP03c	270	6210	31960	178100	3614	3816	208	13370	25010	2546	66	104	474	21820	8	28	67
average	250	6207	30127	172300	3529	3702	212	13250	24637	2508	73	96	482	21663	12	27	68
KCP04c	290	6100	30840	151300	3313	4136	262	13260	25770	2471	74	86	491	21750	26	25	69
KCP04c	240	6650	30910	153800	3405	4165	253	13240	25820	2563	75	89	492	21960	11	25	71
KCP04c	240	6670	31340	156500	3492	4188	256	13410	25890	2573	74	82	482	21850	27	25	68
average	257	6473	31030	153867	3403	4163	257	13303	25827	2536	74	86	488	21853	21	25	69
KCP01d	250	6920	31110	150400	3236	4104	235	13950	23330	2593	97	58	446	23160	23	27	73
KCP01d	240	7040	31440	152200	3285	4149	239	14070	23400	2603	77	70	458	23290	15	29	74
KCP01d	230	6930	31400	153100	3296	4141	237	13930	23500	2619	84	72	452	23290	15	26	76
average	240	6963	31317	151900	3272	4131	237	13983	23410	2605	86	67	452	23247	17	27	74
KCP02d	240	6210	30610	159300	3148	3845	227	13240	23890	2714	83	71	475	23180	23	27	72
KCP02d	240	6690	30310	160900	3193	3805	214	13370	23930	2681	72	72	480	23250	14	28	76
average	260	6150	30497	159133	3156	3814	219	13243	23857	2691	77	69	485	23210	15	28	73
KCP03d	250	6980	28350	163500	3459	3924	265	12840	26730	2494	75	54	470	20910	21	24	64
KCP03d	280	6130	28870	163900	3501	3914	268	12590	26620	2440	80	69	453	20870	29	22	65
KCP03d	300	5070	28570	164300	3517	3915	283	12910	26550	2490	85	71	477	20960	18	26	66
average	277	6060	28597	163900	3492	3918	272	12780	26633	2475	80	65	467	20913	23	24	65
KCP04d	270	6040	31100	155900	3243	3937	255	13350	25070	2691	88	52	461	22760	17	28	73
KCP04d	240	6880	31360	157500	3292	3974	260	13410	24930	2707	74	80	464	22860	14	27	72
KCP04d	240	6550	31290	159000	3429	4048	257	13390	25100	2691	80	58	464	22810	20	27	75
average	250	6490	31250	157467	3321	3986	257	13383	25033	2696	81	63	463	22810	17	28	73
KCP01e	280	5580	30000	173400	3296	4065	210	13800	22670	2441	69	48	443	21170	11	24	65
KCP01e	240	6560	30720	174700	3272	4096	213	13870	22720	2500	74	72	443	21150	20	25	65
KCP01e	240	7060	31080	175400	3363	4077	197	13960	22690	2474	74	60	451	21240	20	23	65
average	253	6400	30600	174500	3310	4079	207	13877	22693	2472	72	60	446	21187	17	24	65
KCP02e	230	6770	32980	173300	3198	3952	235	13720	22340	2792	85	72	471	22820	13	26	70
KCP02e	230	6970	33130	173800	3292	3943	239	13770	22440	2801	95	64	477	22840	8	27	73
KCP02e	290	5920	33200	174800	3274	4005	237	13510	22430	2839	68	84	448	22890	12	28	69
average	250	6553	33103	173967	3255	3967	237	13667	22403	2811	83	73	465	22850	11	27	71
KCP03e	290	6280	29320	157800	3542	4029	238	13180	26990	2494	67	72	511	21440	19	24	71
KCP03e	240	6980	30230	160100	3530	4058	221	13270	27130	2530	81	56	489	21450	7	27	68
KCP03e	240	7150	30450	160100	3683	4205	252	13170	27240	2536	84	65	492	21560	12	24	66

average	257	6803	30000	159333	3585	4097	237	13207	27120	2520	77	64	497	21483	13	25	68
KCP04e	290	6410	33320	165300	3437	4158	253	14060	25020	2798	73	86	465	22440	8	28	69
KCP04e	280	6360	33700	168000	3461	4184	259	14110	25030	2817	98	90	475	22480	8	25	69
KCP04e	270	6750	33810	171300	3483	4091	260	13990	25010	2832	73	57	484	22480	23	25	70
average	280	6507	33610	168200	3460	4144	257	14053	25020	2816	81	78	474	22467	13	26	69
KCP01f	230	7120	28430	181100	3407	3924	210	13410	24780	2452	73	99	428	19170	9	25	56
KCP01f	290	5950	28040	181300	3370	3969	172	13370	24980	2462	66	73	410	19260	26	18	58
KCP01f	230	6640	28280	181400	3430	3906	203	13400	24620	2474	64	75	430	19140	12	23	59
average	250	6570	28250	181267	3402	3933	195	13393	24793	2463	67	82	422	19190	15	22	58
KCP02f	240	7020	31650	192400	3689	3657	183	13380	24350	2663	65	66	440	20960	8	24	56
KCP02f	290	5440	31420	192600	3697	3676	169	13350	24670	2669	60	54	460	20840	10	23	58
KCP02f	230	6900	31550	194500	3676	3703	184	13520	24680	2682	66	64	450	20900	11	22	57
average	253	6453	31540	193167	3687	3679	178	13417	24567	2671	64	61	450	20900	10	23	57
KCP03f	230	6910	30940	196100	3546	3907	180	13320	22630	2653	73	97	470	20300	19	25	65
KCP03f	290	5710	30130	197300	3548	3917	170	13320	22750	2681	81	102	476	20210	26	24	60
KCP03f	270	6460	30450	198300	3540	4010	176	13460	22800	2711	78	89	480	20140	7	25	61
average	263	6360	30507	197233	3545	3945	175	13367	22727	2682	77	96	475	20217	17	25	62
KCP04f	220	6920	32240	193500	3611	3881	203	13770	23030	2711	66	81	445	21010	30	23	64
KCP04f	230	7040	32290	195900	3580	3938	182	13700	23100	2724	77	74	455	21150	10	26	62
KCP04f	220	7670	32370	195900	3565	3951	168	13620	23020	2708	76	73	452	21080	8	26	64
average	223	7210	32300	195100	3585	3923	184	13697	23050	2714	73	76	451	21080	16	25	63
KCP01a	240	6770	29810	155700	3644	4200	240	13540	25570	2428	78	68	449	21040	9	26	70
KCP01a	240	6430	29880	156400	3561	4212	216	13460	25550	2346	82	88	441	21080	14	26	72
KCP01a	290	5760	30700	161400	3835	4435	250	13760	26130	2529	62	88	458	21350	16	27	69
average	257	6320	30130	157833	3680	4282	235	13587	25750	2434	74	81	449	21157	13	26	70
KCP02a	230	6580	31130	162600	3294	4266	198	13100	23330	2639	84	45	482	21900	12	26	76
KCP02a	220	6560	31240	164200	3402	4267	217	13340	23410	2683	78	73	489	22020	18	26	76
KCP02a	230	6510	32030	168000	3573	4423	229	13620	23680	2713	85	64	481	22070	21	27	77
average	227	6550	31467	164933	3423	4319	215	13353	23473	2678	83	61	484	21997	17	26	76
KCP03a	260	6190	31310	172200	3780	4081	242	13370	25800	2503	91	79	458	21970	18	24	68
KCP03a	280	5850	30830	170300	3739	4000	233	13080	25760	2612	62	72	456	21870	12	26	66
KCP03a	280	6020	30920	170900	3763	3992	252	13360	25720	2548	57	80	459	21910	18	26	71
average	273	6020	31020	171133	3761	4024	242	13270	25760	2554	70	77	458	21917	16	25	68
KCP04a	230	6820	32630	158000	3482	4073	213	13610	25530	2777	94	66	479	23000	14	27	73
KCP04a	230	6930	32900	158100	3433	4145	214	13540	25500	2825	83	75	484	22990	25	25	73
KCP04a	230	6740	32780	159500	3559	4147	246	13700	25660	2849	75	87	493	23130	13	30	73
average	230	6830	32770	158533	3491	4122	224	13617	25563	2817	84	76	486	23040	17	28	73
KCP01b	290	5960	32500	162400	3655	3911	241	13720	25020	2656	74	67	492	23250	8	28	73
KCP01b	240	6720	33420	163500	3622	3950	201	13750	25030	2639	89	66	496	23330	14	29	74

KCP01b	240	7120	33760	164300	3657	3945	240	13940	25130	2679	81	64	486	23390	14	28	75
average	257	6600	33227	163400	3645	3935	227	13803	25060	2658	81	66	492	23323	12	28	74
KCP02b	280	5190	31890	169100	3381	3942	216	13260	22800	2585	79	72	441	22200	8	26	70
KCP02b	290	5550	32590	170100	3381	3980	209	13190	22960	2631	77	70	437	22240	9	27	69
KCP02b	230	7390	32860	171400	3437	4064	215	13120	23160	2591	66	61	453	22240	15	25	71
average	267	6043	32447	170200	3400	3995	213	13190	22973	2602	74	68	444	22227	11	26	70
KCP03b	350	6790	32730	166800	3600	3989	240	13860	28020	2774	84	89	479	22290	18	27	70
KCP03b	240	7130	31830	164100	3515	3831	232	13640	27200	2690	92	74	450	22370	23	25	70
KCP03b	230	7000	32330	164000	3667	3797	223	13550	27230	2739	80	79	464	22400	23	28	70
average	273	6973	32297	164967	3594	3872	232	13683	27483	2734	86	81	464	22353	21	27	70
KCP04b	340	6640	31590	168100	3261	4114	210	13270	28600	2682	79	75	494	22660	8	26	77
KCP04b	240	6470	30780	166700	3220	3860	200	13380	27720	2637	94	74	506	22620	22	24	72
KCP04b	240	6780	31080	167800	3469	3906	203	13100	28000	2693	81	61	512	22660	26	25	75
average	273	6630	31150	167533	3317	3960	204	13250	28107	2671	85	70	504	22647	19	25	74
KCP01c	240	6240	28460	152500	3171	3977	238	13260	25290	2468	73	68	489	22160	18	27	76
KCP01c	230	5740	28870	153900	3259	4065	265	13210	25230	2513	72	61	490	22210	19	27	76
KCP01c	240	5930	28430	155000	3236	4102	282	13390	25470	2476	82	68	477	22390	12	28	73
average	237	5970	28587	153800	3222	4048	262	13287	25330	2486	76	66	485	22253	16	27	75
KCP02c	270	5900	32130	174800	3425	3955	218	13210	22760	2688	76	66	471	22270	8	26	68
KCP02c	280	6130	31970	176300	3421	4009	215	13370	22760	2711	78	74	480	22360	11	25	68
KCP02c	290	5920	32840	176100	3349	3965	183	13490	22810	2696	85	66	464	22370	9	25	68
average	280	5983	32313	175733	3398	3976	205	13357	22777	2698	79	69	472	22333	9	25	68
KCP03c	240	5840	29170	168600	3431	3616	180	13000	24180	2493	67	87	481	21620	10	28	68
KCP03c	240	7000	31840	178500	3704	3849	198	13420	24750	2515	68	86	503	21680	23	25	68
KCP03c	260	7080	32080	181900	3701	3890	200	13380	25060	2567	82	96	479	21840	23	26	65
average	247	6640	31030	176333	3612	3785	193	13267	24663	2525	72	90	488	21713	19	26	67
KCP04c	300	4910	31100	159400	3372	4160	217	13310	25340	2524	89	87	482	21430	23	25	68
KCP04c	250	6790	31770	163000	3447	4250	215	13460	25330	2555	82	86	482	21700	7	26	66
KCP04c	240	7040	31680	163200	3513	4244	245	13520	25360	2581	71	89	474	21660	13	25	67
average	263	6247	31517	161867	3444	4218	226	13430	25343	2553	80	87	480	21597	14	26	67
KCP01d	260	7110	31200	156300	3343	4190	212	13990	23510	2703	84	75	463	23190	15	30	74
KCP01d	240	6840	31350	155500	3270	4148	189	14080	23110	2636	89	74	462	23150	12	28	75
KCP01d	240	6670	31030	155400	3335	4153	210	14040	23360	2679	72	65	463	23280	18	29	76
average	247	6873	31193	155733	3316	4164	204	14037	23327	2673	82	71	463	23207	15	29	75
KCP02d	240	6240	30940	161700	3215	3760	218	13380	23690	2711	81	65	487	23120	20	28	76
KCP02d	240	6410	31040	163400	3219	3824	206	13520	23580	2731	76	82	470	23130	8	30	78
KCP02d	240	6550	30660	164700	3230	3816	200	13300	23860	2738	98	73	480	23150	21	29	76
average	240	6400	30880	163267	3221	3800	208	13400	23710	2727	85	73	479	23133	16	29	77
KCP03d	230	6730	28510	165200	3570	3898	272	12780	26590	2493	74	56	465	21030	7	24	67

KCP03d	240	6590	28390	166900	3530	3917	273	12830	26390	2477	61	62	477	20990	9	25	63
KCP03d	230	6690	28170	167900	3544	3936	272	12830	26630	2503	66	70	467	21090	8	26	65
average	233	6670	28357	166667	3548	3917	272	12813	26537	2491	67	63	470	21037	8	25	65
KCP04d	280	5760	31110	159600	3359	3982	241	13390	24830	2697	81	64	463	22790	18	26	76
KCP04d	270	5930	30710	159500	3298	3973	242	13330	24650	2728	85	86	472	22770	13	29	76
KCP04d	270	6060	31210	160200	3392	3981	239	13580	24820	2769	68	77	463	22970	16	29	75
average	273	5917	31010	159767	3350	3979	241	13433	24767	2731	78	76	466	22843	15	28	75
KCP01e	240	7680	30980	172600	3326	4126	207	13830	22570	2476	79	64	451	21310	18	26	64
KCP01e	290	5840	30900	174700	3343	4119	187	13850	22730	2458	68	58	450	21260	20	25	66
KCP01e	230	6790	31090	174900	3345	4145	185	13850	22650	2494	74	68	464	21340	19	26	67
average	253	6770	30990	174067	3338	4130	193	13843	22650	2476	74	64	455	21303	19	26	66
KCP02e	260	6170	33450	174600	3269	3933	253	13740	22420	2782	82	71	449	22830	14	24	68
KCP02e	230	7550	33550	176700	3296	3945	233	13870	22460	2798	74	83	464	22950	8	27	74
KCP02e	310	5930	33080	177100	3312	3976	244	13810	22380	2833	67	98	458	23000	10	28	70
average	267	6550	33360	176133	3292	3951	243	13807	22420	2804	74	84	457	22927	11	26	71
KCP03e	240	6660	29210	160300	3636	4109	245	13420	26940	2555	92	72	483	21520	12	25	69
KCP03e	280	6270	29620	161400	3643	4072	237	13180	26880	2580	83	59	490	21390	12	28	67
KCP03e	310	5420	29950	162500	3619	4123	216	13540	27100	2573	68	72	495	21460	7	28	67
average	277	6117	29593	161400	3633	4101	233	13380	26973	2569	81	68	489	21457	10	27	67
KCP04e	280	5750	33800	169400	3457	4155	207	14270	24860	2792	80	69	472	22430	16	26	70
KCP04e	240	7900	34060	170100	3491	4106	235	14200	24640	2811	79	78	471	22410	21	26	71
KCP04e	300	5870	33810	170000	3549	4145	236	14270	24820	2781	78	81	475	22500	16	26	70
average	273	6507	33890	169833	3499	4135	226	14247	24773	2795	79	76	473	22447	18	26	70
KCP01f	290	5850	27610	174800	3199	3675	180	12830	23550	2464	63	86	405	18550	9	23	58
KCP01f	280	5790	27120	176500	3271	3721	116	12780	23810	2431	64	79	415	18630	22	20	57
KCP01f	230	6820	27400	176400	3322	3718	177	12820	23820	2495	55	83	399	18630	8	22	55
average	267	6153	27377	175900	3264	3705	157	12810	23727	2463	61	82	406	18603	13	22	56
KCP02f	270	5760	29990	186100	3437	3505	147	12760	23370	2579	70	60	434	20260	8	23	58
KCP02f	220	6880	30360	189000	3644	3587	180	12970	23580	2546	66	72	445	20250	26	22	55
KCP02f	220	6530	30790	189900	3583	3631	101	12860	23550	2569	58	71	444	20360	14	23	57
average	237	6390	30380	188333	3555	3574	143	12863	23500	2565	65	68	441	20290	16	23	57
KCP03f	310	5140	29190	192400	3393	3813	164	13140	21930	2620	67	100	466	19760	15	22	61
KCP03f	290	5480	28960	193500	3395	3784	161	13200	22100	2651	91	95	451	19810	7	21	60
KCP03f	270	6420	29550	194500	3430	3814	90	13270	22180	2655	75	83	456	19870	13	23	63
average	290	5680	29233	193467	3406	3804	138	13203	22070	2642	78	93	457	19813	12	22	61
KCP04f	290	5690	30070	188100	3492	3778	198	13140	22250	2681	84	69	427	20510	9	25	60
KCP04f	220	6750	30460	190000	3459	3860	197	13200	22220	2656	65	68	429	20570	15	23	65
KCP04f	270	5960	31320	191700	3489	3821	174	13430	22380	2671	59	86	431	20570	7	23	63
average	260	6133	30617	189933	3480	3820	190	13257	22283	2669	69	74	429	20550	11	24	63

KCP01g	240	7010	28200	161200	3537	3952	246	13010	28270	2420	65	72	505	20020	11	23	63
KCP01g	290	5750	28150	162400	3526	4021	255	13410	28820	2424	61	71	487	20090	12	19	63
KCP01g	240	7130	28250	162500	3598	4085	261	13470	28600	2444	80	64	491	20050	7	23	65
average	257	6630	28200	162033	3554	4019	254	13297	28563	2429	69	69	494	20053	10	21	64
KCP02g	230	6110	30190	185500	3348	3742	215	13630	22950	2637	74	112	456	21640	27	25	66
KCP02g	290	5350	29700	187700	3397	3822	224	13650	22990	2635	86	98	470	21770	19	25	68
KCP02g	230	7080	30400	187800	3385	3771	222	13580	23050	2704	76	83	456	21800	23	22	65
average	250	6180	30097	187000	3377	3778	220	13620	22997	2659	79	98	461	21737	23	24	66
KCP03g	300	5970	31870	192400	3488	4026	249	13310	22910	2691	68	71	409	20930	20	23	65
KCP03g	290	6290	31490	193800	3468	4052	251	13290	22970	2661	68	77	424	21060	9	24	64
KCP03g	280	5780	31800	193900	3460	4037	247	13310	22880	2684	70	67	417	21020	7	25	62
average	290	6013	31720	193367	3472	4038	249	13303	22920	2679	69	72	417	21003	12	24	64
KCP04g	220	7260	32800	192700	3572	3808	174	13990	23330	2869	78	93	472	22580	14	25	64
KCP04g	270	6900	32380	194200	3580	3862	173	13840	23400	2841	64	92	456	22690	12	24	63
KCP04g	210	7460	32190	195000	3638	3898	174	13890	23400	2832	75	102	464	22520	15	26	67
average	233	7207	32457	193967	3597	3856	174	13907	23377	2847	72	96	464	22597	14	25	65
	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Y	Zr	Nb	Mo	Ag	Cd	In	Sn	
KCP01a	180	6	3	12	1	28	53	86	21	286	3	9	1	5	1	67	
KCP01a	182	7	2	14	1	29	54	87	21	268	8	5	1	2	0	65	
KCP01a	183	7	2	13	1	28	53	86	21	281	12	6	1	2	1	65	
Average	182	7	2	13	1	28	53	86	21	278	8	7	1	3	1	66	
KCP02a	202	5	2	12	1	32	55	88	22	301	11	6	5	3	1	49	
KCP02a	203	7	2	12	1	31	55	86	22	309	8	6	1	2	0	49	
KCP02a	205	7	2	15	1	31	56	89	21	299	11	6	1	2	0	49	
Average	203	6	2	13	1	31	55	88	22	303	10	6	2	2	0	49	
KCP03a	196	7	3	12	1	30	53	90	22	246	10	7	1	2	1	53	
KCP03a	198	6	2	13	1	29	53	91	21	231	11	8	3	2	0	54	
KCP03a	193	7	2	11	1	29	52	92	22	235	11	7	1	2	1	56	
Average	196	7	2	12	1	29	53	91	22	237	10	7	1	2	1	54	
KCP04a	197	7	3	13	1	31	55	91	22	282	10	5	2	2	0	24	
KCP04a	201	7	2	13	1	31	55	91	23	291	2	4	1	2	0	26	
KCP04a	199	7	2	14	1	31	55	91	22	282	12	5	1	1	0	24	
Average	199	7	2	13	1	31	55	91	22	285	8	5	1	2	0	25	
KCP01a	176	6	2	12	0	28	50	82	21	270	2	4	1	1	1	61	
KCP01a	178	6	2	12	1	28	50	83	21	269	7	4	3	2	1	66	
KCP01a	174	7	2	11	1	28	50	82	21	267	7	7	1	2	0	67	
Average	176	6	2	12	1	28	50	82	21	269	5	5	1	2	1	65	
KCP02a	197	8	2	10	1	31	55	86	23	245	9	6	1	2	0	42	
KCP02a	202	7	3	14	1	32	55	87	22	240	8	6	3	2	0	42	

KCP02a	202	6	2	10	1	31	55	87	22	240	8	6	3	2	0	41
Average	200	7	2	11	1	31	55	86	22	242	8	6	2	2	0	42
KCP03a	165	6	1	10	1	24	49	84	20	301	7	6	1	2	1	69
KCP03a	167	5	2	10	1	25	50	84	20	287	6	9	1	2	0	72
KCP03a	171	7	2	12	1	25	49	85	20	298	9	8	1	2	0	72
Average	167	6	2	11	1	25	49	84	20	295	7	7	1	2	0	71
KCP04a	191	8	2	11	1	29	54	88	21	241	8	8	0	2	0	24
KCP04a	188	6	2	10	1	30	53	90	22	239	7	7	1	1	0	25
KCP04a	188	6	3	13	1	29	53	88	23	241	8	5	1	2	0	25
Average	189	6	2	12	1	29	53	89	22	240	8	7	0	2	0	25
KCP01b	178	6	2	11	1	26	53	83	22	282	10	5	2	2	0	21
KCP01b	183	7	2	12	1	28	53	83	22	287	2	5	1	1	0	22
KCP01b	181	6	1	12	1	26	54	83	22	279	9	3	1	2	0	23
Average	180	6	2	12	1	27	53	83	22	282	7	4	1	2	0	22
KCP02b	193	7	2	13	1	29	55	86	23	289	10	6	1	2	0	14
KCP02b	188	7	2	13	1	30	54	86	23	290	9	5	3	2	0	13
KCP02b	191	6	2	10	0	30	55	86	23	304	10	6	1	2	0	16
Average	190	7	2	12	1	30	55	86	23	294	10	6	1	2	0	14
KCP03b	173	7	2	10	1	25	52	88	22	282	5	3	1	2	1	23
KCP03b	176	8	2	10	1	25	52	89	22	298	7	5	1	2	0	23
KCP03b	174	6	2	12	1	24	52	88	22	292	9	8	1	2	0	23
Average	174	7	2	11	1	25	52	88	22	291	7	5	1	2	1	23
KCP04b	216	7	2	15	1	33	57	96	22	243	9	3	1	2	0	11
KCP04b	214	7	2	15	1	33	56	95	23	247	10	6	2	2	0	10
KCP04b	212	6	3	15	1	33	57	94	22	235	7	5	2	2	0	10
Average	214	7	2	15	1	33	57	95	23	242	8	5	2	2	0	10
KCP01a	176	6	2	11	1	28	51	84	21	275	9	10	1	1	0	70
KCP01a	175	6	2	10	1	28	51	84	21	259	7	6	1	2	0	68
KCP01a	178	7	3	13	1	28	52	83	21	279	8	5	1	2	1	73
Average	176	6	2	11	1	28	51	84	21	271	8	7	1	2	0	70
KCP02a	201	6	2	11	1	31	55	87	23	246	9	5	1	2	1	43
KCP02a	200	6	2	10	1	31	55	87	23	241	8	5	3	2	0	42
KCP02a	200	7	2	12	1	31	55	86	23	249	9	7	1	2	0	42
Average	200	6	2	11	1	31	55	87	23	245	9	6	1	2	0	42
KCP03a	166	6	2	12	1	24	49	85	20	293	5	4	3	2	1	71
KCP03a	165	6	2	10	1	24	49	84	21	296	7	6	3	2	1	73
KCP03a	169	6	2	10	0	24	49	86	21	299	8	5	3	2	1	72
Average	167	6	2	11	1	24	49	85	21	296	7	5	3	2	1	72
KCP04a	195	6	2	12	1	30	54	89	22	241	6	7	2	2	0	27

KCP04a	190	6	2	11	1	29	54	89	22	253	10	7	1	2	0	28
KCP04a	195	7	2	10	1	30	54	89	21	244	2	6	1	2	0	30
Average	193	6	2	11	1	29	54	89	22	246	6	7	1	2	0	28
KCP01b	179	7	1	12	1	26	52	83	22	276	2	5	1	2	0	24
KCP01b	177	5	2	12	1	27	52	83	23	287	7	7	1	2	1	26
KCP01b	179	7	2	12	1	26	53	84	23	279	9	8	1	2	0	25
Average	178	6	2	12	1	26	53	84	22	281	6	7	1	2	0	25
KCP02b	188	7	2	12	1	29	55	86	22	293	8	6	2	2	0	14
KCP02b	191	6	2	12	1	29	56	87	23	316	10	8	1	2	1	16
KCP02b	191	6	1	12	1	30	55	85	23	318	9	6	3	3	1	16
Average	190	6	2	12	1	29	55	86	23	309	9	7	2	2	1	16
KCP03b	176	7	1	10	1	25	51	88	21	319	10	4	1	3	0	24
KCP03b	177	7	2	11	1	25	51	88	22	329	10	7	1	2	0	24
Average	175	6	2	10	1	26	51	88	21	320	8	6	1	2	0	24
KCP04b	213	7	3	14	1	33	57	95	22	246	6	5	3	2	0	10
KCP04b	212	7	2	13	1	34	56	95	23	245	9	6	0	2	0	9
KCP04b	219	6	3	13	1	33	58	96	22	254	9	3	1	3	0	10
Average	215	7	3	13	1	33	57	95	22	248	8	5	1	2	0	10
KCP01c	180	6	2	8	1	30	52	82	20	238	10	5	1	2	0	14
KCP01c	184	5	3	10	1	30	52	83	21	262	10	5	1	2	0	16
KCP01c	184	6	3	12	1	30	52	84	20	240	2	6	1	3	0	16
Average	183	5	2	10	1	30	52	83	21	247	7	5	1	2	0	15
KCP02c	187	6	2	10	1	29	52	86	22	296	10	8	1	2	1	45
KCP02c	187	6	1	12	1	29	53	85	22	281	9	8	1	2	1	46
KCP02c	188	8	1	12	1	28	53	86	22	292	7	6	1	3	1	47
Average	187	6	2	11	1	28	53	86	22	290	9	7	1	2	1	46
KCP03c	194	7	1	10	1	26	54	91	22	301	12	4	1	3	0	27
KCP03c	194	7	1	11	1	28	55	90	21	308	10	5	1	2	1	27
KCP03c	192	6	3	13	1	28	55	91	22	298	12	5	1	3	2	27
Average	193	7	2	11	1	27	55	91	22	302	11	5	1	3	1	27
KCP04c	173	6	2	12	1	26	50	82	20	291	12	5	1	3	1	16
KCP04c	176	6	3	10	1	25	50	82	21	279	9	5	1	3	0	15
KCP04c	173	6	1	11	1	25	50	83	21	287	12	9	1	3	1	16
Average	174	6	2	11	1	25	50	82	21	286	11	7	1	3	0	16
KCP01a	170	6	1	13	1	28	50	84	21	225	6	6	0	2	0	47
KCP01a	175	6	2	12	1	28	49	84	21	240	7	5	1	2	1	50
KCP01a	174	6	2	12	1	27	50	85	20	233	7	4	3	2	0	49
average	173	6	2	12	1	28	49	84	21	233	7	5	1	2	0	48
KCP02a	195	6	2	13	1	31	54	86	21	303	8	6	1	1	0	45

KCP02a	198	6	2	13	1	30	54	86	22	288	5	7	3	2	0	44
KCP02a	195	7	2	14	1	31	54	85	22	290	2	7	1	2	0	46
average	196	6	2	13	1	31	54	86	22	294	5	6	1	2	0	45
KCP03a	186	6	2	13	1	27	52	89	22	263	8	6	1	2	0	86
KCP03a	189	7	3	12	0	27	50	90	22	266	7	4	3	3	1	85
KCP03a	188	6	2	12	1	28	52	88	21	261	5	6	1	2	1	86
average	188	6	2	12	1	27	51	89	21	263	7	5	1	2	1	86
KCP04a	203	8	2	14	1	32	54	90	23	234	9	6	1	1	0	28
KCP04a	203	6	2	14	1	30	55	89	22	257	7	5	0	1	0	27
KCP04a	201	8	2	13	1	31	56	90	22	259	7	4	1	2	0	27
average	202	7	2	13	1	31	55	90	22	250	7	5	0	1	0	27
KCP01b	169	7	2	12	1	24	49	79	22	271	8	6	1	2	0	22
KCP01b	170	6	2	12	1	26	50	80	21	283	6	6	2	2	0	24
KCP01b	169	7	2	13	1	25	51	81	21	301	8	5	1	2	0	25
average	170	6	2	12	1	25	50	80	21	285	7	6	1	2	0	24
KCP02b	185	6	2	14	1	28	52	82	20	255	9	5	1	2	0	14
KCP02b	185	7	2	14	1	28	51	83	22	248	2	6	3	2	0	14
KCP02b	185	7	2	15	1	28	52	82	21	243	7	5	1	1	0	15
average	185	6	2	14	1	28	52	82	21	249	6	5	1	2	0	14
KCP03b	182	6	2	14	1	26	50	87	21	281	6	5	1	1	0	28
KCP03b	182	7	2	11	1	27	50	87	21	276	6	4	2	1	0	27
KCP03b	183	7	2	10	1	27	51	88	21	293	8	5	1	2	0	28
average	182	7	2	12	1	27	50	87	21	283	7	5	1	2	0	28
KCP04b	207	8	2	13	1	30	54	90	20	262	6	3	1	2	1	11
KCP04b	205	8	3	14	1	31	53	91	21	267	7	2	1	3	0	10
KCP04b	206	7	2	15	1	30	54	91	21	255	7	4	1	2	1	10
average	206	8	2	14	1	30	54	91	21	261	7	3	1	2	1	10
KCP01c	178	5	2	12	1	28	49	80	20	266	6	6	1	2	0	14
KCP01c	181	6	2	13	1	29	50	81	20	272	8	5	1	2	1	15
KCP01c	176	5	2	11	1	29	50	81	21	266	7	5	1	3	0	15
average	178	5	2	12	1	29	50	81	20	268	7	5	1	2	0	15
KCP02c	195	7	2	14	1	28	52	83	21	298	6	6	1	2	1	23
KCP02c	194	7	2	13	1	28	51	82	21	310	9	7	1	1	0	25
KCP02c	195	7	2	13	1	29	52	83	21	314	9	5	1	2	1	28
average	195	7	2	14	1	28	52	83	21	307	8	6	1	2	0	25
KCP03c	194	6	1	13	1	27	51	90	21	267	9	7	2	2	1	25
KCP03c	192	7	2	14	1	28	53	89	21	260	7	5	1	2	0	24
KCP03c	198	6	3	13	1	28	53	90	21	263	9	7	1	3	1	26
average	195	6	2	14	1	28	52	90	21	263	8	6	1	2	0	25

KCP04c	187	6	3	13	1	27	50	82	21	255	7	5	1	2	0	25
KCP04c	187	6	2	13	0	27	50	81	21	258	5	3	1	3	0	25
KCP04c	184	7	2	14	1	26	51	82	21	271	9	5	1	3	1	27
average	186	6	2	13	1	27	50	82	21	262	7	4	1	2	0	26
KCP01d	188	6	2	12	1	30	54	83	22	302	2	4	1	3	2	16
KCP01d	183	6	2	14	1	29	55	82	22	316	6	2	1	2	1	15
KCP01d	183	7	2	12	1	30	55	83	23	305	10	6	1	3	0	14
average	184	6	2	12	1	30	55	83	22	307	6	4	1	3	1	15
KCP02d	179	6	3	10	1	28	52	85	23	302	9	7	3	2	0	16
KCP02d	178	7	2	11	1	27	52	85	23	320	9	6	1	3	0	16
KCP02d	177	7	2	12	0	28	53	84	23	328	2	7	3	3	0	16
average	178	7	2	11	1	27	52	84	23	316	7	7	2	2	0	16
KCP03d	176	7	2	8	1	26	50	88	21	255	11	6	3	2	0	21
KCP03d	176	7	2	11	1	27	49	87	21	273	7	3	3	3	0	21
KCP03d	178	6	2	14	1	26	50	88	21	274	8	4	1	2	1	21
average	176	7	2	11	1	26	50	88	21	267	9	4	2	2	0	21
KCP04d	190	8	2	13	1	29	51	86	23	262	8	6	1	2	0	15
KCP04d	193	6	1	13	1	29	52	87	22	255	9	7	1	2	0	15
KCP04d	193	6	2	11	1	30	53	86	23	278	11	8	1	3	1	15
average	192	7	2	13	1	29	52	87	23	265	9	7	1	3	0	15
KCP01a	173	6	3	13	1	27	49	81	20	300	16	9	8	7	1	70
KCP01a	172	7	2	12	1	27	50	82	20	293	7	5	1	2	1	66
KCP01a	171	6	2	13	1	26	48	81	20	301	11	7	1	2	1	64
average	172	6	2	12	1	26	49	81	20	298	11	7	3	4	1	67
KCP02a	194	7	3	14	1	29	51	82	21	303	8	7	1	3	1	40
KCP02a	191	6	2	14	1	29	52	83	21	303	11	5	1	2	0	39
KCP02a	191	6	2	15	1	29	52	83	22	291	9	6	3	2	0	39
average	192	6	2	14	1	29	52	83	21	299	9	6	1	2	0	39
KCP03a	186	7	2	14	1	27	51	88	21	251	10	7	1	3	0	75
KCP03a	186	6	2	14	1	28	50	88	21	248	7	5	1	2	1	74
KCP03a	189	6	2	17	1	28	50	89	21	249	11	4	1	1	1	77
average	187	6	2	15	1	28	50	88	21	249	9	5	1	2	0	75
KCP04a	178	6	2	13	1	28	51	85	21	265	2	8	1	2	0	23
KCP04a	187	6	2	13	1	28	52	85	22	271	9	5	1	2	0	25
KCP04a	185	5	2	14	1	29	51	85	22	284	10	5	3	2	0	24
average	183	6	2	13	1	28	51	85	22	273	7	6	1	2	0	24
KCP01b	199	7	2	17	1	28	53	83	21	275	9	6	1	2	0	23
KCP01b	202	7	2	15	1	29	52	82	21	280	8	4	2	2	0	18
KCP01b	202	7	3	16	1	29	53	84	21	281	9	5	3	2	2	20

average	201	7	3	16	1	29	52	83	21	279	9	5	2	2	1	21
KCP02b	190	7	1	15	1	28	51	81	20	299	8	6	2	2	0	15
KCP02b	188	7	2	16	1	28	50	81	22	294	8	8	1	2	0	15
KCP02b	185	6	2	14	1	28	51	81	21	294	8	7	1	2	0	17
average	188	6	2	15	1	28	51	81	21	296	8	7	1	2	0	16
KCP03b	186	7	2	15	1	27	52	90	21	286	9	4	1	1	0	23
KCP03b	189	6	3	16	1	27	53	89	21	285	7	3	1	2	0	24
KCP03b	188	8	2	12	1	29	53	89	22	292	12	7	1	2	1	24
average	188	7	2	14	1	28	53	89	21	288	9	4	1	2	0	23
KCP04b	200	7	2	17	1	28	50	87	20	261	8	5	1	2	0	9
KCP04b	198	7	2	15	0	28	50	87	21	250	9	6	1	3	1	9
KCP04b	193	8	2	13	1	28	51	87	20	250	11	6	1	3	0	9
average	197	7	2	15	1	28	50	87	20	254	10	6	1	3	0	9
KCP01c	182	6	2	11	0	28	48	79	19	256	8	6	1	1	0	19
KCP01c	184	5	2	12	1	29	48	79	19	287	2	4	1	2	0	21
KCP01c	183	5	2	11	1	28	48	79	21	285	9	7	1	3	0	20
average	183	5	2	12	1	28	48	79	20	276	7	5	1	2	0	20
KCP02c	199	7	2	14	1	30	51	81	20	274	8	6	1	2	0	28
KCP02c	196	6	2	14	1	28	51	82	21	276	9	6	1	2	1	26
KCP02c	197	7	2	16	1	29	52	83	21	278	12	7	1	3	1	26
average	197	7	2	15	1	29	51	82	21	276	10	6	1	2	0	26
KCP03c	185	7	2	12	1	26	50	85	21	263	9	6	1	2	0	30
KCP03c	187	7	2	13	1	26	51	85	20	263	9	6	3	2	0	27
KCP03c	186	5	3	12	1	26	50	84	20	265	12	7	3	3	1	28
average	186	6	2	12	1	26	50	85	20	264	10	6	2	2	0	28
KCP04c	187	7	2	14	1	27	50	84	20	308	10	4	2	3	0	15
KCP04c	191	6	2	13	1	27	51	84	20	293	11	5	1	3	0	16
KCP04c	190	6	2	13	1	28	50	84	21	291	11	6	1	3	0	15
average	189	6	2	14	1	27	50	84	20	297	10	5	1	3	0	15
KCP01d	194	6	1	16	1	30	53	81	21	249	11	4	1	1	0	13
KCP01d	191	7	2	14	1	30	54	81	21	248	9	6	1	2	0	13
KCP01d	191	7	1	14	1	30	54	82	21	247	10	6	1	2	0	13
average	192	7	2	14	1	30	54	81	21	248	10	5	1	2	0	13
KCP02d	180	7	2	12	1	25	49	79	20	327	10	5	1	2	0	12
KCP02d	177	7	1	15	0	26	50	80	20	320	7	7	1	3	0	14
KCP02d	175	7	2	12	1	26	49	80	20	344	14	7	1	3	1	15
average	177	7	2	13	1	25	49	79	20	330	10	6	1	3	0	14
KCP03d	193	6	1	15	1	28	49	88	21	237	10	3	1	2	0	18
KCP03d	196	6	2	15	1	29	49	89	21	235	9	5	1	3	0	17

KCP03d	195	7	3	16	1	28	50	89	20	246	9	4	1	2	1	19
average	194	6	2	15	1	28	49	89	20	239	9	4	1	2	0	18
KCP04d	195	5	2	13	1	29	51	83	21	292	10	5	1	2	0	17
KCP04d	198	7	1	13	1	29	51	84	21	287	10	5	1	2	0	16
KCP04d	195	7	2	14	2	29	52	84	21	287	9	5	1	3	1	16
average	196	6	2	13	1	29	51	84	21	289	10	5	1	2	0	16
KCP01e	157	6	1	8	0	24	45	72	20	258	10	7	1	7	1	34
KCP01e	162	6	1	9	0	24	45	75	21	252	10	6	1	4	2	33
KCP01e	161	6	1	11	1	23	45	74	20	248	10	11	1	3	1	34
average	160	6	1	9	0	23	45	74	20	253	10	8	1	5	1	33
KCP02e	195	7	3	16	1	30	56	84	22	284	12	10	1	3	0	14
KCP02e	201	6	3	14	1	30	57	86	22	276	10	9	1	2	0	13
KCP02e	202	7	3	14	1	30	56	85	22	265	7	7	1	2	0	13
average	200	7	3	15	1	30	56	85	22	275	10	9	1	2	0	13
KCP03e	190	7	2	11	0	28	51	90	22	239	10	4	1	2	0	23
KCP03e	193	7	2	13	1	29	52	91	22	243	8	4	1	2	0	25
KCP03e	192	6	2	12	1	28	50	90	21	240	9	5	1	2	0	26
average	192	7	2	12	1	28	51	90	22	241	9	5	1	2	0	25
KCP04e	182	7	3	13	1	27	51	83	22	290	8	4	3	2	1	56
KCP04e	180	6	2	13	1	26	52	83	21	284	9	4	2	3	1	56
KCP04e	180	7	3	12	1	27	52	83	21	283	9	4	2	1	0	53
average	181	6	2	13	1	27	51	83	21	285	9	4	2	2	0	55
KCP01a	179	7	2	13	1	28	49	83	20	282	9	7	1	7	1	57
KCP01a	184	6	2	12	1	28	50	83	20	271	9	4	1	3	0	55
KCP01a	179	7	2	14	0	28	48	83	20	266	8	7	1	3	1	57
average	181	7	2	13	1	28	49	83	20	273	9	6	1	4	1	56
KCP02a	197	7	2	11	1	31	53	84	21	318	10	6	1	4	2	48
KCP02a	196	7	2	12	1	30	54	85	21	309	7	3	1	2	1	47
KCP02a	198	6	2	11	1	30	53	84	21	319	9	6	1	2	1	46
average	197	7	2	12	1	30	53	85	21	315	9	5	1	2	1	47
KCP03a	183	7	3	15	1	26	49	86	21	256	9	6	1	3	0	62
KCP03a	180	7	2	11	1	26	49	87	21	266	9	3	1	2	1	68
KCP03a	180	5	1	14	1	26	50	88	21	284	6	4	1	2	1	72
average	181	6	2	13	1	26	49	87	21	269	8	4	1	2	0	67
KCP04a	207	7	2	13	1	32	54	91	22	230	7	3	1	2	1	26
KCP04a	209	6	2	17	1	32	55	90	22	238	7	5	2	1	1	24
KCP04a	207	7	2	16	1	32	55	91	22	236	8	6	2	2	0	25
average	208	7	2	15	1	32	55	90	22	235	7	5	1	2	1	25
KCP01b	200	8	1	16	1	30	52	83	21	272	6	4	2	1	0	27

KCP01b	202	7	2	14	1	30	52	84	21	265	7	2	3	2	0	28
KCP01b	205	6	2	16	1	30	52	83	21	265	7	4	1	2	0	31
average	202	7	2	15	1	30	52	83	21	267	6	3	2	2	0	29
KCP02b	183	6	2	12	1	28	50	80	21	261	6	6	2	2	0	14
KCP02b	188	6	3	14	1	28	52	80	21	270	7	5	1	2	0	14
KCP02b	186	7	3	13	1	28	51	82	21	280	13	6	3	3	1	14
average	186	6	2	13	1	28	51	81	21	270	8	6	2	2	0	14
KCP03b	185	6	2	14	1	28	52	89	21	238	2	5	0	1	0	23
KCP03b	195	6	3	14	1	29	53	90	21	244	8	5	1	3	0	22
KCP03b	191	8	2	15	1	28	53	91	22	254	7	5	1	3	0	24
average	191	7	2	14	1	28	53	90	22	245	6	5	0	2	0	23
KCP04b	190	7	2	14	1	28	51	86	20	230	7	4	1	2	0	10
KCP04b	191	6	2	11	1	28	51	87	21	231	10	4	1	2	0	11
KCP04b	194	5	2	12	1	28	50	87	21	238	9	6	1	2	1	10
average	192	6	2	12	1	28	51	86	21	233	8	4	1	2	0	10
KCP01c	208	6	2	12	1	31	50	81	19	215	6	6	1	1	0	12
KCP01c	205	6	2	13	1	31	50	81	20	220	8	4	1	2	1	14
KCP01c	207	6	2	14	1	31	51	81	20	226	9	4	1	2	0	14
average	207	6	2	13	1	31	50	81	20	221	8	5	1	2	1	13
KCP02c	183	6	1	12	1	28	51	81	21	276	10	4	1	2	0	26
KCP02c	187	6	2	12	1	27	50	81	21	302	8	3	3	3	1	26
KCP02c	185	7	2	12	1	28	52	83	21	290	9	3	1	3	1	27
average	185	6	2	12	1	27	51	82	21	289	9	3	1	2	0	26
KCP03c	181	7	2	10	1	27	50	87	20	266	11	5	1	3	0	49
KCP03c	185	6	1	13	1	27	51	86	21	277	13	7	1	4	1	45
KCP03c	185	6	2	11	1	28	51	87	22	260	8	5	4	3	0	42
average	184	7	2	11	1	27	51	87	21	268	10	6	2	3	0	45
KCP04c	181	8	3	15	1	26	48	81	20	282	8	2	3	2	2	19
KCP04c	183	7	1	14	1	26	49	81	19	280	12	6	1	4	1	20
KCP04c	181	6	2	15	1	25	50	82	20	269	10	7	3	2	0	19
average	182	7	2	14	1	25	49	81	20	277	10	5	2	3	1	19
KCP01d	201	8	2	16	1	31	55	81	21	262	9	7	1	2	0	13
KCP01d	200	7	2	15	1	31	53	81	22	269	7	3	1	3	0	13
KCP01d	203	7	3	15	1	32	54	81	21	270	11	5	1	3	1	13
average	201	7	2	15	1	31	54	81	21	267	9	5	1	3	0	13
KCP02d	203	6	2	11	1	31	54	88	22	276	9	5	1	2	1	16
KCP02d	204	7	3	13	1	31	54	89	22	282	10	7	1	3	1	15
average	202	7	2	12	1	31	54	88	22	275	9	5	1	2	0	15
KCP03d	176	7	2	14	1	26	48	86	21	241	6	6	1	2	0	16

KCP03d	177	5	1	13	1	26	48	87	21	247	8	5	1	3	1	18
KCP03d	181	7	3	15	1	26	49	86	21	238	9	5	4	3	0	17
average	178	7	2	14	1	26	48	86	21	242	8	5	2	3	0	17
KCP04d	203	8	3	13	1	31	53	87	22	241	8	3	1	2	0	15
KCP04d	205	8	1	14	1	31	54	87	22	253	7	4	1	3	0	16
KCP04d	208	7	3	11	1	32	53	87	23	260	10	5	1	2	1	15
average	205	7	2	13	1	31	53	87	22	251	8	4	1	3	0	16
KCP01e	178	7	2	13	1	27	50	79	21	312	8	5	1	3	1	25
KCP01e	180	6	2	13	1	26	50	80	20	329	9	5	1	3	2	27
KCP01e	173	7	1	11	1	27	50	81	21	326	11	7	1	4	1	25
average	177	6	2	12	1	27	50	80	21	322	9	6	1	3	1	26
KCP02e	185	6	2	13	1	29	52	80	22	357	8	4	1	2	1	15
KCP02e	191	7	2	14	1	28	53	80	22	375	9	5	4	3	1	15
KCP02e	185	7	2	12	1	29	53	82	22	356	13	8	1	3	1	15
average	187	7	2	13	1	29	53	81	22	362	10	6	2	3	1	15
KCP03e	183	6	2	13	1	28	49	86	21	238	5	3	1	2	1	24
KCP03e	187	7	2	13	1	27	49	88	21	237	8	4	1	3	1	26
KCP03e	188	7	2	11	1	27	49	87	22	252	11	6	4	4	1	27
average	186	7	2	12	1	27	49	87	21	242	8	4	2	3	1	26
KCP04e	191	8	2	11	1	27	50	81	21	270	9	5	3	3	1	24
KCP04e	188	6	2	12	1	26	50	81	20	267	11	4	1	3	1	23
KCP04e	190	6	3	11	1	27	50	81	21	269	11	7	1	3	1	23
average	190	7	2	11	1	27	50	81	21	269	10	5	1	3	1	23
KCP01f	163	7	2	9	1	24	46	83	19	276	9	6	1	3	2	60
KCP01f	159	7	1	11	1	24	46	84	20	284	11	4	1	3	1	63
KCP01f	157	6	1	9	1	23	46	83	19	269	8	5	1	3	1	61
average	160	6	2	10	1	24	46	83	19	276	10	5	1	3	1	61
KCP02f	168	6	2	11	1	25	49	86	20	307	11	6	1	3	1	17
KCP02f	167	7	2	11	1	25	48	86	21	307	12	8	1	4	1	19
KCP02f	162	6	1	12	1	24	49	85	20	307	11	6	1	3	1	17
average	166	6	2	11	1	25	49	86	20	307	11	7	1	3	1	18
KCP03f	171	6	2	8	1	25	50	83	21	300	11	7	1	4	1	31
KCP03f	170	6	2	9	1	25	49	84	20	306	3	6	1	4	1	33
KCP03f	170	6	1	11	1	25	50	83	20	319	11	6	4	4	1	31
average	170	6	2	9	1	25	50	83	20	308	8	6	2	4	1	32
KCP04f	173	6	3	11	1	27	50	85	22	291	13	4	1	3	1	24
KCP04f	176	6	1	12	1	27	51	86	22	290	11	7	1	3	1	24
KCP04f	174	5	2	11	1	26	51	85	22	304	11	5	1	3	1	23
average	174	6	2	11	1	26	50	85	22	295	12	5	1	3	1	24

KCP01a	180	7	3	10	1	28	49	83	19	254	6	4	1	2	0	51
KCP01a	178	7	2	15	1	27	49	82	19	256	12	7	1	2	1	57
KCP01a	181	7	3	12	1	28	50	84	21	249	10	8	4	3	1	57
average	180	7	2	12	1	28	49	83	20	253	9	7	2	2	0	55
KCP02a	199	6	2	14	1	31	54	85	21	311	9	5	1	2	1	47
KCP02a	197	8	2	14	1	31	53	86	20	315	9	6	3	1	0	46
KCP02a	197	6	2	14	1	31	54	86	21	319	7	5	1	2	0	47
average	198	7	2	14	1	31	54	86	21	315	8	5	1	2	0	47
KCP03a	183	7	2	14	1	27	50	87	21	271	7	4	1	2	1	63
KCP03a	180	6	2	11	1	27	50	87	21	272	8	3	1	2	1	66
KCP03a	181	5	2	8	1	27	50	87	20	270	11	9	2	2	1	65
average	181	6	2	11	1	27	50	87	21	271	9	6	1	2	1	64
KCP04a	212	6	1	13	1	31	54	91	22	233	8	5	2	2	0	28
KCP04a	210	7	2	14	1	32	55	90	23	241	8	4	2	2	0	25
KCP04a	210	8	2	13	1	32	55	92	23	250	8	4	1	2	0	26
average	210	7	2	13	1	32	55	91	23	241	8	4	2	2	0	26
KCP01b	204	7	2	16	0	30	51	83	21	267	7	4	1	2	1	34
KCP01b	201	7	3	17	0	30	53	83	21	265	11	4	1	3	1	33
KCP01b	204	6	2	14	1	30	53	85	21	276	10	2	1	3	1	36
average	203	6	2	15	1	30	52	83	21	269	9	3	1	2	1	35
KCP02b	187	6	2	12	1	29	51	81	21	274	8	6	1	3	0	14
KCP02b	189	6	1	13	1	28	52	81	20	271	10	8	1	2	0	14
KCP02b	189	7	2	12	1	28	51	81	21	270	7	7	1	2	0	14
average	188	6	2	12	1	28	51	81	21	272	8	7	1	2	0	14
KCP03b	188	7	2	14	1	28	54	90	21	258	12	6	2	1	0	26
KCP03b	191	6	2	13	1	29	52	89	22	248	2	6	1	2	1	24
KCP03b	194	8	3	14	0	29	53	91	21	250	7	3	3	3	0	26
average	191	7	2	14	1	29	53	90	22	252	7	5	2	2	0	25
KCP04b	197	7	2	10	1	29	52	88	20	244	7	5	1	2	0	10
KCP04b	195	8	2	15	1	28	52	87	21	261	7	7	1	2	1	10
KCP04b	193	7	2	14	1	30	51	89	21	268	9	7	3	3	1	10
average	195	7	2	13	1	29	51	88	21	258	8	6	1	2	0	10
KCP01c	204	6	2	10	1	32	51	82	20	223	8	5	1	2	0	15
KCP01c	202	5	2	13	1	33	51	82	20	231	10	5	1	2	1	16
KCP01c	207	7	2	12	1	33	51	82	20	229	7	4	3	2	0	15
average	204	6	2	11	1	32	51	82	20	228	8	5	1	2	0	15
KCP02c	183	6	1	13	1	28	52	82	22	285	8	5	3	2	0	35
KCP02c	187	7	2	13	1	28	51	82	21	284	11	7	1	3	1	36
KCP02c	191	6	2	14	1	28	50	82	21	293	8	7	1	3	1	36

average	187	6	2	13	1	28	51	82	21	287	9	6	1	3	1	36
KCP03c	186	6	2	12	1	27	52	87	21	287	12	6	5	3	1	56
KCP03c	188	6	1	12	1	26	52	87	21	279	11	4	1	2	1	57
KCP03c	186	7	3	13	1	27	52	88	21	265	9	4	3	2	1	48
average	187	6	2	12	1	27	52	87	21	277	11	5	3	2	1	54
KCP04c	177	8	2	14	1	24	48	80	19	294	12	8	1	3	1	28
KCP04c	177	7	2	13	1	25	48	80	20	291	11	7	1	2	1	25
KCP04c	179	7	2	16	1	25	48	79	20	291	9	5	1	2	1	24
average	178	7	2	14	1	25	48	80	20	292	10	7	1	2	1	26
KCP01d	201	8	2	17	1	31	54	82	21	329	11	4	1	2	1	15
KCP01d	202	7	2	16	1	31	53	82	21	330	11	7	1	3	1	15
KCP01d	204	7	2	14	1	31	53	81	21	326	11	10	1	3	0	14
average	202	7	2	16	1	31	53	81	21	328	11	7	1	3	0	15
KCP02d	200	7	2	14	1	31	54	89	22	272	11	5	1	3	1	16
KCP02d	202	8	2	13	1	30	55	89	21	280	8	7	1	3	1	16
KCP02d	201	8	2	14	1	31	55	89	21	287	13	6	1	3	1	16
average	201	8	2	14	1	31	55	89	22	280	11	6	1	3	1	16
KCP03d	183	7	2	13	1	27	49	87	21	277	10	3	1	3	1	19
KCP03d	176	6	2	12	1	27	48	85	21	271	12	6	1	3	1	17
KCP03d	185	7	2	11	1	27	48	87	21	261	13	6	1	4	1	19
average	181	7	2	12	1	27	48	86	21	270	12	5	1	3	1	18
KCP04d	204	6	3	13	1	32	54	88	22	246	9	9	1	3	0	16
KCP04d	201	7	1	12	1	32	54	88	22	251	7	6	4	3	0	16
KCP04d	204	7	3	13	1	32	54	88	22	253	11	5	1	4	2	15
average	203	7	2	13	1	32	54	88	22	250	9	7	2	3	1	16
KCP01e	178	6	2	12	1	27	50	81	21	329	11	7	1	4	1	28
KCP01e	181	6	3	9	1	27	50	81	21	347	11	10	1	4	1	26
KCP01e	177	7	2	12	1	27	51	81	21	343	7	4	1	3	1	25
average	179	6	2	11	1	27	50	81	21	340	10	7	1	4	1	27
KCP02e	188	6	2	11	1	29	53	81	20	317	8	5	1	3	1	12
KCP02e	189	8	2	12	1	29	54	82	21	333	13	8	4	3	1	12
KCP02e	188	8	3	13	1	28	53	80	21	338	11	5	1	4	1	13
average	189	7	2	12	1	29	53	81	21	329	10	6	2	3	1	12
KCP03e	191	8	2	13	1	27	50	86	21	257	9	5	1	3	1	25
KCP03e	192	6	2	12	1	27	49	85	20	248	8	6	1	4	1	24
KCP03e	191	6	2	15	1	27	50	87	20	257	11	5	1	4	1	27
average	191	7	2	13	1	27	50	86	20	254	9	6	1	4	1	25
KCP04e	186	6	2	12	1	27	50	81	21	265	11	5	1	3	1	31
KCP04e	188	7	2	11	1	27	50	82	21	280	15	5	1	4	1	32

KCP04e	190	7	2	13	1	26	50	82	21	268	12	5	1	3	1	31
average	188	7	2	12	1	27	50	82	21	271	13	5	1	3	1	31
KCP01f	154	5	2	8	1	23	45	81	19	269	7	6	1	4	1	72
KCP01f	154	5	2	10	1	23	45	83	19	259	6	6	3	2	1	70
KCP01f	153	5	1	9	1	24	45	82	18	258	2	3	1	3	1	75
average	154	5	2	9	1	24	45	82	19	262	5	5	1	3	1	72
KCP02f	162	5	2	10	1	24	48	85	20	318	11	5	4	4	1	18
KCP02f	165	5	3	10	1	24	49	85	20	311	8	5	1	2	1	19
KCP02f	165	7	1	9	1	24	48	85	20	325	10	4	3	2	0	18
average	164	6	2	10	1	24	48	85	20	318	10	5	3	3	0	19
KCP03f	168	6	2	9	1	25	49	81	20	306	10	5	5	4	1	27
KCP03f	170	6	1	9	1	23	49	81	20	285	10	6	1	3	1	27
KCP03f	168	6	2	8	0	24	50	81	19	285	12	6	1	3	1	28
average	169	6	2	9	0	24	49	81	20	292	11	5	2	3	1	27
KCP04f	168	5	2	13	1	26	50	83	22	340	12	7	1	5	1	31
KCP04f	170	6	1	9	1	25	51	84	21	315	8	5	4	3	1	28
KCP04f	173	7	2	11	1	26	51	84	22	327	9	6	1	2	1	28
average	170	6	2	11	1	26	51	84	22	327	10	6	2	3	1	29
KCP01g	177	6	3	10	1	25	47	89	19	288	10	6	1	4	1	14
KCP01g	175	5	2	12	1	25	46	90	20	278	9	3	1	3	1	13
KCP01g	175	6	2	11	1	26	47	90	19	271	11	5	1	3	1	14
average	176	5	2	11	1	25	47	90	19	279	10	5	1	3	1	13
KCP02g	183	7	2	13	1	28	53	88	21	289	15	9	1	4	1	10
KCP02g	179	7	2	13	0	27	53	87	22	290	11	3	4	3	1	10
KCP02g	185	6	3	12	1	28	53	88	22	285	10	4	1	3	1	11
average	182	7	2	12	1	28	53	88	22	288	12	5	2	3	1	10
KCP03g	175	6	2	8	1	26	49	81	21	342	13	4	1	5	1	15
KCP03g	172	7	2	10	1	26	49	83	21	327	7	6	1	3	1	14
KCP03g	174	5	1	10	1	26	50	82	21	327	10	3	5	3	1	13
average	174	6	2	10	1	26	49	82	21	332	10	4	2	3	1	14
KCP04g	179	7	3	13	1	27	52	88	22	302	15	7	1	4	1	13
KCP04g	179	8	2	11	1	27	52	88	22	280	2	8	1	3	1	12
KCP04g	179	6	2	10	1	26	51	89	22	284	11	6	1	3	0	13
average	179	7	2	12	1	27	52	88	22	289	9	7	1	3	0	13
	Sb	Te	I	Cs	Ba	La	Ce	Hf	Ta	W	Hg	Tl	Pb	Bi	Th	U
KCP01a	2	1	1	2	158	9	13	11	3	2	1	1	234	1	6	20
KCP01a	3	1	3	2	152	4	19	8	4	2	1	1	236	1	5	18
KCP01a	2	1	2	2	151	7	15	7	3	2	3	1	236	2	5	18
Average	2	1	2	2	154	7	16	9	3	2	2	1	235	1	5	18

KCP02a	2	1	4	2	176	10	18	12	3	2	1	1	253	0	6	18
KCP02a	2	1	4	2	174	12	20	8	4	2	2	1	248	1	7	15
KCP02a	3	1	2	2	175	13	18	10	4	4	1	1	249	1	5	17
Average	2	1	3	2	175	12	18	10	3	3	1	1	250	1	6	17
KCP03a	2	1	4	2	152	8	9	10	4	3	0	0	252	1	7	6
KCP03a	2	1	2	2	159	11	13	12	3	6	1	1	257	1	5	8
KCP03a	2	1	2	2	160	8	13	7	4	5	2	1	256	2	6	8
Average	2	1	3	2	157	9	11	10	3	4	1	1	255	1	6	7
KCP04a	3	1	4	2	167	12	15	11	4	2	1	1	242	1	5	14
KCP04a	3	1	4	3	177	16	13	12	4	2	1	0	246	0	7	12
KCP04a	2	1	3	2	172	16	11	8	4	4	0	1	241	0	7	10
Average	2	1	3	2	172	15	13	10	4	3	1	1	243	1	6	12
KCP01a	3	1	1	2	150	7	10	8	3	2	1	1	224	1	5	4
KCP01a	2	1	1	2	153	10	12	9	3	5	1	0	226	1	5	4
KCP01a	2	1	2	2	154	12	17	11	3	4	1	1	230	1	5	4
Average	2	1	1	2	152	10	13	10	3	4	1	1	226	1	5	4
KCP02a	2	1	2	2	160	13	20	12	4	2	2	1	243	1	6	4
KCP02a	2	1	2	2	157	8	16	12	3	4	1	1	240	1	6	4
KCP02a	2	1	3	2	162	15	28	9	4	2	2	1	243	1	5	5
Average	2	1	2	2	159	12	21	11	3	3	1	1	242	1	6	4
KCP03a	2	1	2	2	170	10	15	11	3	3	1	1	235	2	4	4
KCP03a	2	1	2	2	170	4	14	13	3	3	1	1	235	1	5	4
KCP03a	2	1	2	2	177	10	21	8	3	3	1	1	234	0	5	5
Average	2	1	2	2	172	8	17	11	3	3	1	1	235	1	5	4
KCP04a	2	1	2	2	158	7	10	10	3	2	1	1	235	1	4	4
KCP04a	2	1	2	2	166	13	14	11	3	4	2	1	239	1	5	4
KCP04a	2	1	1	2	169	15	16	10	3	2	1	0	235	1	5	4
Average	2	1	2	2	164	11	14	10	3	3	1	1	236	1	5	4
KCP01b	2	1	3	2	173	9	12	7	3	2	2	1	238	1	5	4
KCP01b	2	1	3	2	179	13	14	7	3	2	2	1	237	1	6	4
KCP01b	2	1	1	2	180	14	14	8	3	5	2	0	236	2	5	4
Average	2	1	2	2	177	12	13	8	3	3	2	1	237	1	6	4
KCP02b	2	1	2	2	180	11	11	9	4	2	1	0	244	1	6	4
KCP02b	2	1	2	2	185	8	15	6	4	3	2	1	243	0	5	4
KCP02b	3	1	3	2	184	13	15	12	3	6	1	1	243	1	7	4
Average	2	1	3	2	183	11	14	9	3	4	2	1	243	1	6	4
KCP03b	2	1	1	2	180	4	22	10	3	2	2	1	252	1	4	4
KCP03b	2	1	1	2	176	13	15	3	3	2	1	1	245	0	6	4
KCP03b	2	1	1	2	178	12	12	11	3	2	2	1	247	1	5	5

Average	2	1	1	2	178	10	16	8	3	2	2	1	248	1	5	5
KCP04b	2	1	2	2	164	16	11	11	4	2	1	1	256	1	6	4
KCP04b	3	1	4	2	163	7	5	10	4	2	1	1	255	1	6	4
KCP04b	1	1	2	2	169	7	13	8	4	3	1	1	252	1	6	4
Average	2	1	3	2	165	10	10	10	4	2	1	1	254	1	6	4
KCP01a	2	1	3	2	153	12	19	8	3	2	3	1	229	1	5	4
KCP01a	3	1	3	2	149	4	13	11	3	2	1	1	229	1	5	4
KCP01a	2	1	3	2	153	9	9	11	3	2	1	1	226	1	5	4
Average	2	1	3	2	152	8	13	10	3	2	2	1	228	1	5	4
KCP02a	3	1	3	2	161	8	14	8	4	5	2	1	242	1	6	4
KCP02a	2	1	1	2	164	13	19	9	4	2	1	0	243	1	5	4
KCP02a	2	1	3	2	157	8	17	7	4	5	1	1	246	2	5	8
Average	2	1	2	2	161	9	16	8	4	4	1	1	243	1	5	5
KCP03a	2	1	2	2	172	10	14	10	3	2	2	1	237	1	4	7
KCP03a	2	1	2	2	171	9	12	9	3	2	1	1	237	1	6	4
KCP03a	2	1	2	2	173	14	15	12	3	4	2	1	237	1	6	9
Average	2	1	2	2	172	11	14	10	3	3	2	1	237	1	5	7
KCP04a	3	1	1	2	160	10	15	8	4	2	2	1	237	1	5	4
KCP04a	2	1	4	2	165	14	14	11	4	4	1	1	239	2	5	4
KCP04a	1	1	3	2	168	11	16	10	3	3	2	1	241	0	6	8
Average	2	1	3	2	165	12	15	10	4	3	2	1	239	1	5	5
KCP01b	3	1	1	2	180	7	13	10	3	2	2	2	235	1	5	4
KCP01b	2	1	2	2	181	9	19	12	4	2	1	1	235	1	6	4
KCP01b	3	1	1	2	189	9	6	5	3	2	2	1	238	1	5	4
Average	2	1	2	2	183	8	12	9	3	2	2	1	236	1	5	4
KCP02b	2	1	3	2	180	13	17	7	3	2	1	1	243	1	6	5
KCP02b	3	1	2	2	187	12	23	10	3	2	2	1	241	1	5	5
KCP02b	3	1	1	2	194	14	15	12	3	6	1	1	242	1	7	4
Average	2	1	2	2	187	13	18	10	3	3	1	1	242	1	6	5
KCP03b	3	1	1	2	183	12	12	8	3	3	3	1	248	1	5	4
KCP03b	3	2	4	2	180	10	16	10	3	2	2	1	246	1	7	4
Average	2	1	3	2	181	12	13	10	3	2	2	1	248	1	6	5
KCP04b	2	1	3	2	164	9	16	8	4	2	1	1	254	1	5	5
KCP04b	1	1	1	2	162	10	17	6	4	3	2	1	255	2	5	4
KCP04b	2	1	1	2	165	12	14	10	4	2	1	1	257	1	6	11
Average	2	1	2	2	164	10	15	8	4	3	1	1	255	1	5	7
KCP01c	1	1	3	2	159	12	12	9	3	3	2	1	299	1	5	6
KCP01c	3	1	1	2	162	13	14	9	3	2	1	1	298	1	6	10
KCP01c	2	1	2	2	165	11	5	10	3	2	1	1	294	1	7	10

Average	2	1	2	2	162	12	11	9	3	2	1	1	297	1	6	9
KCP02c	2	1	3	2	195	12	15	11	3	7	1	1	239	1	5	5
KCP02c	2	1	2	2	190	6	15	13	4	4	1	1	242	1	6	8
KCP02c	2	1	3	2	191	7	16	7	3	4	2	1	240	1	6	11
Average	2	1	2	2	192	8	15	11	3	5	1	1	241	1	6	8
KCP03c	2	1	1	2	176	4	16	10	3	4	4	1	252	2	5	13
KCP03c	3	1	3	2	179	14	16	11	3	3	3	1	255	1	6	14
KCP03c	3	1	3	2	177	5	13	10	3	2	1	0	251	1	7	10
Average	2	1	2	2	177	8	15	10	3	3	3	1	253	1	6	12
KCP04c	2	1	3	2	192	16	14	10	3	3	1	1	219	1	6	9
KCP04c	2	1	1	2	191	14	10	8	3	2	2	1	218	1	5	10
KCP04c	1	1	3	2	194	12	16	9	3	3	2	2	219	1	6	13
Average	2	1	2	2	192	14	13	9	3	3	2	1	219	1	6	11
KCP01a	2	1	3	2	152	15	19	8	3	3	1	1	223	1	5	4
KCP01a	2	1	1	2	162	11	16	8	3	2	1	1	225	1	5	4
KCP01a	2	1	1	2	151	9	17	9	3	3	1	1	225	1	4	4
average	2	1	2	2	155	12	17	8	3	2	1	1	224	1	5	4
KCP02a	2	1	3	2	174	11	12	12	4	2	1	1	239	1	6	4
KCP02a	2	1	3	2	172	12	13	10	3	4	1	1	242	1	6	4
KCP02a	2	1	1	2	172	12	23	8	3	3	1	1	242	1	5	4
average	2	1	2	2	173	12	16	10	3	3	1	1	241	1	6	4
KCP03a	2	1	2	2	169	13	13	9	3	2	1	1	262	1	5	4
KCP03a	2	1	3	2	171	7	12	6	4	2	1	1	263	1	6	5
KCP03a	1	1	3	2	170	10	10	10	3	5	1	1	263	0	7	4
average	2	1	2	2	170	10	12	8	3	3	1	1	263	1	6	4
KCP04a	3	1	3	2	160	11	13	8	4	2	1	1	244	1	5	4
KCP04a	3	1	1	2	169	9	15	11	4	4	1	1	246	1	6	4
KCP04a	2	1	3	2	174	10	18	7	4	5	1	1	249	1	6	4
average	2	1	2	2	168	10	15	9	4	4	1	1	246	1	6	4
KCP01b	2	1	3	2	173	10	10	7	3	4	2	1	225	1	5	4
KCP01b	2	1	2	2	177	11	17	12	3	2	2	0	226	1	6	5
KCP01b	2	1	1	2	184	14	20	9	3	4	2	1	225	1	6	4
average	2	1	2	2	178	12	16	9	3	3	2	1	225	1	5	4
KCP02b	3	1	1	2	175	9	13	8	3	6	1	1	233	1	6	5
KCP02b	2	1	3	2	176	14	19	8	3	2	1	1	231	1	5	4
KCP02b	2	1	2	2	170	17	22	8	3	5	1	1	232	1	6	4
average	2	1	2	2	174	13	18	8	3	4	1	1	232	1	6	4
KCP03b	2	1	1	2	170	8	18	9	3	2	1	0	246	1	5	4
KCP03b	3	1	2	2	172	12	18	10	3	2	1	1	249	1	5	8

KCP03b	2	1	4	2	174	10	19	9	3	3	1	1	251	1	6	4
average	2	1	2	2	172	10	18	9	3	2	1	1	248	1	5	5
KCP04b	2	1	3	2	163	10	13	7	4	3	1	1	242	1	6	4
KCP04b	1	0	3	2	165	7	16	8	4	2	1	1	241	1	7	4
KCP04b	2	1	1	2	168	4	21	11	4	5	1	1	241	1	5	4
average	2	1	2	2	165	7	17	8	4	3	1	1	241	1	6	4
KCP01c	2	1	3	2	150	4	13	11	3	6	2	1	283	0	7	3
KCP01c	3	1	1	2	153	5	14	8	3	2	1	1	286	1	5	4
KCP01c	2	1	3	2	153	12	13	11	3	2	1	1	285	1	5	10
average	2	1	3	2	152	7	13	10	3	3	1	1	285	1	6	6
KCP02c	1	1	1	2	181	11	9	9	4	4	1	1	234	1	5	4
KCP02c	2	1	5	2	181	7	17	5	4	3	1	1	233	1	6	4
KCP02c	3	2	1	2	182	9	16	11	4	3	1	1	235	1	6	10
average	2	1	3	2	181	9	14	8	4	3	1	1	234	1	5	6
KCP03c	1	0	3	2	171	8	10	9	3	2	2	1	246	1	7	5
KCP03c	2	1	1	2	171	10	14	8	4	2	1	1	247	1	7	4
KCP03c	3	1	3	2	176	9	14	9	3	2	1	1	249	1	7	10
average	2	1	3	2	173	9	13	9	3	2	1	1	247	1	7	6
KCP04c	3	1	2	2	200	13	19	5	3	2	1	1	215	1	6	4
KCP04c	2	0	1	2	199	10	6	9	3	3	1	2	216	1	5	4
KCP04c	2	1	1	2	199	14	15	9	3	3	2	2	214	1	6	12
average	2	1	2	2	199	12	13	8	3	2	1	1	215	1	6	7
KCP01d	3	1	1	2	179	10	12	9	3	2	0	1	235	1	6	8
KCP01d	2	1	3	2	187	13	18	10	3	2	1	1	234	1	5	5
KCP01d	2	1	1	2	177	12	15	10	3	6	1	1	240	1	6	12
average	2	1	2	2	181	12	15	10	3	3	1	1	236	1	6	8
KCP02d	2	1	1	2	176	11	16	13	3	2	1	1	235	1	5	4
KCP02d	2	1	1	2	176	4	18	8	3	3	1	1	231	1	5	4
KCP02d	2	1	2	2	177	4	14	9	3	4	1	1	230	1	6	11
average	2	1	1	2	176	6	16	10	3	3	1	1	232	1	6	6
KCP03d	2	1	1	2	154	10	12	9	3	2	2	1	238	1	5	4
KCP03d	2	1	1	2	158	6	14	8	3	2	1	1	232	0	4	8
KCP03d	2	1	1	2	157	7	14	8	3	2	2	1	231	1	6	5
average	2	1	1	2	156	8	13	8	3	2	2	1	234	1	5	6
KCP04d	2	1	1	2	174	7	12	7	4	2	1	1	233	1	6	4
KCP04d	1	1	1	2	172	11	15	13	3	4	1	1	237	1	6	5
KCP04d	2	1	3	2	178	13	30	9	3	2	1	1	237	1	5	12
average	1	1	2	2	175	10	19	10	3	3	1	1	236	1	6	7
KCP01a	3	1	1	2	155	10	13	10	3	2	0	1	216	1	6	15

KCP01a	2	1	1	2	153	10	14	12	3	4	1	1	217	1	6	17
KCP01a	2	1	1	2	154	12	14	9	3	3	0	1	219	1	5	16
average	2	1	1	2	154	10	14	10	3	3	0	1	218	1	6	16
KCP02a	1	1	3	3	160	10	15	10	3	2	1	0	232	1	5	14
KCP02a	2	1	3	2	158	12	12	11	4	3	1	1	230	1	5	12
KCP02a	2	1	2	2	158	9	13	13	4	2	1	0	232	1	6	14
average	2	1	3	2	159	11	13	11	3	2	1	1	231	1	5	14
KCP03a	2	1	3	2	159	10	12	11	3	7	1	1	252	0	5	12
KCP03a	2	1	2	2	158	13	5	11	3	8	1	1	252	1	6	12
KCP03a	1	1	2	2	165	11	18	11	4	2	1	1	250	1	6	6
average	1	1	2	2	161	11	12	11	3	6	1	1	251	1	5	10
KCP04a	2	1	1	2	149	12	13	9	3	2	1	1	232	1	6	9
KCP04a	3	1	3	2	160	11	16	11	3	4	0	1	235	1	6	9
KCP04a	2	1	2	2	162	14	15	10	3	3	1	1	233	1	7	10
average	2	1	2	2	157	12	15	10	3	3	1	1	233	1	6	9
KCP01b	2	1	3	2	173	4	10	10	3	2	1	0	245	1	5	4
KCP01b	1	1	2	2	166	7	13	11	4	2	1	1	249	0	5	13
KCP01b	2	1	1	2	177	11	16	10	4	2	1	1	246	1	5	12
average	2	1	2	2	172	7	13	10	3	2	1	1	247	1	5	10
KCP02b	2	1	3	2	176	11	20	11	3	3	1	1	227	1	5	8
KCP02b	2	1	1	2	178	13	17	8	4	2	1	1	225	1	6	5
KCP02b	3	1	1	2	170	10	20	9	4	5	1	2	229	1	5	14
average	2	1	2	2	175	11	19	9	3	4	1	1	227	1	5	9
KCP03b	3	1	1	2	177	12	8	10	3	4	1	1	255	1	8	4
KCP03b	2	1	2	2	179	8	15	11	3	2	1	1	251	1	5	18
KCP03b	3	1	1	2	179	10	17	10	3	3	1	1	258	1	6	9
average	3	1	1	2	178	10	13	10	3	3	1	1	254	1	6	10
KCP04b	1	1	1	2	183	12	6	8	4	2	1	1	234	1	6	10
KCP04b	1	1	2	2	178	4	11	11	4	3	1	1	236	1	5	13
KCP04b	1	1	2	2	172	5	13	10	4	3	1	1	235	1	6	17
average	1	1	2	2	178	7	10	10	4	3	1	1	235	1	5	13
KCP01c	2	1	1	2	159	10	13	9	3	2	1	1	277	1	6	5
KCP01c	3	1	3	2	153	4	13	8	3	4	1	1	281	1	6	9
KCP01c	2	1	3	2	159	10	13	9	3	2	0	1	280	0	5	9
average	2	1	3	2	157	8	13	9	3	3	0	1	279	1	6	8
KCP02c	2	1	1	2	182	13	17	10	3	2	1	1	249	0	5	10
KCP02c	2	1	2	2	176	15	14	13	3	3	1	1	251	1	5	11
KCP02c	2	1	3	2	178	12	13	8	3	2	1	1	250	1	5	18
average	2	1	2	2	179	13	15	10	3	2	1	1	250	1	5	13

KCP03c	1	1	3	2	176	10	13	9	3	2	1	1	233	1	4	4
KCP03c	2	1	2	2	172	14	6	11	3	2	1	1	237	1	5	14
KCP03c	1	1	3	2	171	10	15	11	3	2	2	1	236	1	5	9
average	1	1	2	2	173	11	11	10	3	2	1	1	235	1	5	9
KCP04c	2	1	1	2	196	13	18	10	3	4	1	1	225	1	5	6
KCP04c	2	1	1	2	190	4	15	11	3	2	1	1	229	1	5	11
KCP04c	1	1	2	2	188	4	17	11	3	2	2	1	229	1	6	14
average	2	1	2	2	191	7	16	11	3	3	1	1	228	1	5	11
KCP01d	3	1	1	2	165	10	16	7	3	3	2	1	239	1	5	12
KCP01d	3	1	1	2	159	4	19	13	3	2	1	1	238	1	6	13
KCP01d	1	1	1	2	164	8	18	9	3	6	2	1	239	1	5	13
average	2	1	1	2	163	7	18	10	3	4	2	1	239	1	5	12
KCP02d	3	1	1	2	178	12	23	9	3	2	2	1	216	1	5	4
KCP02d	1	1	1	2	178	12	15	5	3	3	2	1	217	1	5	9
KCP02d	1	1	2	2	180	11	16	8	3	2	2	2	220	1	5	10
average	1	1	2	2	179	12	18	7	3	2	2	2	218	1	5	8
KCP03d	2	1	2	2	140	10	12	8	3	3	1	1	235	1	5	12
KCP03d	2	1	2	2	145	5	19	7	3	3	1	1	237	1	6	14
KCP03d	2	1	1	2	143	10	11	8	3	3	1	1	236	1	5	14
average	2	1	2	2	143	9	14	8	3	3	1	1	236	1	6	13
KCP04d	2	1	2	2	169	13	16	11	3	4	1	1	233	1	5	11
KCP04d	3	1	3	2	167	9	15	11	4	6	1	1	233	0	5	14
KCP04d	2	1	1	2	166	10	11	8	4	2	1	1	237	1	5	20
average	2	1	2	2	167	11	14	10	3	4	1	1	235	1	5	15
KCP01e	1	1	2	2	182	12	15	7	3	2	2	1	199	1	6	17
KCP01e	2	1	3	2	177	8	16	6	3	4	2	1	197	1	6	12
KCP01e	2	1	1	2	180	8	11	7	3	3	3	1	197	1	6	6
average	2	1	2	2	180	9	14	7	3	3	2	1	198	1	6	12
KCP02e	2	1	1	2	185	10	17	10	4	2	1	1	240	1	5	10
KCP02e	2	1	3	2	189	14	11	11	4	2	0	2	241	1	6	4
KCP02e	2	1	1	2	189	9	15	12	4	2	1	1	239	1	6	7
average	2	1	2	2	188	11	14	11	4	2	1	1	240	1	6	7
KCP03e	1	1	3	2	151	9	15	10	3	2	2	2	237	1	5	4
KCP03e	2	1	2	4	159	13	18	10	3	3	1	1	238	1	6	4
KCP03e	1	1	1	2	150	10	13	10	3	5	1	1	240	1	6	8
average	1	1	2	3	153	11	15	10	3	3	1	1	238	1	6	6
KCP04e	2	1	3	2	179	9	16	10	3	2	1	1	223	1	6	4
KCP04e	2	1	3	2	174	12	14	12	3	2	1	2	223	1	6	7
KCP04e	2	1	3	2	182	6	15	10	3	2	1	1	224	1	6	4

average	2	1	3	2	178	9	15	11	3	2	1	1	223	1	6	5
KCP01a	2	1	1	2	153	9	15	9	3	2	0	1	220	1	5	17
KCP01a	2	1	3	2	159	4	13	10	3	3	1	2	218	1	4	9
KCP01a	2	1	2	2	156	19	15	11	3	6	1	1	218	1	6	14
average	2	1	2	2	156	11	14	10	3	4	1	1	219	1	5	13
KCP02a	2	1	3	2	172	9	20	9	3	2	1	1	239	0	4	7
KCP02a	2	1	3	2	176	13	13	13	4	3	2	1	239	2	5	7
KCP02a	1	1	3	2	172	12	14	10	4	4	1	1	242	1	5	5
average	1	1	3	2	173	11	15	11	3	3	1	1	240	1	5	6
KCP03a	2	1	2	2	168	5	15	10	3	2	1	1	237	1	6	4
KCP03a	3	1	2	2	170	4	9	9	3	2	1	1	243	0	7	5
KCP03a	2	1	2	2	169	9	6	9	3	2	1	1	240	1	7	5
average	2	1	2	2	169	6	10	9	3	2	1	1	240	1	7	4
KCP04a	1	1	2	2	159	8	10	13	4	2	1	1	247	0	6	4
KCP04a	2	1	2	2	161	6	14	9	4	4	1	1	243	1	6	4
KCP04a	1	1	2	2	162	10	11	9	4	4	1	1	244	1	5	4
average	1	1	2	2	161	8	12	10	4	3	1	1	245	1	6	4
KCP01b	2	1	2	2	158	8	11	6	3	3	2	1	244	1	7	5
KCP01b	2	1	2	3	162	9	11	10	4	3	1	0	247	0	6	5
KCP01b	1	1	2	2	163	8	16	6	4	2	1	1	243	1	5	4
average	1	1	2	2	161	8	12	7	4	3	1	1	245	1	6	5
KCP02b	2	1	2	2	169	14	16	9	3	2	2	1	227	1	6	4
KCP02b	2	1	3	2	169	11	15	10	3	2	1	2	222	0	5	4
KCP02b	2	1	2	2	180	9	21	8	3	2	1	0	226	0	5	4
average	2	1	2	2	173	11	18	9	3	2	1	1	225	1	5	4
KCP03b	2	1	1	2	164	13	15	8	3	3	0	1	248	1	6	4
KCP03b	2	1	2	2	156	10	16	9	3	2	1	1	252	1	5	4
KCP03b	1	1	2	2	164	4	13	6	4	2	1	1	252	0	7	6
average	1	1	2	2	161	9	14	8	3	2	1	1	251	1	6	5
KCP04b	2	1	1	2	170	11	19	7	3	3	1	1	236	2	4	4
KCP04b	2	1	2	2	172	9	17	11	3	2	0	1	236	1	6	4
KCP04b	3	1	3	2	173	11	25	8	4	2	0	1	234	1	5	5
average	2	1	2	2	172	10	20	9	3	2	0	1	235	1	5	4
KCP01c	2	1	3	2	151	11	11	8	4	2	1	1	276	1	6	4
KCP01c	2	0	3	2	151	11	15	11	4	2	1	1	275	2	5	4
KCP01c	1	0	2	2	158	10	18	10	4	2	1	1	276	0	6	4
average	2	1	3	2	153	11	15	10	4	2	1	1	276	1	5	4
KCP02c	2	1	1	2	189	13	19	10	3	6	1	0	230	1	6	4
KCP02c	1	1	3	2	198	13	18	10	3	2	2	1	231	1	5	5

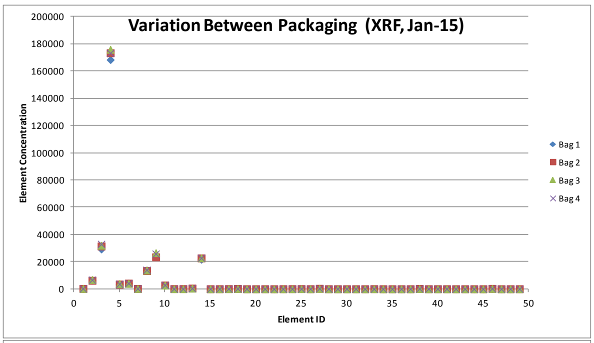
KCP02c	2	1	1	2	202	12	18	8	4	4	1	1	234	0	6	5
average	1	1	2	2	196	13	18	9	3	4	1	0	232	1	6	4
KCP03c	2	1	2	2	169	14	12	5	3	2	1	1	242	1	5	9
KCP03c	3	1	3	2	163	10	16	9	3	5	4	2	242	2	5	28
KCP03c	2	1	3	2	164	8	17	11	3	2	1	1	240	1	6	14
average	2	1	3	2	165	10	15	8	3	3	2	1	241	1	5	17
KCP04c	1	1	2	2	199	19	14	7	3	3	1	1	215	0	5	10
KCP04c	2	1	3	2	186	9	9	10	4	3	1	1	215	2	5	10
KCP04c	2	1	2	2	193	12	16	10	3	3	1	2	214	1	6	13
average	2	1	2	2	193	13	13	9	3	3	1	1	215	1	5	11
KCP01d	3	1	2	2	165	10	12	10	3	2	0	1	233	1	5	5
KCP01d	2	1	1	2	164	11	13	10	4	2	2	1	237	1	6	12
KCP01d	3	1	1	2	166	4	15	7	4	3	1	1	233	1	5	17
average	3	1	2	2	165	9	13	9	3	2	1	1	234	1	5	11
KCP02d	2	1	3	2	174	6	17	14	4	3	2	1	248	1	6	5
KCP02d	1	1	2	2	176	10	16	10	4	2	1	1	246	1	5	14
average	2	1	2	2	174	9	16	11	4	3	1	1	247	1	5	8
KCP03d	1	1	2	2	149	10	17	9	3	3	1	1	218	1	6	4
KCP03d	2	1	3	2	144	11	15	10	3	4	3	0	223	1	5	4
KCP03d	1	1	3	2	144	10	10	9	3	2	1	0	220	1	5	13
average	1	1	2	2	145	10	14	10	3	3	1	1	220	1	6	7
KCP04d	2	1	1	2	167	11	21	10	3	2	1	1	238	1	5	4
KCP04d	3	2	1	2	160	13	12	9	3	4	1	1	242	1	6	12
KCP04d	2	1	3	2	166	8	18	10	4	2	1	1	245	1	5	19
average	3	1	2	2	164	11	17	9	3	3	1	1	242	1	5	12
KCP01e	2	1	1	2	185	12	13	9	3	3	1	1	214	2	4	4
KCP01e	3	1	2	2	178	10	15	11	3	2	2	1	214	1	5	16
KCP01e	2	1	1	2	179	7	22	12	3	4	2	1	217	1	5	17
average	2	1	2	2	180	10	17	11	3	3	2	1	215	1	5	12
KCP02e	3	1	2	2	180	9	15	8	3	2	1	1	221	1	5	4
KCP02e	2	1	4	2	181	10	14	8	4	3	2	0	226	1	6	15
KCP02e	3	1	3	2	179	7	12	8	3	4	1	1	227	1	5	17
average	2	1	3	2	180	9	14	8	3	3	1	1	224	1	5	12
KCP03e	2	1	1	2	153	11	12	7	3	2	0	1	229	1	4	4
KCP03e	2	1	1	2	152	10	16	10	3	5	1	1	226	2	4	10
KCP03e	2	1	2	2	153	4	10	11	3	6	1	1	232	1	5	15
average	2	1	2	2	153	8	13	9	3	4	1	1	229	1	4	10
KCP04e	3	1	2	2	172	10	13	8	3	2	1	1	227	1	5	7
KCP04e	2	1	2	2	172	12	11	11	3	2	3	0	228	1	5	16

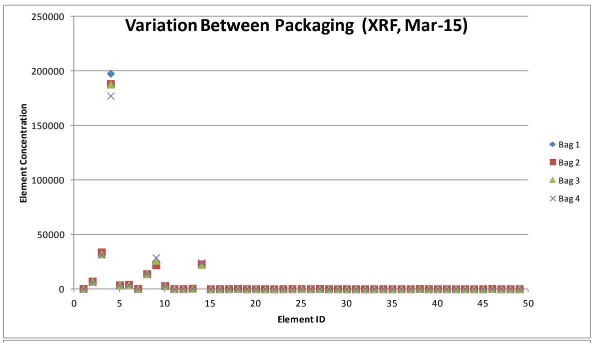
KCP04e	2	1	3	2	163	8	9	9	3	2	1	2	232	1	6	15
average	2	1	2	2	169	10	11	9	3	2	1	1	229	1	5	12
KCP01f	2	1	3	2	164	6	9	11	3	2	1	1	203	0	6	9
KCP01f	3	1	3	2	167	10	16	8	3	6	2	1	206	1	5	13
KCP01f	1	1	3	2	162	10	16	7	3	4	2	1	206	2	5	13
average	2	1	3	2	165	9	14	9	3	4	2	1	205	1	5	12
KCP02f	2	1	2	2	178	7	19	13	3	3	1	1	226	1	6	12
KCP02f	2	1	1	2	187	15	17	12	3	2	2	1	223	1	6	20
KCP02f	2	1	2	2	178	7	17	11	3	9	1	1	221	1	6	12
average	2	1	2	2	181	10	18	12	3	5	1	1	223	1	6	15
KCP03f	2	1	4	2	184	11	15	9	3	2	3	1	234	0	8	15
KCP03f	2	1	2	2	186	6	14	12	3	3	1	1	234	2	5	16
KCP03f	3	1	1	2	190	9	15	10	3	4	3	1	230	1	5	20
average	2	1	2	2	187	9	15	10	3	3	2	1	233	1	6	17
KCP04f	2	1	5	2	188	11	17	11	3	2	1	2	227	1	6	21
KCP04f	2	1	2	2	187	16	16	13	3	5	2	1	226	1	6	19
KCP04f	1	1	3	2	180	7	12	11	3	2	2	2	225	2	5	26
average	1	1	4	2	185	11	15	11	3	3	2	2	226	1	6	22
KCP01a	2	1	3	2	164	9	14	6	3	2	1	0	221	1	5	4
KCP01a	2	1	1	2	165	11	13	6	3	2	1	1	217	0	5	15
KCP01a	2	1	2	2	164	10	11	10	3	2	1	1	222	1	5	8
average	2	1	2	2	164	10	12	7	3	2	1	1	220	1	5	9
KCP02a	2	1	3	2	174	4	15	10	4	3	0	1	240	1	4	3
KCP02a	2	1	1	2	175	13	20	8	4	4	1	1	242	2	5	3
KCP02a	2	1	3	2	178	10	14	9	4	5	1	1	242	0	6	6
average	2	1	2	2	176	9	16	9	4	4	1	1	241	1	5	4
KCP03a	2	1	1	2	174	9	18	9	3	2	1	1	239	0	6	5
KCP03a	2	1	2	2	178	12	17	9	3	2	0	1	241	1	5	4
KCP03a	2	1	2	2	178	12	16	8	3	3	1	1	243	1	5	5
average	2	1	1	2	177	11	17	9	3	2	1	1	241	1	5	4
KCP04a	3	1	3	2	163	4	15	9	4	2	2	1	246	2	5	4
KCP04a	2	1	1	2	166	11	15	11	4	4	0	1	244	1	5	4
KCP04a	2	1	2	2	171	17	10	11	4	2	1	1	248	1	7	6
average	2	1	2	2	167	11	14	10	4	3	1	1	246	1	5	4
KCP01b	3	1	3	2	171	12	14	9	4	4	1	1	246	0	5	4
KCP01b	3	1	1	2	170	14	9	10	4	2	1	1	249	1	5	4
KCP01b	2	1	1	3	177	12	16	8	4	2	1	0	246	1	5	7
average	3	1	2	2	172	13	13	9	4	3	1	1	247	1	5	5
KCP02b	2	2	4	2	178	8	18	11	4	3	1	1	226	2	5	4

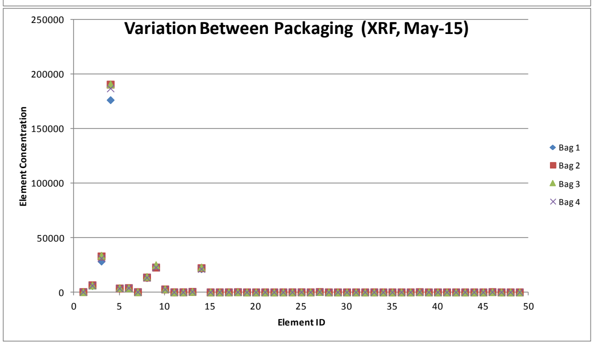
KCP02b	3	1	2	2	178	11	13	10	4	2	2	1	229	1	6	4
KCP02b	2	1	1	2	178	13	22	7	3	2	2	1	228	1	6	4
average	2	1	2	2	178	11	18	9	3	2	1	1	228	1	5	4
KCP03b	1	1	2	2	165	11	5	8	4	4	1	1	250	1	5	4
KCP03b	1	1	1	2	168	12	13	8	3	3	1	1	252	1	5	4
KCP03b	3	1	4	2	163	10	5	8	4	2	1	1	252	1	6	7
average	1	1	3	2	165	11	8	8	3	3	1	1	251	1	5	5
KCP04b	3	1	1	2	189	8	15	8	4	4	1	1	245	1	6	5
KCP04b	2	1	2	2	193	8	9	8	4	2	1	1	240	0	5	7
KCP04b	2	1	1	2	196	16	17	6	4	6	1	1	246	1	5	5
average	2	1	2	2	193	10	14	7	4	4	1	1	244	1	5	6
KCP01c	2	1	1	2	149	10	11	10	4	2	1	1	275	1	6	4
KCP01c	3	0	1	2	151	4	20	10	4	2	1	1	273	2	3	6
KCP01c	2	1	3	2	157	9	13	11	3	4	1	1	276	0	5	3
average	2	1	2	2	152	8	15	10	3	3	1	1	275	1	4	4
KCP02c	2	1	1	2	190	13	7	9	4	2	2	1	231	1	6	4
KCP02c	3	1	2	2	195	12	18	8	3	4	1	1	235	1	4	5
KCP02c	3	1	3	2	194	10	17	8	3	3	1	1	234	1	5	5
average	3	1	2	2	193	11	14	9	3	3	1	1	233	1	5	4
KCP03c	2	1	2	2	170	7	6	10	3	5	2	1	240	2	5	28
KCP03c	2	1	2	2	177	13	11	10	3	4	1	1	239	1	5	19
KCP03c	2	1	2	2	178	8	11	10	3	4	1	1	241	1	6	15
average	2	1	2	2	175	9	9	10	3	4	1	1	240	1	5	21
KCP04c	2	1	1	2	205	11	23	6	3	3	2	2	209	1	6	15
KCP04c	3	1	2	2	204	11	14	10	3	4	2	1	210	1	5	12
KCP04c	3	1	1	2	208	11	13	7	3	2	1	1	208	1	6	17
average	3	1	1	2	205	11	17	8	3	3	2	1	209	1	6	15
KCP01d	3	1	3	2	181	9	17	10	4	2	2	1	231	0	7	13
KCP01d	2	1	2	2	182	4	17	9	3	2	1	1	231	1	6	11
KCP01d	3	1	2	2	180	12	12	11	4	3	1	1	234	1	6	15
average	3	1	2	2	181	8	16	10	4	2	1	1	232	1	6	13
KCP02d	2	1	2	2	173	9	16	10	4	3	2	1	246	0	6	16
KCP02d	3	1	3	2	183	12	14	8	4	2	2	1	249	1	4	13
KCP02d	2	1	3	2	184	14	20	8	4	6	2	1	250	1	5	14
average	2	1	3	2	180	12	17	9	4	4	2	1	248	1	5	14
KCP03d	2	1	3	2	157	10	16	4	3	2	1	1	223	1	6	13
KCP03d	1	1	2	2	156	4	25	11	3	5	1	1	225	1	6	15
KCP03d	3	1	3	2	154	10	18	11	3	2	2	1	226	1	4	13
average	2	1	2	2	156	8	20	8	3	3	1	1	225	1	5	14

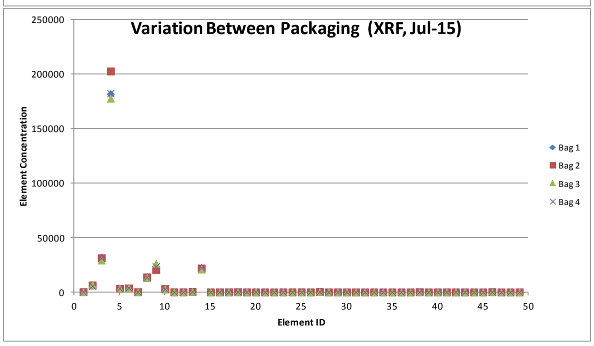
KCP04d	2	1	1	2	167	12	14	10	4	6	0	1	245	1	6	7
KCP04d	2	1	3	2	158	10	18	11	4	6	1	1	246	0	6	14
KCP04d	2	1	1	2	156	8	13	8	4	3	1	0	241	1	6	8
average	2	1	2	2	160	10	15	10	4	5	1	1	244	1	6	9
KCP01e	3	1	1	2	188	14	14	11	3	5	1	1	216	1	6	14
KCP01e	2	1	3	2	191	7	6	13	3	3	2	1	220	1	5	14
KCP01e	3	1	2	2	186	12	16	12	3	4	2	1	217	1	6	21
average	2	1	2	2	188	11	12	12	3	4	1	1	217	1	6	16
KCP02e	2	1	2	2	190	11	20	11	3	4	2	1	226	1	6	21
KCP02e	3	1	3	2	190	7	6	9	4	2	2	1	228	1	5	21
KCP02e	2	1	2	2	190	4	15	11	4	4	2	2	228	1	6	20
average	2	1	2	2	190	7	14	10	4	3	2	1	228	1	6	21
KCP03e	1	1	2	2	155	11	10	10	3	2	1	1	226	1	5	13
KCP03e	2	1	1	2	154	9	7	9	3	2	2	1	225	0	6	21
KCP03e	2	1	3	2	154	7	15	10	3	2	2	1	226	0	6	24
average	1	1	2	2	154	9	11	9	3	2	2	1	226	1	6	19
KCP04e	2	1	1	2	173	10	11	10	4	3	1	1	229	1	4	13
KCP04e	2	1	1	2	174	9	15	10	3	2	1	1	229	1	6	17
KCP04e	1	1	3	2	172	12	13	10	4	2	3	0	228	1	5	19
average	2	1	2	2	173	10	13	10	3	2	2	1	228	1	5	16
KCP01f	2	1	3	2	164	9	15	10	3	3	2	1	198	1	4	15
KCP01f	2	1	4	2	173	4	9	9	3	2	1	1	202	1	4	4
KCP01f	2	1	1	2	174	14	18	10	3	1	3	1	204	1	4	5
average	2	1	3	2	170	9	14	10	3	2	2	1	201	1	4	8
KCP02f	3	1	1	2	201	13	16	12	3	4	2	1	217	1	6	17
KCP02f	2	1	3	2	203	4	16	10	3	2	1	1	219	0	5	4
KCP02f	2	1	3	2	205	11	17	9	3	2	3	0	221	0	5	6
average	2	1	2	2	203	9	16	10	3	3	2	1	219	1	5	9
KCP03f	2	1	3	3	186	12	17	11	3	3	1	1	229	1	7	18
KCP03f	2	1	1	2	185	9	14	9	3	2	4	1	230	1	5	4
KCP03f	3	1	2	2	189	13	15	9	3	2	2	0	232	1	5	4
average	2	1	2	2	187	11	15	10	3	2	2	1	230	1	6	9
KCP04f	2	1	2	2	190	11	20	13	3	3	1	2	220	1	6	17
KCP04f	2	1	4	2	196	14	20	11	3	2	3	1	224	0	6	5
KCP04f	2	1	2	2	193	9	18	9	3	2	2	1	222	1	4	5
average	2	1	2	2	193	11	19	11	3	2	2	1	222	1	5	9
KCP01g	2	1	2	2	170	11	6	11	3	2	1	1	225	1	5	23
KCP01g	2	1	2	2	170	8	6	11	3	2	2	1	221	1	4	5
KCP01g	2	1	3	2	165	4	15	6	3	3	1	1	221	1	6	4

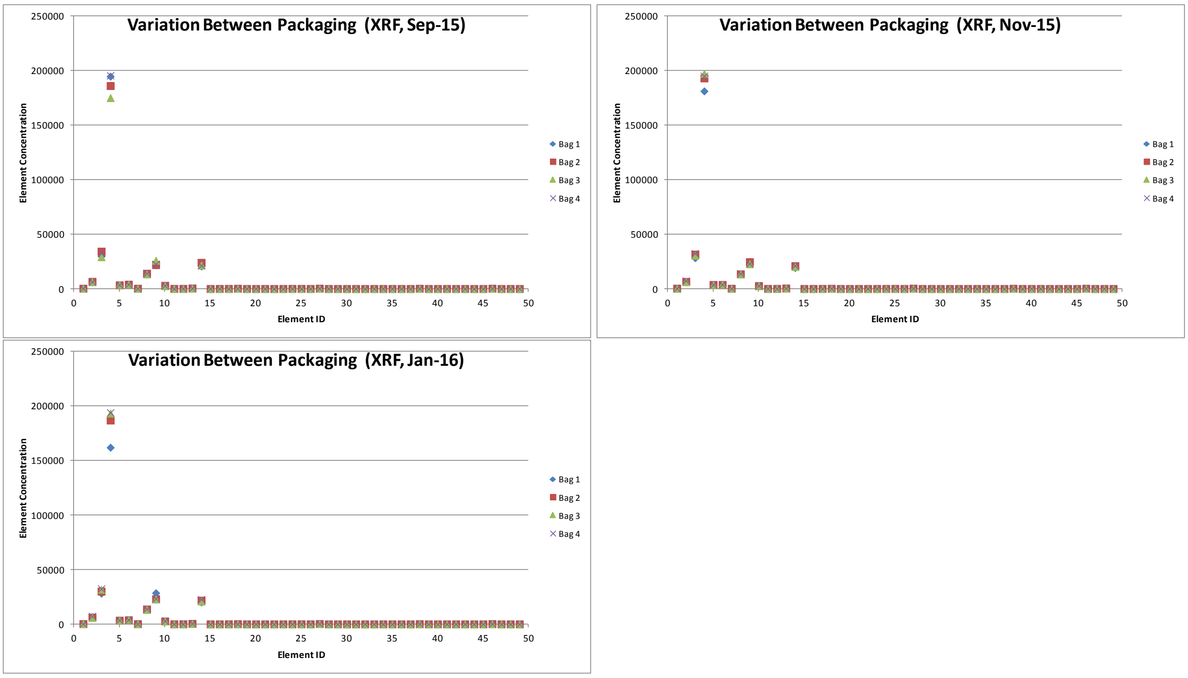
average	2	1	2	2	168	8	9	9	3	2	1	1	222	1	5	11
KCP02g	2	1	3	2	169	8	18	9	3	3	2	1	230	0	6	18
KCP02g	3	1	3	2	174	7	12	8	3	3	2	1	233	1	6	11
KCP02g	3	1	3	2	173	9	14	6	3	4	1	1	231	1	6	11
average	2	1	3	2	172	8	15	8	3	4	2	1	231	1	6	13
KCP03g	2	1	3	2	181	10	17	8	3	4	1	2	211	0	5	19
KCP03g	2	1	3	2	185	14	18	7	3	2	2	2	209	1	5	10
KCP03g	3	0	1	2	188	4	15	9	3	5	3	1	207	0	6	5
average	2	1	2	2	184	10	17	8	3	4	2	1	209	0	5	11
KCP04g	1	1	3	2	166	9	15	11	3	3	1	2	225	1	5	18
KCP04g	2	1	2	2	169	11	18	8	3	3	1	1	228	1	5	6
KCP04g	1	1	2	2	169	4	14	9	3	2	2	1	230	1	5	5
average	1	1	3	2	168	8	15	9	3	3	1	1	228	1	5	10



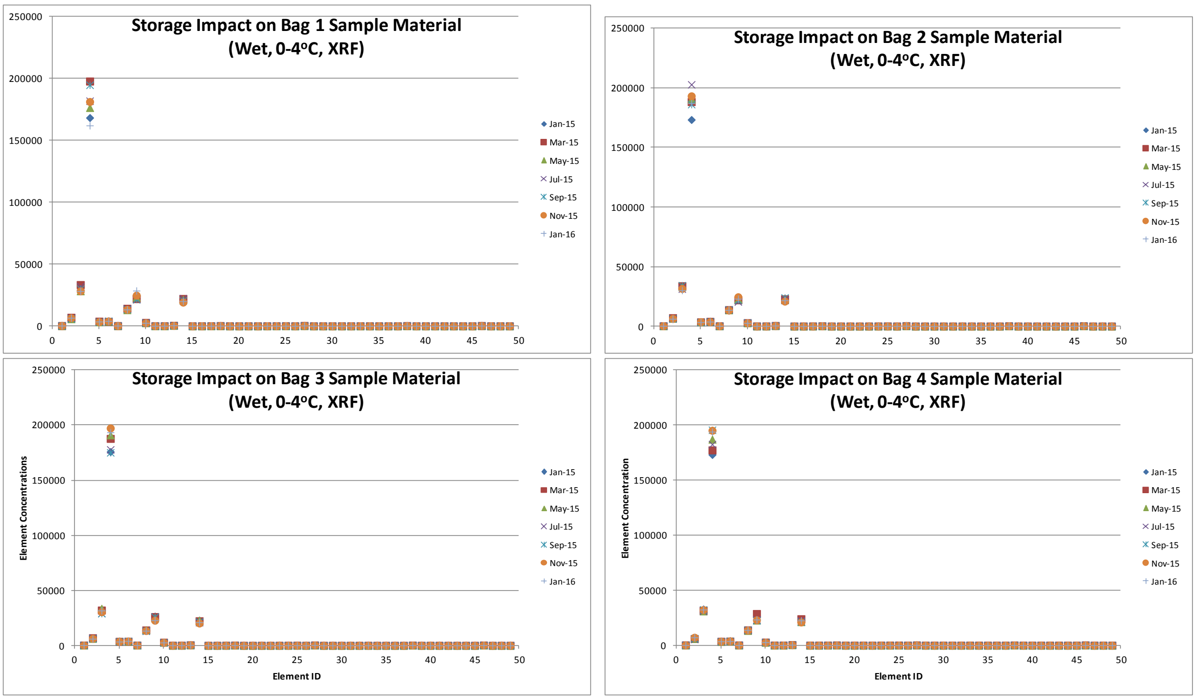




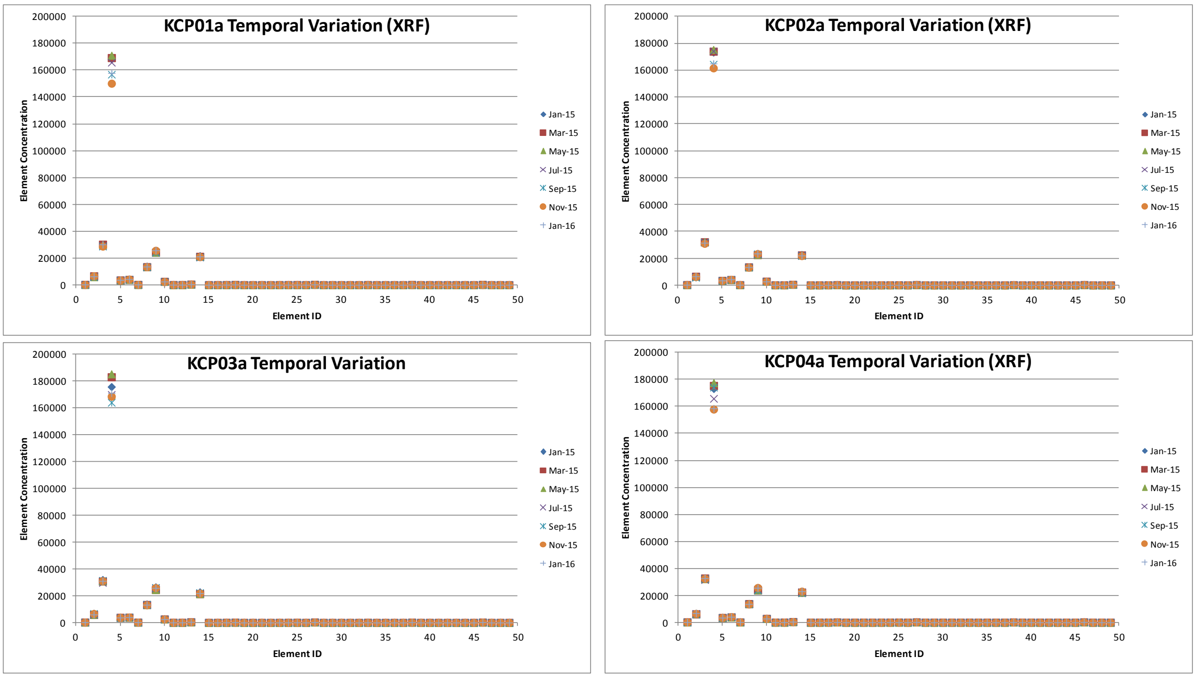




Appendix 4.6: XRF Elemental Variance in garden soil samples in different manufactured packaging.



Appendix 4.7: Temporal variance in XRF elemental concentration for garden soil samples stored wet at 0 - 4 oC



Appendix 4.8: Temporal variance in XRF elemental concentration for garden soil samples stored dry at room temperature.

4.1.3 XRF Paired T-test Outputs

Appendix 4.9: Paired t-test output for samples in different bags assessed by XRF

Site	Pair	t	df	Sig.
Garden	Bag 1 - Bag 2	-.458	48	.649
	Bag 1 - Bag 3	-.105	48	.917
	Bag 1 - Bag 4	2.336	48	.024
	Bag 2 - Bag 3	.623	48	.536
	Bag 2 - Bag 4	1.447	48	.154
	Bag 3 - Bag 4	1.890	48	.065
Park	Bag 1 - Bag 2	-1.252	48	.217
	Bag 1 - Bag 3	-1.743	48	.088
	Bag 1 - Bag 4	-1.935	48	.059
	Bag 2 - Bag 3	-1.822	48	.075
	Bag 2 - Bag 4	-1.781	48	.081
	Bag 3 - Bag 4	.794	48	.431

Appendix 4.10: Paired t-test output assessing temporal variation in garden soil samples stored dry at room temperature (XRF)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan15) - 1a (Mar 15)	2.324	48	.024
	1a (Jan 15) - 1a (May 15)	1.169	48	.248
	1a (Jan 15) - 1a (Jul 15)	1.008	48	.318
	1a (Jan 15) - 1a (Sep 15)	1.167	48	.249
	1a (Jan 15) - 1a (Nov 15)	1.177	48	.245
	1a (Jan 15) - 1a (Jan 16)	1.189	48	.240
	1b (Mar 15) - 1b (May 15)	-.827	48	.412
	1b (Mar 15) - 1b (Jul 15)	.157	48	.876
	1b (Mar 15) - 1b (Sep 15)	.811	48	.422
	1b (Mar 15) - 1b (Nov 15)	.945	48	.349
	1b (Mar 15) - 1b (Jan 16)	.941	48	.351
	1c (May 15) - 1c (Jul 15)	.813	48	.420
	1c (May 15) - 1c (Sep 15)	.818	48	.417
	1c (May 15) - 1c (Nov 15)	.938	48	.353
	1c (May 15) - 1c (Jan 16)	.934	48	.355
	1d (Jul 15) - 1d (Sep 15)	.555	48	.582
	1d (Jul 15) - 1d (Nov 15)	.739	48	.464
	1d (Jul 15) - 1d (Jan 16)	.725	48	.472
	1e (Sep 15) - 1e (Nov 15)	1.189	48	.240
	1e (Sep 15) - 1e (Jan 16)	1.228	48	.226
	1f (Sep 15) - 1f (Jan 16)	-.982	48	.331

2	2a (Jan15) - 2a (Mar 15)	-.704	48	.485
	2a (Jan 15) - 2a (May 15)	-.845	48	.403
	2a (Jan 15) - 2a (Jul 15)	1.158	48	.253
	2a (Jan 15) - 2a (Sep 15)	1.012	48	.316
	2a (Jan 15) - 2a (Nov 15)	.866	48	.391
	2a (Jan 15) - 2a (Jan 16)	.768	48	.446
	2b (Mar 15) - 2b (May 15)	-1.591	48	.118
	2b (Mar 15) - 2b (Jul 15)	.919	48	.363
	2b (Mar 15) - 2b (Sep 15)	.800	48	.427
	2b (Mar 15) - 2b (Nov 15)	.773	48	.443
	2b (Mar 15) - 2b (Jan 16)	.726	48	.471
	2c (May 15) - 2c (Jul 15)	.984	48	.330
	2c (May 15) - 2c (Sep 15)	.905	48	.370
	2c (May 15) - 2c (Nov 15)	.859	48	.395
	2c (May 15) - 2c (Jan 16)	.853	48	.398
	2d (Jul 15) - 2d (Sep 15)	-1.171	48	.247
	2d (Jul 15) - 2d (Nov 15)	-1.638	48	.108
	2d (Jul 15) - 2d (Jan 16)	-1.197	48	.237
	2e (Sep 15) - 2e (Nov 15)	.663	48	.510
	2e (Sep 15) - 2e (Jan 16)	-1.155	48	.254
	2f (Sep 15) - 2f (Jan 16)	-.865	48	.391

3	3a (Jan15) - 3a (Mar 15)	1.698	48	.096
	3a (Jan 15) - 3a (May 15)	1.876	48	.067
	3a (Jan 15) - 3a (Jul 15)	1.125	48	.266
	3a (Jan 15) - 3a (Sep 15)	1.228	48	.225
	3a (Jan 15) - 3a (Nov 15)	1.142	48	.259
	3a (Jan 15) - 3a (Jan 16)	1.194	48	.238
	3b (Mar 15) - 3b (May 15)	-.883	48	.382
	3b (Mar 15) - 3b (Jul 15)	.898	48	.374
	3b (Mar 15) - 3b (Sep 15)	1.068	48	.291
	3b (Mar 15) - 3b (Nov 15)	.972	48	.336
	3b (Mar 15) - 3b (Jan 16)	.998	48	.323
	3c (May 15) - 3c (Jul 15)	.905	48	.370
	3c (May 15) - 3c (Sep 15)	1.063	48	.293
	3c (May 15) - 3c (Nov 15)	.973	48	.335
	3c (May 15) - 3c (Jan 16)	.999	48	.323
	3d (Jul 15) - 3d (Sep 15)	1.837	48	.072
	3d (Jul 15) - 3d (Nov 15)	1.206	48	.234
	3d (Jul 15) - 3d (Jan 16)	1.695	48	.097
	3e (Sep 15) - 3e (Nov 15)	.080	48	.936
	3e (Sep 15) - 3e (Jan 16)	-1.430	48	.159
	3f (Sep 15) - 3f (Jan 16)	-.844	48	.403

4	4a (Jan15) - 4a (Mar 15)	.263	48	.794
	4a (Jan 15) - 4a (May 15)	-.440	48	.662
	4a (Jan 15) - 4a (Jul 15)	1.008	48	.318
	4a (Jan 15) - 4a (Sep 15)	.993	48	.325
	4a (Jan 15) - 4a (Nov 15)	1.080	48	.286
	4a (Jan 15) - 4a (Jan 16)	1.192	48	.239
	4b (Mar 15) - 4b (May 15)	-1.428	48	.160
	4b (Mar 15) - 4b (Jul 15)	.828	48	.412
	4b (Mar 15) - 4b (Sep 15)	.879	48	.384
	4b (Mar 15) - 4b (Nov 15)	.750	48	.457
	4b (Mar 15) - 4b (Jan 16)	.843	48	.403
	4c (May 15) - 4c (Jul 15)	.888	48	.379
	4c (May 15) - 4c (Sep 15)	.916	48	.364
	4c (May 15) - 4c (Nov 15)	.861	48	.394
	4c (May 15) - 4c (Jan 16)	.938	48	.353
	4d (Jul 15) - 4d (Sep 15)	.970	48	.337
	4d (Jul 15) - 4d (Nov 15)	-.928	48	.358
	4d (Jul 15) - 4d (Jan 16)	-.806	48	.424
	4e (Sep 15) - 4e (Nov 15)	-.952	48	.346
	4e (Sep 15) - 4e (Jan 16)	-.900	48	.373
	4f (Sep 15) - 4f (Jan 16)	2.372	48	.022

Appendix 4.11: Paired t-test output assessing temporal variation in park soil samples stored dry at room temperature (XRF)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan15) - 1a (Mar 15)	-.676	48	.502
	1a (Jan 15) - 1a (May 15)	-.801	48	.427
	1a (Jan 15) - 1a (Jul 15)	1.879	48	.066
	1a (Jan 15) - 1a (Sep 15)	1.189	48	.240
	1a (Jan 15) - 1a (Nov 15)	.995	48	.325

	1a (Jan 15) - 1a (Jan 16)	.804	48	.425
	1b (Mar 15) - 1b (May 15)	-.661	48	.512
	1b (Mar 15) - 1b (Jul 15)	1.692	48	.097
	1b (Mar 15) - 1b (Sep 15)	1.180	48	.244
	1b (Mar 15) - 1b (Nov 15)	1.000	48	.322
	1b (Mar 15) - 1b (Jan 16)	.832	48	.409
	1c (May 15) - 1c (Jul 15)	1.418	48	.163
	1c (May 15) - 1c (Sep 15)	1.125	48	.266
	1c (May 15) - 1c (Nov 15)	.976	48	.334
	1c (May 15) - 1c (Jan 16)	.817	48	.418
	1d (Jul 15) - 1d (Sep 15)	.942	48	.351
	1d (Jul 15) - 1d (Nov 15)	.820	48	.416
	1d (Jul 15) - 1d (Jan 16)	.405	48	.687
	1e (Sep 15) - 1e (Nov 15)	.652	48	.518
	1e (Sep 15) - 1e (Jan 16)	-2.234	48	.030
	1f (Sep 15) - 1f (Jan 16)	-1.230	48	.225
2	2a (Jan15) - 2a (Mar 15)	-.245	48	.808
	2a (Jan 15) - 2a (May 15)	-.859	48	.394
	2a (Jan 15) - 2a (Jul 15)	-.651	48	.518
	2a (Jan 15) - 2a (Sep 15)	1.137	48	.261
	2a (Jan 15) - 2a (Nov 15)	1.128	48	.265
	2a (Jan 15) - 2a (Jan 16)	1.009	48	.318
	2b (Mar 15) - 2b (May 15)	-1.255	48	.216
	2b (Mar 15) - 2b (Jul 15)	-.950	48	.347
	2b (Mar 15) - 2b (Sep 15)	1.090	48	.281
	2b (Mar 15) - 2b (Nov 15)	1.089	48	.281
	2b (Mar 15) - 2b (Jan 16)	.966	48	.339
	2c (May 15) - 2c (Jul 15)	1.039	48	.304
	2c (May 15) - 2c (Sep 15)	1.111	48	.272
	2c (May 15) - 2c (Nov 15)	1.106	48	.274

	2c (May 15) - 2c (Jan 16)	1.004	48	.320
	2d (Jul 15) - 2d (Sep 15)	1.114	48	.271
	2d (Jul 15) - 2d (Nov 15)	1.108	48	.273
	2d (Jul 15) - 2d (Jan 16)	.995	48	.325
	2e (Sep 15) - 2e (Nov 15)	1.023	48	.312
	2e (Sep 15) - 2e (Jan 16)	-1.567	48	.124
	2f (Sep 15) - 2f (Jan 16)	-1.405	48	.166
3	3a (Jan15) - 3a (Mar 15)	-.182	48	.856
	3a (Jan 15) - 3a (May 15)	-.411	48	.683
	3a (Jan 15) - 3a (Jul 15)	1.809	48	.077
	3a (Jan 15) - 3a (Sep 15)	1.148	48	.257
	3a (Jan 15) - 3a (Nov 15)	1.443	48	.156
	3a (Jan 15) - 3a (Jan 16)	1.740	48	.088
	3b (Mar 15) - 3b (May 15)	-1.203	48	.235
	3b (Mar 15) - 3b (Jul 15)	.964	48	.340
	3b (Mar 15) - 3b (Sep 15)	.775	48	.442
	3b (Mar 15) - 3b (Nov 15)	.815	48	.419
	3b (Mar 15) - 3b (Jan 16)	.823	48	.415
	3c (May 15) - 3c (Jul 15)	1.000	48	.322
	3c (May 15) - 3c (Sep 15)	.820	48	.416
	3c (May 15) - 3c (Nov 15)	.867	48	.390
	3c (May 15) - 3c (Jan 16)	.883	48	.382
	3d (Jul 15) - 3d (Sep 15)	.340	48	.735
	3d (Jul 15) - 3d (Nov 15)	-.432	48	.668

	3d (Jul 15) - 3d (Jan 16)	-1.679	48	.100
	3e (Sep 15) - 3e (Nov 15)	-.645	48	.522
	3e (Sep 15) - 3e (Jan 16)	-.691	48	.493
	3f (Sep 15) - 3f (Jan 16)	-.754	48	.455
4	4a (Jan15) - 4a (Mar 15)	.449	48	.656
	4a (Jan 15) - 4a (May 15)	-.198	48	.844
	4a (Jan 15) - 4a (Jul 15)	1.421	48	.162
	4a (Jan 15) - 4a (Sep 15)	1.493	48	.142
	4a (Jan 15) - 4a (Nov 15)	1.053	48	.298
	4a (Jan 15) - 4a (Jan 16)	1.017	48	.314
	4b (Mar 15) - 4b (May 15)	-1.056	48	.296
	4b (Mar 15) - 4b (Jul 15)	.963	48	.341
	4b (Mar 15) - 4b (Sep 15)	1.654	48	.105
	4b (Mar 15) - 4b (Nov 15)	.833	48	.409
	4b (Mar 15) - 4b (Jan 16)	.796	48	.430
	4c (May 15) - 4c (Jul 15)	.991	48	.327
	4c (May 15) - 4c (Sep 15)	1.331	48	.189
	4c (May 15) - 4c (Nov 15)	.862	48	.393
	4c (May 15) - 4c (Jan 16)	.829	48	.411
	4d (Jul 15) - 4d (Sep 15)	-.834	48	.409
	4d (Jul 15) - 4d (Nov 15)	.667	48	.508

	4d (Jul 15) - 4d (Jan 16)	.565	48	.575
	4e (Sep 15) - 4e (Nov 15)	.757	48	.453
	4e (Sep 15) - 4e (Jan 16)	.713	48	.479
	4f (Sep 15) - 4f (Jan 16)	-1.506	48	.139

Appendix 4.12: Paired t-test output assessing temporal variation in garden soil samples stored wet at 0-4 ^{o}C (XRF)

Sample Bag	Sample Pair	t	df	Significance
1	G01a - G01b	1.979	48	.054
	G01a - G01c	.431	48	.668
	G01a - G01d	-.400	48	.691
	G01a - G01e	-.733	48	.467
	G01a - G01f	-.346	48	.731
	G01a - G01g	1.247	48	.219
	G01b - G01c	-1.173	48	.246
	G01b - G01d	-.937	48	.354
	G01b - G01e	-1.197	48	.237
	G01b - G01f	-1.074	48	.288
	G01b - G01g	.649	48	.519
	G01c - G01d	-.718	48	.476
	G01c - G01e	-1.193	48	.239

	G01c - G01f	-.880	48	.383
	G01c - G01g	.906	48	.369
	G01d - G01e	-1.722	48	.092
	G01d - G01f	.496	48	.622
	G01d - G01g	.844	48	.403
	G01e - G01f	1.596	48	.117
	G01e - G01g	1.016	48	.315
	G01f - G01g	.909	48	.368
2	G02a - G02b	1.121	48	.268
	G02a - G02c	1.442	48	.156
	G02a - G02d	1.409	48	.165
	G02a - G02e	1.153	48	.255
	G02a - G02f	1.147	48	.257
	G02a - G02g	1.139	48	.260
	G02b - G02c	-.840	48	.405
	G02b - G02d	-.849	48	.400
	G02b - G02e	-.926	48	.359
	G02b - G02f	-.973	48	.335
	G02b - G02g	1.113	48	.271
	G02c - G02d	.771	48	.445
	G02c - G02e	.248	48	.805
	G02c - G02f	.622	48	.537
	G02c - G02g	.953	48	.346
	G02d - G02e	-1.272	48	.209
	G02d - G02f	.374	48	.710

	G02d - G02g	.991	48	.327
	G02e - G02f	.790	48	.433
	G02e - G02g	1.026	48	.310
	G02f - G02g	1.093	48	.280
3	G03a - G03b	.578	48	.566
	G03a - G03c	.037	48	.970
	G03a - G03d	-.696	48	.490
	G03a - G03e	-.689	48	.494
	G03a - G03f	-.956	48	.344
	G03a - G03g	-.693	48	.492
	G03b - G03c	-.822	48	.415
	G03b - G03d	-.971	48	.336
	G03b - G03e	-1.092	48	.280
	G03b - G03f	-1.110	48	.272
	G03b - G03g	-1.143	48	.259
	G03c - G03d	-.944	48	.350
	G03c - G03e	-1.101	48	.276
	G03c - G03f	-1.105	48	.275
	G03c - G03g	-1.276	48	.208
	G03d - G03e	.701	48	.487
	G03d - G03f	-1.237	48	.222

	G03d - G03g	.650	48	.519
	G03e - G03f	-1.103	48	.275
	G03e - G03g	.470	48	.641
	G03f - G03g	1.024	48	.311
4	G04a - G04b	-1.005	48	.320
	G04a - G04c	-2.010	48	.050
	G04a - G04d	-.914	48	.365
	G04a - G04e	-.959	48	.342
	G04a - G04f	-1.001	48	.322
	G04a - G04g	-1.081	48	.285
	G04b - G04c	-.701	48	.487
	G04b - G04d	-.867	48	.390
	G04b - G04e	-.941	48	.351
	G04b - G04f	-.984	48	.330
	G04b - G04g	-1.073	48	.289
	G04c - G04d	-.657	48	.514
	G04c - G04e	-.815	48	.419
	G04c - G04f	-.813	48	.420
	G04c - G04g	-.836	48	.407
	G04d - G04e	-1.022	48	.312
	G04d - G04f	-1.285	48	.205

	G04d - G04g	-.764	48	.449
	G04e - G04f	.815	48	.419
	G04e - G04g	.741	48	.462
	G04f - G04g	.603	48	.549

Appendix 4.13: Paired t-test output assessing temporal variation in park soil samples stored wet at 0-4 ^{o}C (XRF)

Sample Bag	**Sample Pair**	**t**	**df**	**Significance**
1	P01a - P01b	-1.097	48	.278
	P01a - P01c	-.507	48	.614
	P01a - P01d	-1.027	48	.309
	P01a - P01e	-.848	48	.401
	P01a - P01f	-.707	48	.483
	P01a - P01g	.629	48	.532
	P01b - P01c	1.300	48	.200
	P01b - P01d	1.138	48	.261
	P01b - P01e	2.120	48	.039
	P01b - P01f	1.320	48	.193
	P01b - P01g	1.024	48	.311
	P01c - P01d	-1.497	48	.141
	P01c - P01e	-.995	48	.325

	P01c - P01f	-.930	48	.357
	P01c - P01g	.593	48	.556
	P01d - P01e	-.612	48	.543
	P01d - P01f	.865	48	.391
	P01d - P01g	.903	48	.371
	P01e - P01f	.941	48	.351
	P01e - P01g	.821	48	.416
	P01f - P01g	.729	48	.470
2	P02a - P02b	-1.130	48	.264
	P02a - P02c	-1.043	48	.302
	P02a - P02d	-.861	48	.393
	P02a - P02e	-1.224	48	.227
	P02a - P02f	-.962	48	.341
	P02a - P02g	-.773	48	.443
	P02b - P02c	-.347	48	.730
	P02b - P02d	-.559	48	.579
	P02b - P02e	.401	48	.690
	P02b - P02f	-.310	48	.758
	P02b - P02g	1.536	48	.131
	P02c - P02d	-.589	48	.559
	P02c - P02e	.387	48	.701
	P02c - P02f	-.274	48	.785
	P02c - P02g	1.613	48	.113
	P02d - P02e	.544	48	.589
	P02d - P02f	.603	48	.550

	P02d - P02g	.927	48	.359
	P02e - P02f	-.348	48	.730
	P02e - P02g	1.127	48	.265
	P02f - P02g	1.301	48	.199
3	P03a - P03b	-.908	48	.368
	P03a - P03c	-1.018	48	.314
	P03a - P03d	.967	48	.339
	P03a - P03e	2.034	48	.047
	P03a - P03f	-.568	48	.572
	P03a - P03g	-.578	48	.566
	P03b - P03c	-1.222	48	.228
	P03b - P03d	1.406	48	.166
	P03b - P03e	1.333	48	.189
	P03b - P03f	-.159	48	.874
	P03b - P03g	.061	48	.951
	P03c - P03d	1.378	48	.175
	P03c - P03e	1.335	48	.188
	P03c - P03f	.378	48	.707
	P03c - P03g	1.196	48	.238
	P03d - P03e	.928	48	.358
	P03d - P03f	-.817	48	.418

	P03d - P03g	-.876	48	.385
	P03e - P03f	-.840	48	.405
	P03e - P03g	-.898	48	.374
	P03f - P03g	.498	48	.621
4	P04a - P04b	-1.134	48	.262
	P04a - P04c	-.421	48	.675
	P04a - P04d	-.322	48	.749
	P04a - P04e	-.739	48	.463
	P04a - P04f	-.759	48	.452
	P04a - P04g	-.859	48	.395
	P04b - P04c	.003	48	.998
	P04b - P04d	.382	48	.704
	P04b - P04e	-.543	48	.589
	P04b - P04f	-.562	48	.577
	P04b - P04g	-.670	48	.506
	P04c - P04d	.612	48	.544
	P04c - P04e	-1.251	48	.217
	P04c - P04f	-1.326	48	.191
	P04c - P04g	-1.674	48	.101
	P04d - P04e	-1.033	48	.307
	P04d - P04f	-1.072	48	.289

P04d - P04g	-1.284	48	.205
P04e - P04f	-.058	48	.954
P04e - P04g	-.502	48	.618
P04f - P04g	-.581	48	.564

Appendix 4.14: Paired t test output comparing garden soil samples stored wet at 0-4 oC to sample stored dry at room temperature (XRF)

Bag	Pair	t	df	Sig.
Bag 1	Wet1 - Dry1	1.473	48	.147
	Wet2 - Dry2	-1.268	48	.211
	Wet3 - Dry3	-1.386	48	.172
	Wet4 - Dry4	-1.102	48	.276
	Wet5 - Dry5	-1.053	48	.298
	Wet6 - Dry6	.721	48	.475
Bag 2	Wet1 - Dry1	.999	48	.323
	Wet2 - Dry2	-.881	48	.383
	Wet3 - Dry3	.409	48	.684
	Wet4 - Dry4	-1.000	48	.322
	Wet5 - Dry5	-1.113	48	.271
	Wet6 - Dry6	.935	48	.354
Bag 3	Wet1 - Dry1	-.485	48	.630
	Wet2 - Dry2	-.375	48	.709

	Wet3 - Dry3	-1.246	48	.219
	Wet4 - Dry4	-1.093	48	.280
	Wet5 - Dry5	-1.095	48	.279
	Wet6 - Dry6	.842	48	.404
Bag 4	Wet1 - Dry1	-2.065	48	.044
	Wet2 - Dry2	-.100	48	.921
	Wet3 - Dry3	-1.032	48	.307
	Wet4 - Dry4	-1.006	48	.320
	Wet5 - Dry5	-.941	48	.351
	Wet6 - Dry6	-.356	48	.723

Appendix 4.15: Paired t test output comparing park soil samples stored wet at 0-4 oC to sample stored dry at room temperature (XRF)

Bag	**Pair**	**t**	**df**	**Sig.**
Bag 1	Wet1 - Dry1	-1.100	48	.277
	Wet2 - Dry2	1.263	48	.213
	Wet3 - Dry3	-1.556	48	.126
	Wet4 - Dry4	-.906	48	.369
	Wet5 - Dry5	-.518	48	.607
	Wet6 - Dry6	.337	48	.737
Bag 2	Wet1 - Dry1	-1.172	48	.247
	Wet2 - Dry2	.084	48	.933
	Wet3 - Dry3	-.943	48	.351
	Wet4 - Dry4	-1.481	48	.145
	Wet5 - Dry5	-.886	48	.380
	Wet6 - Dry6	-.065	48	.949
Bag 3	Wet1 - Dry1	-1.851	48	.070
	Wet2 - Dry2	-1.464	48	.150
	Wet3 - Dry3	-.623	48	.536
	Wet4 - Dry4	-.919	48	.363

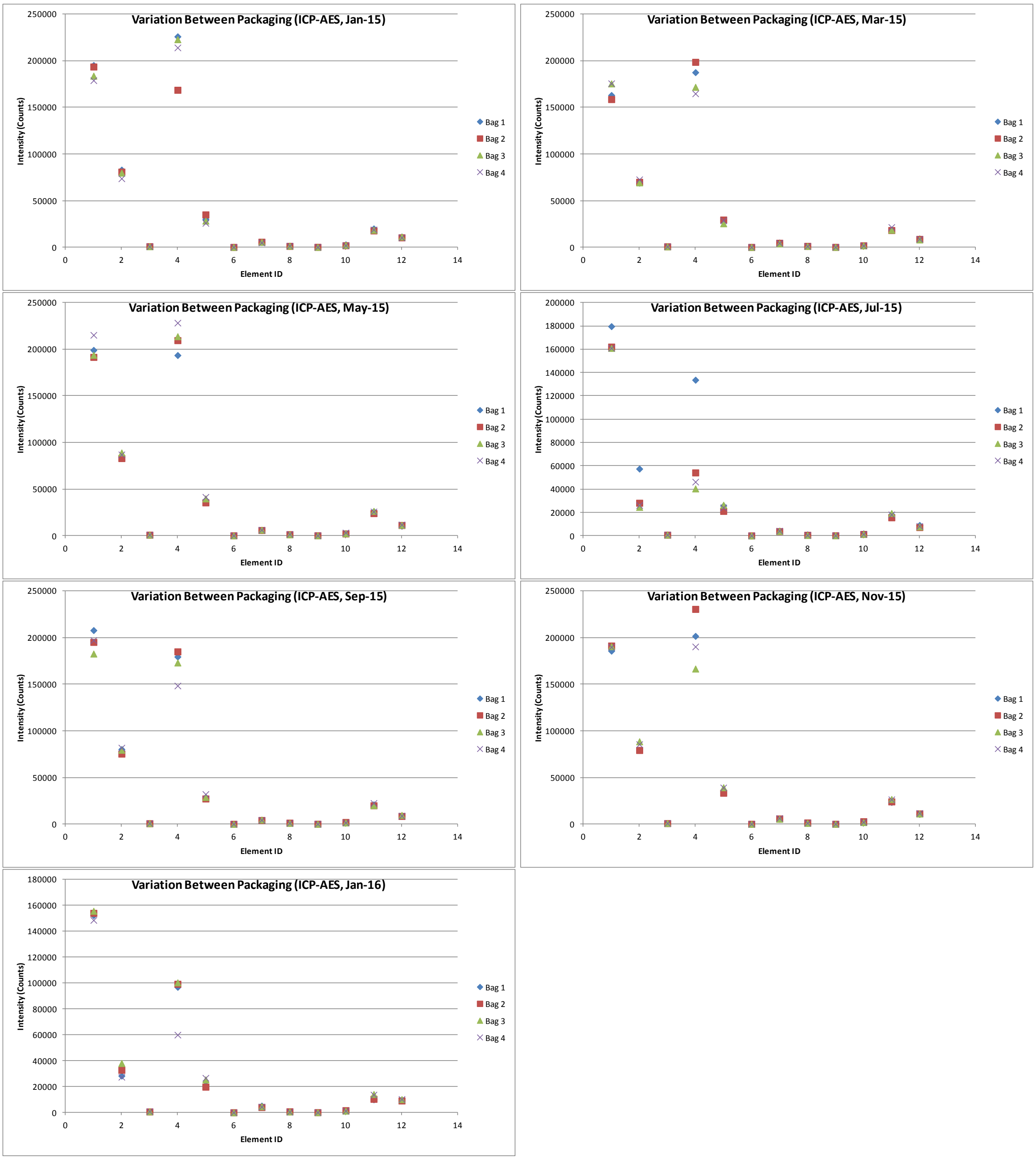
	Wet5 - Dry5	-.848	48	.400
	Wet6 - Dry6	-1.843	48	.072
Bag 4	Wet1 - Dry1	-1.339	48	.187
	Wet2 - Dry2	.203	48	.840
	Wet3 - Dry3	-.973	48	.336
	Wet4 - Dry4	-.937	48	.354
	Wet5 - Dry5	-.820	48	.416
	Wet6 - Dry6	-2.219	48	.031

Appendix 4.16: Garden Sample Site ICP-AES Elemental Data

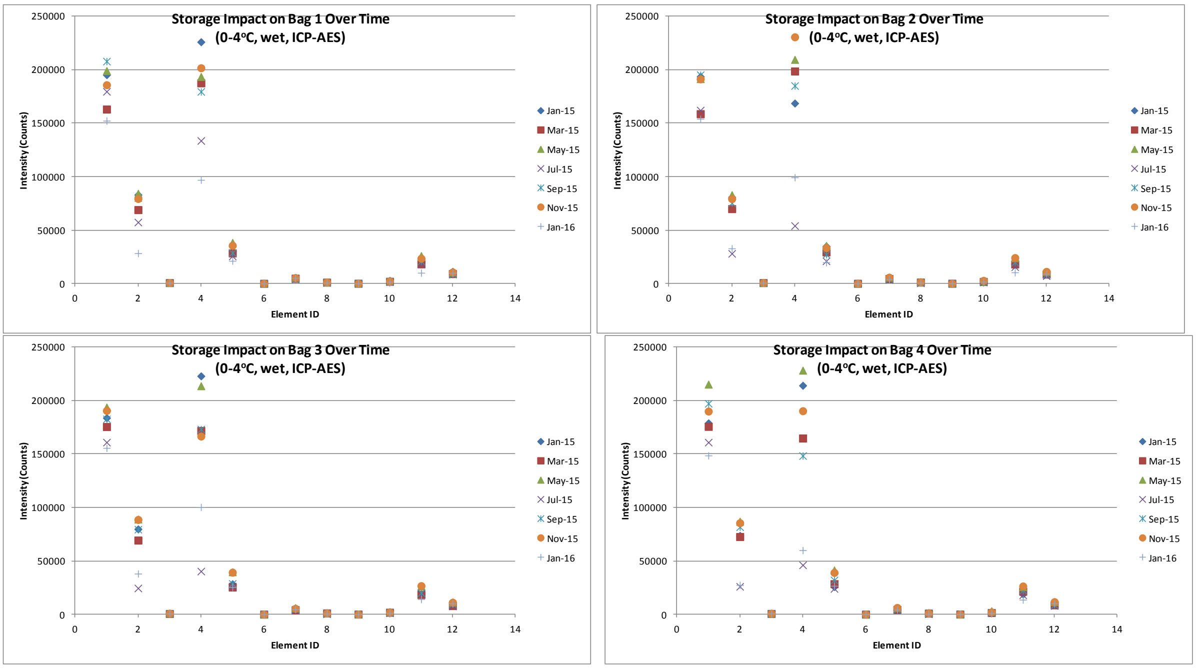
Sample	K	Al	Be	Ca	Fe	Mg	Mn	Na	Ni	P	Ti	Zn
KCG01a	195270	83039.3	871.443	226062	30107.1	119.434	5413.61	1443.29	161.338	2846.88	19961	11273.2
KCG02a	193670	80896.2	864.365	168708	34980	105.218	5670.1	1177.31	185.946	1892.32	17813.7	10399.3
KCG03a	183850	79819.6	839.181	222974	28386.9	128.996	5557.92	1442.88	149.268	2294.14	18549.8	11229.5
KCG04a	178980	73702.9	722.711	214143	25900.7	116.848	4900.96	1383.39	149.076	1882.9	18933.7	10316.7
KCG01a	233800	96194	1016.31	249616	36313.2	120.696	6110.84	1604.98	186.443	3137.58	23888.8	12460.9
KCG02a	250640	101681	1108.7	200996	46009.7	119.301	7000.7	1440.88	247.286	2250.94	23305	12389.5
KCG03a	223990	93202.2	992.442	248032	33549.3	129.053	6313.68	1595.37	181.018	2520.33	22187.1	12302.1
KCG04a	207210	81542	831.532	228086	29696.2	113.54	5336.2	1398.63	157.759	1977.4	21566.1	10798.5
KCG01b	163090	69034.3	747.317	187614	28494.8	92.9985	4856.78	1165.32	155.694	1963.24	18293.2	9190.5
KCG02b	158730	69948.3	744.429	198688	29456.4	99.8812	4543.31	1220.38	151.445	1816.04	18199.9	8675.45
KCG03b	175560	69376	690.478	171869	25473.5	99.97	4017.94	1169.66	142.809	1844.42	18523.6	8100.99
KCG04b	175730	72680.6	702.372	164840	28556.2	93.1878	4472.33	1042.13	152.463	1613.29	21507.4	8776.06
KCG01a	235440	102950	1160.66	289909	43868.4	148.361	7630.98	1800.71	173.668	3896.54	27436.4	15341.8
KCG02a	251360	107426	1242.83	228703	55926.9	136.176	8727.14	1585.89	220.789	2736.21	26775.4	15269.3
KCG03a	224640	98754.1	1105.82	284567	41039.9	160.422	7835.28	1805.73	180.62	3109.56	25421.5	15140.5
KCG04a	205770	86124.1	917.209	258965	35549.4	139.046	6569.3	1554.36	157.246	2448.09	24409.3	13220.1
KCG01b	196680	85556.1	985.806	254616	41187.2	135.308	7154.21	1543.64	164.138	2860.54	25082.2	13351.4
KCG02b	185540	84925	941.604	262842	41600	136.555	6572.84	1572.18	167.306	2601.24	24258.4	12344.4
KCG03b	206240	84665.5	879.692	229194	35900.5	135.348	5819.55	1559.78	155.247	2652.72	24925.7	11683.5
KCG04b	208270	88622.8	900.531	220668	39373.7	134.927	6410.27	1423.75	171.084	2323.04	28602.4	12443.8
KCG01c	199090	84305	805.52	193559	38363.8	123.885	5692.5	1338.85	149.367	2281.83	26010	10461.7
KCG02c	191570	83020.1	833.864	209559	35490.3	127.981	5826.57	1341.95	148.882	2143.54	23975.1	11189.1
KCG03c	193820	89043.3	966.363	213757	39750.3	133.664	6194.57	1321.55	156.359	2430.38	26339.5	11477
KCG04c	215250	87013.2	928.696	228325	41448.4	126.524	6172.43	1558.87	165.198	3202.19	25766.2	11806.2
KCG01a	234890	102764	1177.35	291759	44975.3	151.134	7780.97	1770.34	176.584	3964.88	27707	15594.3
KCG02a	253570	109378	1291.07	235700	59745.9	140.508	9170.34	1622.15	222.737	2860.24	27819.6	15797.8
KCG03a	226330	100426	1165.14	290894	43481.1	156.933	8219.49	1746.09	181.248	3228.74	26515.9	15668.8
KCG04a	208150	87647.4	951.767	265619	37617.6	140.692	6887.77	1536.34	156.728	2535.58	25517.3	13689.9
KCG01b	196320	84894.4	958.255	255483	41820.3	140.809	7268.73	1558.82	168.493	2886.09	25170.8	13545.3
KCG02b	186990	85488.7	968.73	267314	42721.2	136.213	6786.79	1610.38	169.101	2658.01	24878.2	12622.6
KCG03b	207970	86210.4	921.233	235112	38383.7	135.643	6125.86	1561.65	153.618	2752.08	26073.5	12108.7
KCG04b	213350	90416.1	920.391	226331	43165.3	133.881	6909.74	1422.07	160.635	2429.47	30543.2	13020.2
KCG01c	204850	86450.5	924.792	199673	41846.6	136.471	6123.48	1381.39	161.579	2411.61	27786.2	10962.8
KCG02c	193180	83878.1	852.732	214101	37353.3	132.218	6060.88	1355.79	151.669	2198.73	24939.6	11433.3
KCG03c	192300	87059.6	956.903	211444	39804.9	133.053	6222.36	1304.83	148.404	2449.71	26363.5	11545.5

KCG04c	215190	87158.6	924.172	230890	42278	133.405	6309.88	1527.81	159.779	3246.23	26062.7	11965.3
KCG01d	179650	57391	767.797	133669	25671.1	81.3915	4104.39	920.903	141.607	1764.31	18243.6	8999.64
KCG02d	162090	28080.1	661.2	54109.4	21075.1	50.5998	3688.41	552.981	124.284	1264.9	15582.2	7191.99
KCG03d	160990	24539	753.956	40372.3	26349	49.7849	3869.17	411.409	153.695	1380.27	19284.5	7771.5
KCG04d	160980	26079.6	742.058	46183.3	24136.6	49.9898	4128.31	426.871	145.186	1252.94	18122.3	8178.77
KCG01a	198380	82217.6	849.729	212442	28673.3	111.272	4967.87	1358.46	177.09	2577.15	19411.4	10234.4
KCG02a	201870	82806.9	894.376	161587	36597.3	93.2042	5536.62	1114.88	195.208	1760.04	18477.6	9796.24
KCG03a	188530	78891.2	838.307	207680	27826.2	114.973	5213.05	1332.22	175.553	2075.11	18546.5	10203.6
KCG04a	186050	73894.6	743.859	201612	25708.3	103.578	4617.91	1251.94	155.314	1734.67	18680.3	9369.21
KCG01b	164840	68219.1	748.091	183408	26956.7	97.2157	4648.91	1175.15	156.981	1881.12	17625.3	8859.4
KCG02b	158450	68951.2	722.399	194893	28150.9	100.683	4350.27	1216.47	161.676	1768.5	17614.7	8295.06
KCG03b	180040	70551	695.384	172190	25644.8	100.587	4016.79	1184.39	152.011	1852.02	18731.2	8050.87
KCG04b	178120	72579.1	692.643	163557	27534.8	101.011	4360.9	1061.6	152.291	1585.2	21255.4	8510.45
KCG01c	179680	72295.8	672.946	149008	27289.2	90.8884	3955.29	1044.86	153.2	1638.07	19820.7	7421.43
KCG02c	169280	69684.1	652.838	159149	25112.6	95.0694	4015.96	1030.46	138.129	1491.78	18218.9	7763.68
KCG03c	168940	72610.3	719.776	157618	26182.2	90.6237	4076.5	985.803	155.989	1649.57	18800.5	7817.97
KCG04c	184060	70740.3	675.57	166783	26882.5	91.8987	3986.41	1236.49	151.761	2121.33	17996.8	7873.8
KCG01d	177470	56158	716.095	130170	23938.5	70.1658	3860.01	907.58	137.702	1700.12	17397.3	8706.12
KCG02d	161030	27547.4	651.463	53200.9	19903.1	54.3608	3523.85	542.508	127.773	1234.04	15016.4	6967.3
KCG03d	161720	24577.8	750.831	40140.9	26324.9	46.7332	3843.54	390.216	149.634	1363.11	19256.8	7691.63
KCG04d	159530	25684.8	718.149	45113.6	23418.9	49.9425	3962.69	450.467	138.996	1221.03	17645.1	7935.69
KCG01e	207930	80245.2	771.265	179565	28806.6	106.976	4364.46	1248.58	163.997	1890.66	20937.1	8615.16
KCG02e	195260	75419.9	706.466	185081	27272	101.313	4140.3	1318.92	160.059	2035.66	19944.3	8536.64
KCG03e	182750	79526.3	848.701	173194	28839.2	93.6254	4670.86	1109.52	167.411	1569.59	20138.9	9638.39
KCG04e	197260	81810.1	781.368	148427	32091.9	90.7031	4360.28	1042.63	178.166	1551.44	22479.2	8874.05
KCG01a	189290	80707.3	845.224	221617	29131.3	113.81	5315.78	1449.51	155.364	2840.53	19463.5	11249.8
KCG02a	193850	81461	900.88	170185	37569.1	107.728	6003.8	1140.01	182.242	1942.75	18672.9	10790.9
KCG03a	184970	80034.6	860.074	221934	29927.1	139.154	5797.12	1408.09	149.141	2345.26	19098.8	11519.4
KCG04a	178480	73170.1	733.025	211634	26424	125.247	4983.48	1344.76	135.39	1923.31	18936.8	10382
KCG01b	163670	67812.6	727.887	185304	26783.5	95.216	4653.92	1194.07	148.247	1918.88	17573	8947.13
KCG02b	158460	70108.5	747.239	197195	29615.9	98.7976	4540.91	1191.47	157.994	1821.63	18158.3	8658.71
KCG03b	177860	70371.1	723.035	172633	26138.1	97.3627	4105.08	1223.39	133.45	1860.77	18968.8	8165.18
KCG04b	175540	71482.3	687.031	161091	26958.9	89.0309	4285.16	1067.17	148.688	1572.83	20732.2	8476.72
KCG01c	175270	72420.1	688.484	159867	28664.9	112.018	4326.88	1153.94	149.799	1799.24	20583.9	8243.76
KCG02c	164690	69243.5	648.968	167682	25579.1	107.248	4263.38	1118.86	135.554	1636.51	18206.6	8506.07
KCG03c	162890	72076.1	693.779	165911	26464.6	106.573	4280.22	1085.83	133.971	1782.48	18871.1	8467.29
KCG04c	175980	69410.9	667.231	175180	26685.6	115.8	4190.24	1259.37	139.013	2290.62	17867.7	8524.74
KCG01d	173690	56506.8	737.6	138362	25253.7	88.4311	4254.9	997.798	129.821	1888.08	17924.3	9579.29
KCG02d	154700	27233.1	627.415	55537.3	19855.5	55.411	3701.48	587.289	112.729	1325.55	14849.5	7533.31

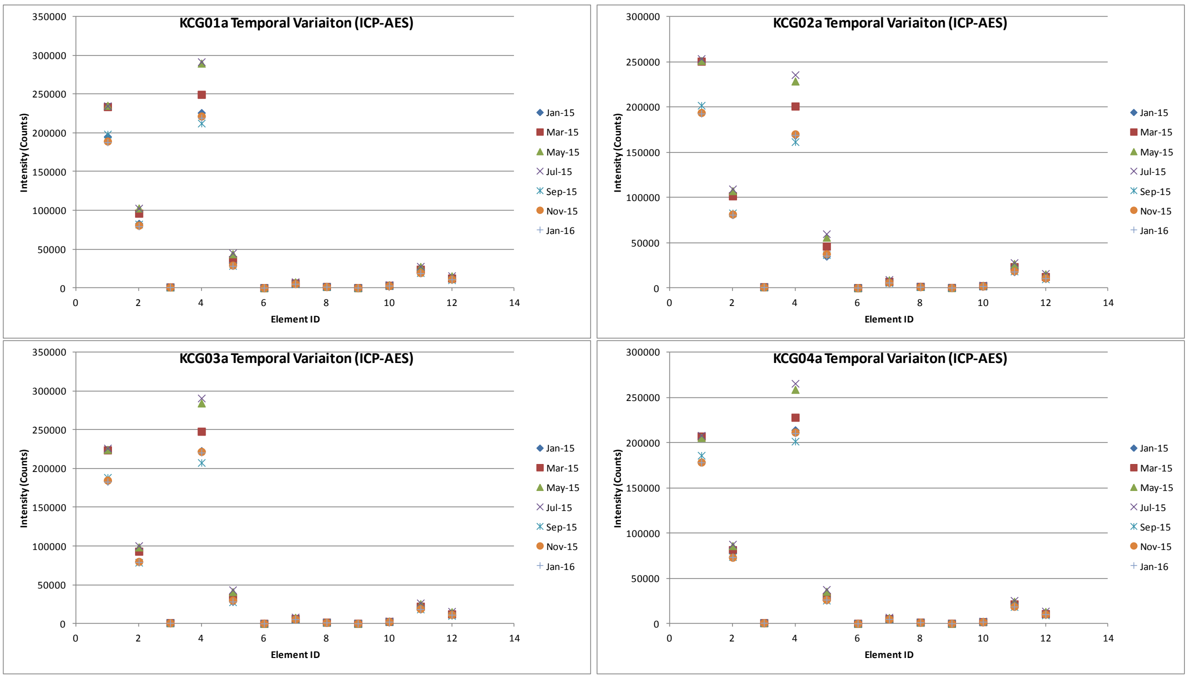
KCG03d	155320	23947.8	734.709	41605.9	25305.9	57.9472	3944.78	412.939	142.196	1444.16	18651.9	8204.7
KCG04d	154770	25516.3	705.551	47416.2	23971.9	54.1429	4271.07	435.594	125.944	1321.38	17673.3	8688.3
KCG01e	202150	79821.6	771.429	190201	29718.5	121.583	4703.99	1333.35	158.472	2106.32	21108.6	9502.23
KCG02e	187290	74383.7	689.701	193802	27301.6	119.729	4336.1	1462.41	143.611	2211.74	19817.4	9269.88
KCG03e	180350	80219.4	864.671	184740	30294.1	114.552	5137.7	1165.98	157.28	1750.02	20695.1	10700.5
KCG04e	193580	81381.9	792.331	156437	33259.9	109.119	4777.9	1120.39	171.151	1694.98	22933.4	9732.12
KCG01f	185840	79435.5	846.672	201711	35643.2	119.034	5429.45	1305.13	145.37	2309.19	23511.6	10660.7
KCG02f	191350	79299	820.808	230672	33416.4	127.842	5812	1524.25	139.189	2834.67	24129.3	11217
KCG03f	190650	88633.7	981.386	166678	39306.9	111.713	5483.81	1084.16	157.221	1954.1	26736.4	11191.1
KCG04f	190030	85585.5	925.897	190371	39105.5	117.102	6313.8	1164.41	152.723	2104.27	26398.4	11729.2
KCG01a	187950	79519.7	833.674	219361	28278.6	115.761	5150.87	1407.65	151.929	2766.16	18960.4	10997
KCG02a	192850	80834.5	882.244	169069	35491.8	108.927	5785.69	1194.13	188.404	1925.04	17994.5	10588
KCG03a	182970	79362	835.385	220710	28399.7	128.185	5607.02	1407.46	148.236	2284.24	18497.7	11275.3
KCG04a	178300	73475.8	742.8	210601	26391.4	125.45	4971.67	1348.5	138.205	1896.52	18780.8	10329.4
KCG01b	164050	68401	735.621	186488	27633	97.1797	4759.71	1166.6	146.151	1924.53	18137.2	9053.59
KCG02b	158470	69548.5	740.285	196381	28912.7	105.894	4482.74	1225.49	153.11	1791.83	17890.2	8528.44
KCG03b	177760	70438.6	693.849	173354	26211.5	100.535	4096.68	1204.48	149.169	1870.92	18942.7	8186.68
KCG04b	175700	72445.7	695.852	164668	28118.6	94.9449	4413.25	1031.66	155.144	1603.26	21393.3	8641.93
KCG01c	172630	71109.9	654.953	157353	26738	104.915	4131.14	1176.99	135.026	1744.03	19325.2	7986.49
KCG02c	164890	69831.8	645.201	168467	25711.3	108.231	4294.95	1111.37	133.417	1652.06	18275.8	8591.13
KCG03c	164080	73005.6	710.61	166583	26897.9	108.039	4398.29	1110.78	140.775	1822.21	18966.2	8574.78
KCG04c	176810	70062.1	663.328	176474	26661	115.1	4200.67	1307.51	143.01	2318.9	18073.6	8529.6
KCG01d	171760	55878.9	702.782	137008	24298.2	83.5414	4146.79	996.908	136.789	1855.51	17258.7	9473.86
KCG02d	155100	27250.2	622.301	55646.2	19932.7	56.7958	3716.41	571.544	110.104	1340.46	14882.4	7491.79
KCG03d	156050	24082.5	743.175	41954.5	25607.8	54.3339	4000.68	431.878	135.141	1466.31	18814.2	8291.15
KCG04d	154730	25404	688.855	47277.6	23179.3	57.2391	4180.87	432.355	131.447	1311.04	17411.9	8611.4
KCG01e	202220	80047.6	774.633	190627	29504.2	121.636	4669.18	1353.54	157.076	2120.34	21031.2	9493.19
KCG02e	184980	73751	684.478	194390	26551.5	118.953	4251.69	1453.17	134.286	2190.85	19501.8	9162.43
KCG03e	177370	79940.5	831.262	184144	29323.7	114.386	5014.04	1194.51	154.887	1748.17	20164.3	10599
KCG04e	189940	79965.2	753.071	154101	31287.6	106.801	4541.19	1121.55	161.547	1659.27	21946.5	9517.35
KCG01f	184840	79342.4	850.261	204270	36134.2	122.106	5508.31	1345.84	145.187	2350.94	23712.3	10785.3
KCG02f	192460	79891.4	847.609	233407	34587.1	126.157	5994.32	1519.46	132.906	2912.11	24707.4	11487.7
KCG03f	194000	90500.8	1039.03	170664	42340.6	112.705	5840.61	1049	158.246	2028.61	28201.3	11604.8
KCG04f	191740	86385.3	948.77	192861	40623.4	112.588	6546	1181.17	153.839	2141.82	27085.7	11950.7
KCG01g	152320	28349.4	717.76	96947.8	21199	65.5948	5183.46	716.859	124.306	1562.39	10043.3	9889.9
KCG02g	154080	32869.3	669.002	99305.5	19824.9	62.6883	4092.58	775.946	115.391	1656.84	10433.1	9159.91
KCG03g	155660	38086.2	806.769	100397	25456	62.6397	4709.99	672.713	144.721	1302.61	14153.7	10203.3
KCG04g	148620	27460.6	869.242	59999.9	26690.4	50.8314	4517.48	456.949	150.718	1250.98	13698.9	10278.8



Appendix 4.17: ICP-AES Elemental Variance in garden soil samples in different manufactured packaging.



Appendix 4.18: Temporal variance in ICP-AES elemental concentration for garden soil samples stored wet at 0 - 4 oC.



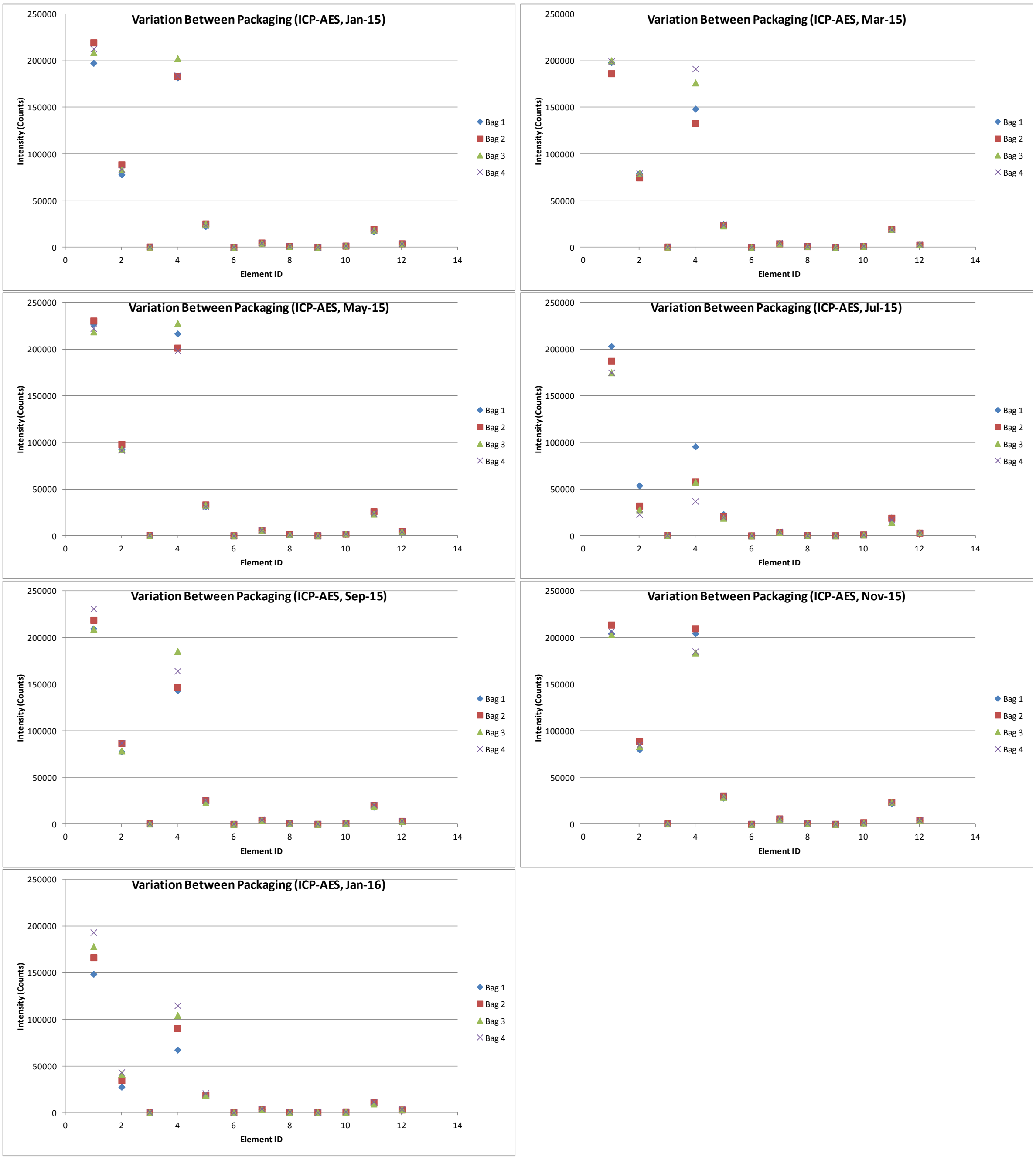
Appendix 4.19: Temporal variance in ICP-AES elemental concentration for garden soil samples stored dry at room temperature.

Appendix 4.20: Park Sample Site ICP-AES Elemental Data

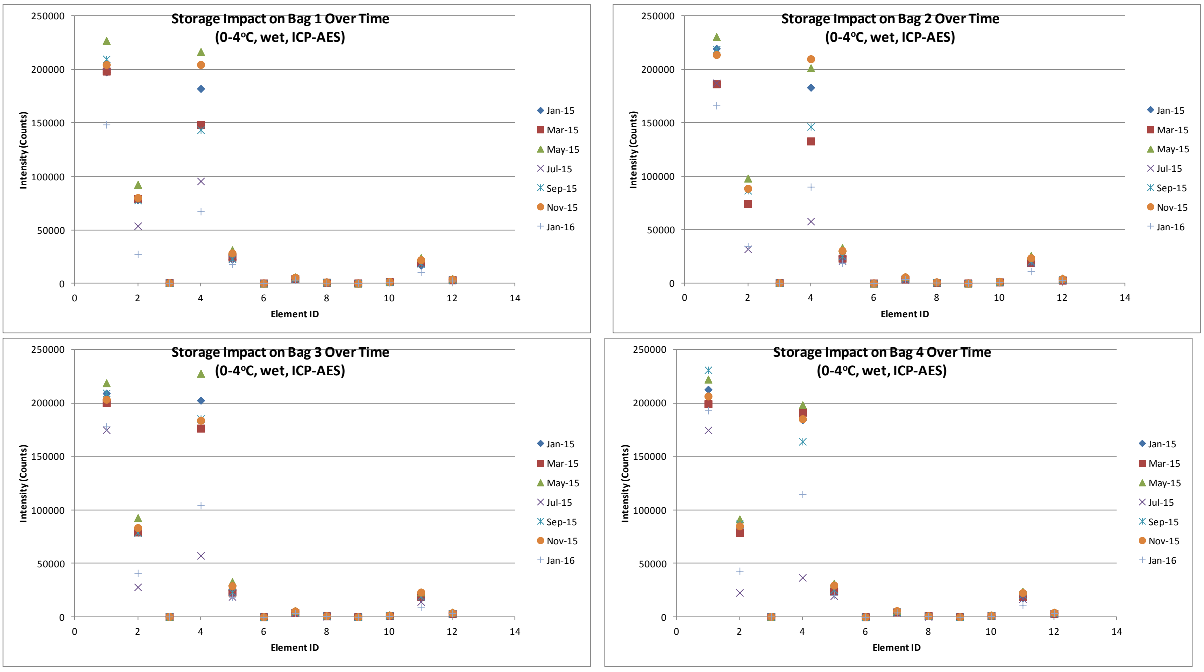
Sample	K	Al	Be	Ca	Fe	Mg	Mn	Na	Ni	P	Ti	Zn
KCP01a	197610	77936.8	444.451	182133	22540.5	113.464	4049.33	1137.86	118.429	1414.39	16750.3	3357.28
KCP02a	219650	88654.6	488.026	183230	25291.5	112.626	4809.95	1140.72	133.596	1488.66	19490.5	3952.73
KCP03a	209330	83388.4	472.029	202684	25067.1	118	4705.05	1232.57	126.348	1611.9	18390.2	3972.48
KCP04a	212910	83587.7	452.542	184401	23652	116.191	4576.93	1149.85	122.566	1457.42	18052.1	3758.63
KCP01a	240550	90744.2	547.772	203711	27634.7	111.979	4698.75	1244.48	141.27	1555.79	20478.8	3748.69
KCP02a	265810	104450	608.864	204834	30899.2	117.136	5515.1	1268.33	162.199	1652.83	23586	4388.63
KCP03a	251570	96207.1	564.541	224825	29321.2	114.593	5212.39	1349.44	154.392	1728.67	21676.8	4280.27
KCP04a	256160	97028	549.986	205660	27564.9	105.905	5115.87	1277.58	154.573	1586.05	21194.4	4063.47
KCP01b	198410	79267.9	458.785	148423	24349.3	96.2698	4165.78	880.471	133.361	1276.28	19470.7	3095.24
KCP02b	186450	74651.5	445.097	133035	23362.5	82.5897	3874.34	805.953	127.428	1126.77	19210	2855.83
KCP03b	200370	79451.9	464.6	176589	23185.1	93.6926	4035	1008.33	134.645	1316.37	19207.1	3116.54
KCP04b	199380	79080.6	482.601	191427	24077.8	94.1187	4594.27	1105.54	125.25	1287.31	18953.7	3266.2
KCP01a	240780	96713.4	574.152	234647	33475.1	139.04	5827.41	1342.07	136.614	1941.94	23405.5	4605.41
KCP02a	264470	109487	633.455	233231	37320.1	142.085	6862.98	1384.08	146.356	2027.63	27027.2	5396.11
KCP03a	251370	102146	572.234	256208	35487	147.376	6454.96	1480.88	144.267	2140.02	24672.8	5259.27
KCP04a	251940	101993	561.035	232666	33334.2	140.662	6277.87	1379.82	137.382	1940.13	24060.7	4957.25
KCP01b	232250	96120.9	550.238	195696	33599.1	127.302	5890.32	1180.85	138.816	1831.86	25749	4361.62
KCP02b	224090	92326.3	546.384	179340	34190.9	116.187	5750.78	1097.27	134.716	1633.63	26341.4	4175.39
KCP03b	245110	101114	576.833	243338	34988.6	137.217	6133.62	1378.9	147.562	1963.26	26953.8	4645.43
KCP04b	219710	90387	540.718	238560	31660.5	121.195	6195.5	1365.01	131.835	1741.75	23647	4378.66
KCP01c	227000	92463	521.05	216693	31210.4	128.609	5925.19	1220.39	130.582	1799.64	23888.3	4473.6
KCP02c	230650	98277.4	572.815	201491	33255.8	129.978	6134.61	1183.87	126.339	1800.15	25886.4	4786.05
KCP03c	218980	92853.9	536.822	227930	32938.9	129.347	6143.07	1262.76	125.034	1947.83	23328.1	4530.11
KCP04c	222430	91634.4	519.36	198451	31473	123.397	6064.35	1161.06	117.787	1744.81	23957.2	4477.93
KCP01a	240710	96195.5	579.467	235894	33732.4	137.827	5878.49	1324.44	136.728	1973.08	23535.6	4648.84
KCP02a	265480	109753	662.39	236273	38806.1	150.673	7086.67	1388.69	151.707	2089.7	27682.9	5558.43
KCP03a	254910	103580	603.432	262141	38364.4	141.168	6899.77	1470.48	148.065	2241.35	26205.2	5498.97
KCP04a	254060	103179	602.26	236772	35825.2	140.025	6661.83	1344.62	145.637	2011.28	25404	5155.56
KCP01b	232930	96465.4	565.568	199023	35322.6	130.301	6178.21	1167.13	132.22	1864.05	26509.7	4504.12
KCP02b	224330	92492.2	554.825	181120	34798.7	109.475	5862.4	1029	140.96	1675.23	26765.3	4256.23
KCP03b	246590	101834	592.05	247878	35916.3	138.43	6304.72	1406.83	147.688	2021.94	27477.1	4741.66
KCP04b	221840	92716.8	556.147	246192	33661.2	122.828	6495.92	1342.18	127.516	1782.41	24772	4505.57
KCP01c	228170	93377.5	529.784	219740	32641	123.858	6165.69	1213.38	124.863	1853.34	24670.6	4602.83
KCP02c	235230	100831	594.507	207557	36242.2	136.472	6538.21	1193.77	137.113	1887.34	27499.5	4976.49
KCP03c	221160	93800	559.738	230411	34549.3	129.503	6401.58	1196.89	126.673	2001.36	24183.6	4652.65

KCP04c	221830	91525.4	521.284	199504	31994.3	127.508	6141.39	1094.55	125.242	1766.13	24165	4551.58
KCP01d	203440	53674.7	498.294	95575.6	22937.8	64.5992	3964.42	613.52	129.538	1196.08	19241.1	3261.19
KCP02d	187380	32050.5	445.891	58012.9	21100	47.9384	3487.16	440.207	125.238	1033.05	18963.1	3070.15
KCP03d	175060	28046.3	451.521	57521.3	19030.2	55.7845	3965.15	647.365	107.429	1028.02	14325.8	3484.65
KCP04d	174900	22852.6	468.325	36950.9	19840.9	56.0492	4232.36	312.088	116.601	1049.24	17087.8	3111.99
KCP01a	201010	76364.6	477.56	169332	21223.1	100.842	3711	1067.2	125.66	1273.9	16130.9	3039.42
KCP02a	225670	88820.6	535.013	173140	25531.1	96.9088	4596.63	1042.64	139.247	1393.82	19819.9	3690.45
KCP03a	213390	82401.1	488.596	189131	24579.9	101.967	4313.44	1086.5	136.933	1437.2	18259.3	3605.35
KCP04a	218600	83334.8	472.756	173526	23193.2	104.318	4256.06	1046.78	132.741	1314.66	17713.2	3395.11
KCP01b	200920	78457.9	482.399	146366	23244	92.4699	3985.08	834.423	133.466	1238.04	18932.2	2998.79
KCP02b	186520	73591.9	440.068	130459	21910.3	86.5675	3663.2	807.898	120.945	1083.48	18294.6	2733.16
KCP03b	203540	80435.8	470.51	175541	23104.8	94.4528	3922.22	1031.55	133.741	1290.36	19101.7	3044.42
KCP04b	199490	77866.5	467.309	186317	22236.2	99.6428	4302.08	1090.68	124.382	1221.89	18061.8	3095.72
KCP01c	198320	76876.2	449.472	162637	21274.8	91.3663	3988.44	957.583	119.359	1230.5	17552.9	3092.16
KCP02c	200530	81282.6	462.607	151553	23076.7	94.851	4146.68	917.492	123.506	1226.31	19240.5	3287
KCP03c	195340	77786.1	452.549	172546	22779.4	91.3165	4184.47	993.487	125.996	1352.46	17387.3	3141.81
KCP04c	191530	74880.3	427.065	146644	20244.4	86.8107	3931.1	914.454	121.946	1156.87	16816.1	3028.29
KCP01d	200600	52330.4	485.718	93008	21336.6	70.5892	3741	565.306	131.033	1151.54	18375.1	3122.15
KCP02d	184880	31182.6	428.611	56303.7	19568.9	49.3151	3304.9	424.368	122.387	994.56	17900.8	2945.3
KCP03d	177060	28242.6	460.281	57470.4	18898.4	52.387	3947.81	670.768	114.597	1041.94	14398.8	3481.46
KCP04d	174790	22739.2	461.279	36454.4	19648	51.6297	4142.56	346.941	121.263	1030.77	16905	3040.27
KCP01e	209780	77735.5	459.338	143502	22990.8	86.2125	4182.48	884.151	132.624	1172.49	18425.8	3178.49
KCP02e	218930	86854.1	515.354	146535	25478	99.2942	4251.16	956.695	144.976	1229.85	20413.2	3327.17
KCP03e	209510	78878.4	445.488	185585	23156.9	90.4442	4228.09	1084.54	127.108	1391.98	19213.3	3312.92
KCP04e	231150	87007.2	463.293	164208	25479.6	100.654	4743.5	1003.31	134.598	1331.36	20920.4	3391.24
KCP01a	193680	76121.7	428.747	178775	21978.8	110.836	4020.11	1080.78	108.751	1411.22	16364.9	3332.74
KCP02a	216360	87581	493.848	182187	25686.8	117.877	4896.04	1102.71	132.913	1500.42	19612.6	4010.8
KCP03a	206830	82252.6	488.856	200521	25981.3	117.918	4784.24	1165.04	120.493	1613.65	18725.4	3998.56
KCP04a	214120	83860.6	481.03	185580	24661	110.833	4712.58	1084.17	128.142	1484.69	18527.2	3823.45
KCP01b	197420	78025.4	434.872	145463	22834.1	91.2351	4003.29	908.318	125.197	1233.93	18555	3000.17
KCP02b	185250	74075.7	439.224	129711	23174.2	78.3712	3802.18	793.51	122.72	1096.6	18599.8	2834.42
KCP03b	203830	80731.8	466.684	177910	24146.5	94.6898	4147.2	1050.09	125.906	1315.6	19811.1	3171.49
KCP04b	200280	78110.5	469.175	187979	23113.8	93.241	4455.5	1092.71	121.482	1258.8	18471.8	3178.46
KCP01c	192570	76413.8	384.508	172080	21940.8	102.968	4317.84	1026.93	116.288	1363.35	17849.5	3404.34
KCP02c	194470	80740.2	460.026	158269	24090.7	114.181	4460.98	964.872	123.587	1350.97	19452.9	3616.04
KCP03c	188300	77521.9	439.139	180500	23019.2	108.397	4427.95	1073.62	115.882	1478.35	17375.7	3414.92
KCP04c	183520	73595	380.856	153698	20437.4	99.6668	4146.19	925.622	102.424	1265.37	16833.6	3289.6
KCP01d	196890	53018.2	462.543	99439.8	23089.8	74.2481	4165.5	635.435	121.511	1275.79	19160.9	3483.61
KCP02d	179110	31090.3	422.74	59391.5	20263.7	57.3201	3543.19	464.434	114.954	1070.08	18154.2	3198.94

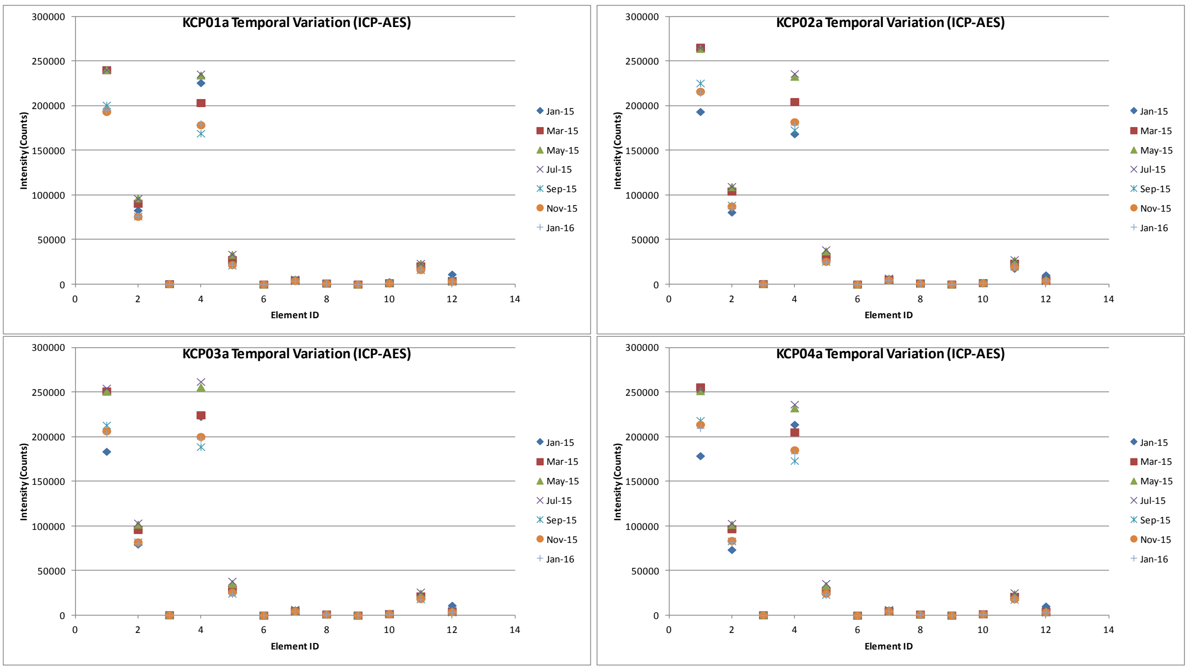
KCP03d	170730	27712.7	432.512	59868.9	18718.2	57.0833	4121.05	686.838	96.9371	1126.5	14160.2	3742.47
KCP04d	169140	22512.1	426.313	38309.3	19882.7	56.4716	4378.14	341.683	109.193	1144.21	16813.9	3319.49
KCP01e	204840	77921.4	436.217	151894	23889	99.7689	4497.25	939.495	122.386	1281.1	18712.6	3489.48
KCP02e	212280	86024.1	491.478	153732	25574.8	109.301	4533.16	954.95	134.307	1343.24	20413.5	3635.49
KCP03e	200210	78076	422.168	193594	22853.2	113.271	4406.84	1183.2	122.761	1506.48	18790.4	3587.39
KCP04e	225320	86882.3	470.415	174025	26330.2	122.712	5164.89	1082.55	128.433	1460.3	21333.4	3703.02
KCP01f	204550	80049.5	441.217	204570	28224.2	121.348	5524.16	1129.71	112.895	1644.91	21899.6	3795.54
KCP02f	213900	88732.4	515.004	209899	30516.6	124.264	5885.85	1203.03	124.808	1787.89	23685.3	4157.94
KCP03f	203610	83522.4	484.072	183989	29125.6	108.874	5550.72	1055.59	111.654	1610.31	23192.5	3898.17
KCP04f	206620	85133.8	491.009	185391	29710.7	109.241	5826	1082.44	116.458	1645.07	22698.3	4151.52
KCP01a	195550	76553.5	422.371	180291	21951.4	111.704	4012.33	1075.65	117.886	1397.53	16508	3314.03
KCP02a	214750	86242.7	483.992	178855	24850.9	114.619	4731.4	1098.66	129.885	1469.59	19166.7	3937.94
KCP03a	204730	80963	436.057	197965	24145.2	118.604	4568	1170.14	130.623	1558.14	17870.1	3899.74
KCP04a	210050	82184.8	458.721	181678	23719.2	115.998	4585.7	1097.14	120.273	1448.23	17965	3730.36
KCP01b	201010	79064.8	455.687	148491	23848.5	90.5169	4133.56	888.01	126.18	1291.97	19467.8	3089.69
KCP02b	186030	74098.5	463.045	131271	22718.3	85.5597	3797.88	778.212	121.925	1114.23	18873.5	2802.17
KCP03b	201570	79877.5	464.66	176926	23723.3	99.6445	4090.21	1012.19	127.25	1303.69	19490.6	3123.5
KCP04b	199290	78689.8	482.131	190064	23524.9	93.4321	4483.32	1100.95	128.186	1263.06	18744.8	3201.17
KCP01c	188760	74865.9	415.675	167931	20385.7	105.992	4081	1062.64	119.358	1315.18	16959.5	3267.68
KCP02c	192760	80244.1	447.916	158689	23385.6	109.906	4384.05	954.836	123.809	1339.03	19129.6	3597.12
KCP03c	189000	78128.6	435.796	182116	23264.2	111.506	4482.9	1098.87	116.019	1500.42	17511.1	3444.78
KCP04c	185430	74814.5	385.038	154740	20573	98.9156	4176.63	971.056	103.527	1289.66	16838.3	3305.49
KCP01d	193480	52006.8	448.84	98024.5	21501.9	74.311	3926.38	654.954	112.02	1236.1	18147.9	3395.5
KCP02d	177360	30778.3	402.268	58875.2	19491.8	56.6876	3446.77	449.978	107.483	1062.92	17657.2	3187.79
KCP03d	172000	27939.6	441.789	60555.7	18944.7	53.1461	4167.27	673.163	99.4539	1122.11	14320.8	3777.15
KCP04d	171050	22815.5	443.311	38730.6	19885.1	57.6761	4430.61	346.562	106.76	1153.84	16980.1	3353.91
KCP01e	203030	77716.4	411.191	151435	23147	100.614	4426.88	950.937	124.316	1255.57	18474.2	3464.82
KCP02e	209750	85239.3	467.126	152018	25035.8	109.202	4471.61	1012.48	131.994	1325.29	20089.6	3625.38
KCP03e	199240	77660.1	405.8	191706	22065.9	118.597	4293.72	1153.55	115.867	1491.17	18406.8	3522.76
KCP04e	222000	85575.8	460.104	171800	24842.1	118.523	4983.07	1078.04	128.114	1428.75	20424	3635.87
KCP01f	204690	79980	455.695	205361	28422	119.246	5604.81	1133.13	119.79	1666.14	21929.4	3848.9
KCP02f	213230	87785.9	512.367	208323	30795.2	126.549	5932.08	1172.7	120.789	1827.54	23813.4	4203
KCP03f	205350	84673.5	479.204	187243	30305	107.012	5756.02	1050.56	118.144	1657.04	23810.1	4005.29
KCP04f	210860	87566.7	521.324	192041	31934.5	114.789	6157.03	1110.24	118.045	1715.26	23822.8	4305.68
KCP01g	148490	27435.3	372.621	67250.7	18021.2	53.7884	3308.48	443.995	98.3099	805.918	10322.6	2460.8
KCP02g	166360	34646.9	415.16	90301.6	18843.7	56.272	3760.4	601.354	105.03	896.587	11185.2	3037.5
KCP03g	178190	41247.3	423.834	104448	18858.2	66.9176	3628.17	668.015	101.377	808.37	9512.21	3468.26
KCP04g	193270	43170.3	449.025	114851	20686.4	66.9869	4156.54	722.616	112.632	950.064	11399.8	3670.95



Appendix 4.21: ICP-AES Elemental Variance in park soil samples in different manufactured packaging.



Appendix 4.22: Temporal variance in ICP-AES elemental concentration for park soil samples stored wet at 0 - 4 oC.



Appendix 4.23: Temporal variance in ICP-AES elemental concentration for park soil samples stored dry at room temperature.

Appendix 4.24: Paired t-test output for sample bag assessment (ICP-AES)

Site	Pair	t	df	Sig.
Garden	Bag 1 - Bag 2	1.048	11	.317
	Bag 1 - Bag 3	1.884	11	.086
	Bag 1 - Bag 4	2.347	11	.039
	Bag 2 - Bag 3	-.684	11	.508
	Bag 2 - Bag 4	-.289	11	.778
	Bag 3 - Bag 4	2.323	11	.040
Park	Bag 1 - Bag 2	-1.787	11	.102
	Bag 1 - Bag 3	-1.981	11	.073
	Bag 1 - Bag 4	-1.737	11	.110
	Bag 2 - Bag 3	-.112	11	.913
	Bag 2 - Bag 4	1.749	11	.108
	Bag 3 - Bag 4	.895	11	.390

Appendix 4.25: Paired t-test output assessing temporal variation in garden soil samples stored dry at room temperature (ICP-AES)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan15) - 1a (Mar 15)	-2.087	11	.061
	1a (Jan 15) - 1a (May 15)	-2.211	11	.049
	1a (Jan 15) - 1a (Jul 15)	-2.216	11	.049
	1a (Jan 15) - 1a (Sep 15)	1.081	11	.303
	1a (Jan 15) - 1a (Nov 15)	2.056	11	.064
	1a (Jan 15) - 1a (Jan 16)	2.280	11	.044
	1b (Mar 15) - 1b (May 15)	-1.673	11	.123
	1b (Mar 15) - 1b (Jul 15)	-1.668	11	.123
	1b (Mar 15) - 1b (Sep 15)	2.189	11	.051
	1b (Mar 15) - 1b (Nov 15)	2.084	11	.061
	1b (Mar 15) - 1b (Jan 16)	2.130	11	.057
	1c (May 15) - 1c (Jul 15)	-1.345	11	.206

	1c (May 15) - 1c (Sep 15)	2.121	11	.057
	1c (May 15) - 1c (Nov 15)	2.214	11	.049
	1c (May 15) - 1c (Jan 16)	2.231	11	.047
	1d (Jul 15) - 1d (Sep 15)	2.122	11	.057
	1d (Jul 15) - 1d (Nov 15)	2.220	11	.048
	1d (Jul 15) - 1d (Jan 16)	2.237	11	.047
	1e (Sep 15) - 1e (Nov 15)	-.057	11	.955
	1e (Sep 15) - 1e (Jan 16)	.444	11	.665
	1f (Sep 15) - 1f (Jan 16)	2.694	11	.021
2	2a (Jan15) - 2a (Mar 15)	-2.132	11	.056
	2a (Jan 15) - 2a (May 15)	-2.400	11	.035
	2a (Jan 15) - 2a (Jul 15)	-2.428	11	.034
	2a (Jan 15) - 2a (Sep 15)	-.376	11	.714
	2a (Jan 15) - 2a (Nov 15)	-2.369	11	.037
	2a (Jan 15) - 2a (Jan 16)	-.496	11	.630
	2b (Mar 15) - 2b (May 15)	-1.929	11	.080
	2b (Mar 15) - 2b (Jul 15)	-2.035	11	.067
	2b (Mar 15) - 2b (Sep 15)	2.183	11	.052
	2b (Mar 15) - 2b (Nov 15)	2.045	11	.066
	2b (Mar 15) - 2b (Jan 16)	2.101	11	.059
	2c (May 15) - 2c (Jul 15)	-2.350	11	.038
	2c (May 15) - 2c (Sep 15)	2.345	11	.039
	2c (May 15) - 2c (Nov 15)	2.350	11	.038
	2c (May 15) - 2c (Jan 16)	2.383	11	.036
	2d (Jul 15) - 2d (Sep 15)	2.367	11	.037
	2d (Jul 15) - 2d (Nov 15)	2.385	11	.036
	2d (Jul 15) - 2d (Jan 16)	2.414	11	.034
	2e (Sep 15) - 2e (Nov 15)	-.167	11	.870
	2e (Sep 15) - 2e (Jan 16)	.306	11	.765
	2f (Nov 15) - 2f (Jan 16)	2.628	11	.023

3	3a (Jan15) - 3a (Mar 15)	-2.032	11	.067
	3a (Jan 15) - 3a (May 15)	-2.193	11	.051
	3a (Jan 15) - 3a (Jul 15)	-2.215	11	.049
	3a (Jan 15) - 3a (Sep 15)	.848	11	.414
	3a (Jan 15) - 3a (Nov 15)	-1.341	11	.207
	3a (Jan 15) - 3a (Jan 16)	1.534	11	.153
	3b (Mar 15) - 3b (May 15)	-1.655	11	.126
	3b (Mar 15) - 3b (Jul 15)	-1.757	11	.107
	3b (Mar 15) - 3b (Sep 15)	2.091	11	.061
	3b (Mar 15) - 3b (Nov 15)	1.974	11	.074
	3b (Mar 15) - 3b (Jan 16)	2.032	11	.067
	3c (May 15) - 3c (Jul 15)	-2.263	11	.045
	3c (May 15) - 3c (Sep 15)	2.064	11	.063
	3c (May 15) - 3c (Nov 15)	2.135	11	.056
	3c (May 15) - 3c (Jan 16)	2.174	11	.052
	3d (Jul 15) - 3d (Sep 15)	2.086	11	.061
	3d (Jul 15) - 3d (Nov 15)	2.161	11	.054
	3d (Jul 15) - 3d (Jan 16)	2.196	11	.050
	3e (Sep 15) - 3e (Nov 15)	-1.133	11	.281
	3e (Sep 15) - 3e (Jan 16)	-.701	11	.498
	3f (Nov 15) - 3f (Jan 16)	2.763	11	.018

4	4a (Jan15) - 4a (Mar 15)	-1.951	11	.077
	4a (Jan 15) - 4a (May 15)	-2.186	11	.051
	4a (Jan 15) - 4a (Jul 15)	-2.196	11	.050
	4a (Jan 15) - 4a (Sep 15)	.484	11	.638
	4a (Jan 15) - 4a (Nov 15)	1.080	11	.303
	4a (Jan 15) - 4a (Jan 16)	1.115	11	.289
	4b (Mar 15) - 4b (May 15)	-1.555	11	.148
	4b (Mar 15) - 4b (Jul 15)	-1.693	11	.119
	4b (Mar 15) - 4b (Sep 15)	2.086	11	.061
	4b (Mar 15) - 4b (Nov 15)	1.951	11	.077
	4b (Mar 15) - 4b (Jan 16)	1.956	11	.076
	4c (May 15) - 4c (Jul 15)	-2.207	11	.049
	4c (May 15) - 4c (Sep 15)	1.978	11	.073
	4c (May 15) - 4c (Nov 15)	2.141	11	.056
	4c (May 15) - 4c (Jan 16)	2.127	11	.057
	4d (Jul 15) - 4d (Sep 15)	2.004	11	.070
	4d (Jul 15) - 4d (Nov 15)	2.156	11	.054
	4d (Jul 15) - 4d (Jan 16)	2.143	11	.055
	4e (Sep 15) - 4e (Nov 15)	-.331	11	.747
	4e (Sep 15) - 4e (Jan 16)	-.256	11	.803
	4f (Sep 15) - 4f (Jan 16)	1.065	11	.310

Appendix 4.26: Paired t-test output assessing temporal variation in park soil samples stored dry at room temperature (ICP-AES)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan15) - 1a (Mar 15)	-.346	11	.736
	1a (Jan 15) - 1a (May 15)	-1.425	11	.182
	1a (Jan 15) - 1a (Jul 15)	-1.453	11	.174
	1a (Jan 15) - 1a (Sep 15)	1.472	11	.169
	1a (Jan 15) - 1a (Nov 15)	1.734	11	.111

	1a (Jan 15) - 1a (Jan 16)	1.693	11	.119
	1b (Mar 15) - 1b (May 15)	-1.597	11	.138
	1b (Mar 15) - 1b (Jul 15)	-1.574	11	.144
	1b (Mar 15) - 1b (Sep 15)	2.088	11	.061
	1b (Mar 15) - 1b (Nov 15)	1.958	11	.076
	1b (Mar 15) - 1b (Jan 16)	1.966	11	.075
	1c (May 15) - 1c (Jul 15)	-.826	11	.427
	1c (May 15) - 1c (Sep 15)	2.113	11	.058
	1c (May 15) - 1c (Nov 15)	2.167	11	.053
	1c (May 15) - 1c (Jan 16)	2.180	11	.052
	1d (Jul 15) - 1d (Sep 15)	2.102	11	.059
	1d (Jul 15) - 1d (Nov 15)	2.160	11	.054
	1d (Jul 15) - 1d (Jan 16)	2.172	11	.053
	1e (Sep 15) - 1e (Nov 15)	-.285	11	.781
	1e (Sep 15) - 1e (Jan 16)	-.590	11	.567
	1f (Sep 15) - 1f (Jan 16)	-1.711	11	.115
2	2a (Jan15) - 2a (Mar 15)	-1.595	11	.139
	2a (Jan 15) - 2a (May 15)	-1.880	11	.087
	2a (Jan 15) - 2a (Jul 15)	-1.909	11	.083
	2a (Jan 15) - 2a (Sep 15)	-.783	11	.450
	2a (Jan 15) - 2a (Nov 15)	-.919	11	.378
	2a (Jan 15) - 2a (Jan 16)	-.709	11	.493
	2b (Mar 15) - 2b (May 15)	-1.597	11	.138
	2b (Mar 15) - 2b (Jul 15)	-1.675	11	.122
	2b (Mar 15) - 2b (Sep 15)	2.069	11	.063
	2b (Mar 15) - 2b (Nov 15)	1.923	11	.081
	2b (Mar 15) - 2b (Jan 16)	1.977	11	.074
	2c (May 15) - 2c (Jul 15)	-2.216	11	.049
	2c (May 15) - 2c (Sep 15)	2.168	11	.053
	2c (May 15) - 2c (Nov 15)	2.227	11	.048

	2c (May 15) - 2c (Jan 16)	2.234	11	.047
	2d (Jul 15) - 2d (Sep 15)	2.182	11	.052
	2d (Jul 15) - 2d (Nov 15)	2.246	11	.046
	2d (Jul 15) - 2d (Jan 16)	2.252	11	.046
	2e (Sep 15) - 2e (Nov 15)	.058	11	.955
	2e (Sep 15) - 2e (Jan 16)	.668	11	.518
	2f (Sep 15) - 2f (Jan 16)	2.238	11	.047
3	3a (Jan15) - 3a (Mar 15)	-1.186	11	.261
	3a (Jan 15) - 3a (May 15)	-1.797	11	.100
	3a (Jan 15) - 3a (Jul 15)	-1.891	11	.085
	3a (Jan 15) - 3a (Sep 15)	.342	11	.739
	3a (Jan 15) - 3a (Nov 15)	.250	11	.807
	3a (Jan 15) - 3a (Jan 16)	.508	11	.622
	3b (Mar 15) - 3b (May 15)	-1.594	11	.139
	3b (Mar 15) - 3b (Jul 15)	-1.794	11	.100
	3b (Mar 15) - 3b (Sep 15)	2.022	11	.068
	3b (Mar 15) - 3b (Nov 15)	1.877	11	.087
	3b (Mar 15) - 3b (Jan 16)	1.958	11	.076
	3c (May 15) - 3c (Jul 15)	-2.471	11	.031
	3c (May 15) - 3c (Sep 15)	2.056	11	.064
	3c (May 15) - 3c (Nov 15)	2.114	11	.058
	3c (May 15) - 3c (Jan 16)	2.154	11	.054
	3d (Jul 15) - 3d (Sep 15)	2.099	11	.060
	3d (Jul 15) - 3d (Nov 15)	2.159	11	.054

	3d (Jul 15) - 3d (Jan 16)	2.193	11	.051
	3e (Sep 15) - 3e (Nov 15)	-.562	11	.585
	3e (Sep 15) - 3e (Jan 16)	.106	11	.918
	3f (Sep 15) - 3f (Jan 16)	2.745	11	.019
4	4a (Jan15) - 4a (Mar 15)	-1.108	11	.291
	4a (Jan 15) - 4a (May 15)	-1.702	11	.117
	4a (Jan 15) - 4a (Jul 15)	-1.801	11	.099
	4a (Jan 15) - 4a (Sep 15)	.067	11	.948
	4a (Jan 15) - 4a (Nov 15)	-.152	11	.882
	4a (Jan 15) - 4a (Jan 16)	.082	11	.936
	4b (Mar 15) - 4b (May 15)	-1.420	11	.183
	4b (Mar 15) - 4b (Jul 15)	-1.637	11	.130
	4b (Mar 15) - 4b (Sep 15)	2.031	11	.067
	4b (Mar 15) - 4b (Nov 15)	1.847	11	.092
	4b (Mar 15) - 4b (Jan 16)	1.895	11	.085
	4c (May 15) - 4c (Jul 15)	-2.607	11	.024
	4c (May 15) - 4c (Sep 15)	2.097	11	.060
	4c (May 15) - 4c (Nov 15)	2.159	11	.054
	4c (May 15) - 4c (Jan 16)	2.164	11	.053
	4d (Jul 15) - 4d (Sep 15)	2.144	11	.055
	4d (Jul 15) - 4d (Nov 15)	2.213	11	.049
	4d (Jul 15) - 4d (Jan 16)	2.213	11	.049
	4e (Sep 15) - 4e (Nov 15)	-.875	11	.400
	4e (Sep 15) - 4e (Jan 16)	-.005	11	.996
	4f (Sep 15) - 4f (Jan 16)	2.189	11	.051

Appendix 4.27: Paired t-test output assessing temporal variation in garden soil samples stored wet at 0-4 oC (ICP-AES)

Sample Bag	Sample Pair	t	df	Significance

1	G01a - G01b	1.958	11	.076
	G01a - G01c	.404	11	.694
	G01a - G01d	1.583	11	.142
	G01a - G01e	.857	11	.410
	G01a - G01f	1.099	11	.295
	G01a - G01g	1.859	11	.090
	G01b - G01c	-2.121	11	.057
	G01b - G01d	.918	11	.378
	G01b - G01e	-1.069	11	.308
	G01b - G01f	-2.470	11	.031
	G01b - G01g	1.682	11	.121
	G01c - G01d	2.119	11	.058
	G01c - G01e	1.410	11	.186
	G01c - G01f	.904	11	.386
	G01c - G01g	2.186	11	.051
	G01d - G01e	-1.954	11	.077
	G01d - G01f	-1.713	11	.115
	G01d - G01g	2.168	11	.053
	G01e - G01f	-.368	11	.720
	G01e - G01g	2.071	11	.063
	G01f - G01g	2.000	11	.071

2	G02a - G02b	.489	11	.635
	G02a - G02c	-1.201	11	.255
	G02a - G02d	1.861	11	.090
	G02a - G02e	-.180	11	.860
	G02a - G02f	-1.046	11	.318
	G02a - G02g	2.233	11	.047
	G02b - G02c	-2.207	11	.050
	G02b - G02d	1.357	11	.202
	G02b - G02e	-.686	11	.507
	G02b - G02f	-2.150	11	.055
	G02b - G02g	1.580	11	.143
	G02c - G02d	1.738	11	.110
	G02c - G02e	1.778	11	.103
	G02c - G02f	-.733	11	.479
	G02c - G02g	2.028	11	.068
	G02d - G02e	-1.690	11	.119
	G02d - G02f	-1.640	11	.129
	G02d - G02g	-.818	11	.431
	G02e - G02f	-1.362	11	.200
	G02e - G02g	1.989	11	.072
	G02f - G02g	1.877	11	.087
3	G03a - G03b	1.565	11	.146
	G03a - G03c	-1.474	11	.168
	G03a - G03d	1.467	11	.170
	G03a - G03e	1.062	11	.311
	G03a - G03f	.363	11	.723
	G03a - G03g	1.639	11	.129
	G03b - G03c	-2.466	11	.031
	G03b - G03d	1.424	11	.182
	G03b - G03e	-2.260	11	.045

	G03b - G03f	-2.133	11	.056
	G03b - G03g	1.662	11	.125
	G03c - G03d	1.711	11	.115
	G03c - G03e	2.083	11	.061
	G03c - G03f	1.123	11	.286
	G03c - G03g	1.985	11	.073
	G03d - G03e	-1.580	11	.143
	G03d - G03f	-1.864	11	.089
	G03d - G03g	-1.065	11	.309
	G03e - G03f	-1.782	11	.102
	G03e - G03g	1.881	11	.087
	G03f - G03g	2.282	11	.043
4	G04a - G04b	1.030	11	.325
	G04a - G04c	-2.403	11	.035
	G04a - G04d	1.430	11	.181
	G04a - G04e	.450	11	.661
	G04a - G04f	-.686	11	.507
	G04a - G04g	1.525	11	.156
	G04b - G04c	-2.061	11	.064
	G04b - G04d	1.563	11	.146
	G04b - G04e	-.636	11	.538
	G04b - G04f	-2.641	11	.023
	G04b - G04g	1.703	11	.117
	G04c - G04d	1.800	11	.099
	G04c - G04e	1.573	11	.144
	G04c - G04f	1.572	11	.144
	G04c - G04g	1.884	11	.086
	G04d - G04e	-1.875	11	.088
	G04d - G04f	-1.798	11	.100
	G04d - G04g	-.179	11	.861

	G04e - G04f	-1.298	11	.221
	G04e - G04g	1.987	11	.072
	G04f - G04g	1.921	11	.081

Appendix 4.28: Paired t-test output assessing temporal variation in park soil samples stored wet at 0-4 oC (IXP-AES)

Sample Bag	Sample Pair	t	df	Significance
1	P01a - P01b	.801	11	.440
	P01a - P01c	-2.340	11	.039
	P01a - P01d	1.159	11	.271
	P01a - P01e	.602	11	.559
	P01a - P01f	-2.001	11	.071
	P01a - P01g	1.858	11	.090
	P01b - P01c	-1.808	11	.098
	P01b - P01d	1.318	11	.214
	P01b - P01e	-.190	11	.852
	P01b - P01f	-1.308	11	.218
	P01b - P01g	2.084	11	.061
	P01c - P01d	1.657	11	.126
	P01c - P01e	1.714	11	.114

	P01c - P01f	2.121	11	.058
	P01c - P01g	2.008	11	.070
	P01d - P01e	-1.520	11	.157
	P01d - P01f	-1.358	11	.202
	P01d - P01g	2.092	11	.060
	P01e - P01f	-1.142	11	.278
	P01e - P01g	2.083	11	.061
	P01f - P01g	1.906	11	.083
2	P02a - P02b	1.805	11	.098
	P02a - P02c	-2.694	11	.021
	P02a - P02d	1.692	11	.119
	P02a - P02e	1.088	11	.300
	P02a - P02f	-1.157	11	.272
	P02a - P02g	2.036	11	.067
	P02b - P02c	-2.089	11	.061
	P02b - P02d	1.451	11	.175
	P02b - P02e	-1.840	11	.093
	P02b - P02f	-1.748	11	.108
	P02b - P02g	2.097	11	.060
	P02c - P02d	1.855	11	.091
	P02c - P02e	1.786	11	.102
	P02c - P02f	1.126	11	.284
	P02c - P02g	2.163	11	.053
	P02d - P02e	-1.835	11	.094
	P02d - P02f	-1.653	11	.127

	P02d - P02g	-.098	11	.923
	P02e - P02f	-1.137	11	.280
	P02e - P02g	2.184	11	.052
	P02f - P02g	1.986	11	.073
3	P03a - P03b	1.601	11	.138
	P03a - P03c	-2.305	11	.042
	P03a - P03d	1.664	11	.124
	P03a - P03e	1.404	11	.188
	P03a - P03f	.707	11	.494
	P03a - P03g	1.861	11	.090
	P03b - P03c	-1.981	11	.073
	P03b - P03d	1.661	11	.125
	P03b - P03e	-1.473	11	.169
	P03b - P03f	-3.038	11	.011
	P03b - P03g	1.913	11	.082
	P03c - P03d	1.769	11	.105
	P03c - P03e	1.995	11	.071
	P03c - P03f	1.676	11	.122
	P03c - P03g	1.962	11	.076
	P03d - P03e	-1.687	11	.120
	P03d - P03f	-1.785	11	.102

	P03d - P03g	-1.196	11	.257
	P03e - P03f	-.861	11	.408
	P03e - P03g	1.922	11	.081
	P03f - P03g	2.075	11	.062
4	P04a - P04b	.634	11	.539
	P04a - P04c	-2.844	11	.016
	P04a - P04d	1.652	11	.127
	P04a - P04e	-.198	11	.847
	P04a - P04f	-.851	11	.413
	P04a - P04g	1.858	11	.090
	P04b - P04c	-2.404	11	.035
	P04b - P04d	1.543	11	.151
	P04b - P04e	-.363	11	.724
	P04b - P04f	-1.528	11	.155
	P04b - P04g	1.633	11	.131
	P04c - P04d	1.799	11	.100
	P04c - P04e	1.182	11	.262
	P04c - P04f	2.035	11	.067
	P04c - P04g	2.085	11	.061
	P04d - P04e	-1.851	11	.091
	P04d - P04f	-1.717	11	.114

P04d - P04g	-1.415	11	.185
P04e - P04f	-.089	11	.931
P04e - P04g	2.184	11	.051
P04f - P04g	1.972	11	.074

Appendix 4.29: Paired t test output comparing garden soil samples stored wet at 0-4 oC to sample stored dry at room temperature (ICP-AES)

Bag	**Pair**	**t**	**df**	**Sig.**
Bag 1	Wet1 - Dry1	2.058	11	.064
	Wet2 - Dry2	1.106	11	.292
	Wet3 - Dry3	2.212	11	.049
	Wet4 - Dry4	-2.012	11	.069
	Wet5 - Dry5	-.240	11	.815
	Wet6 - Dry6	1.987	11	.072
Bag 2	Wet1 - Dry1	1.682	11	.121
	Wet2 - Dry2	1.087	11	.300
	Wet3 - Dry3	1.757	11	.107
	Wet4 - Dry4	-1.714	11	.114
	Wet5 - Dry5	-1.703	11	.117
	Wet6 - Dry6	1.891	11	.085
Bag 3	Wet1 - Dry1	2.003	11	.070
	Wet2 - Dry2	.881	11	.397

	Wet3 - Dry3	1.705	11	.116
	Wet4 - Dry4	-1.575	11	.143
	Wet5 - Dry5	-.657	11	.525
	Wet6 - Dry6	2.336	11	.039
Bag 4	Wet1 - Dry1	1.624	11	.133
	Wet2 - Dry2	-1.130	11	.282
	Wet3 - Dry3	1.800	11	.099
	Wet4 - Dry4	-1.897	11	.084
	Wet5 - Dry5	-1.424	11	.182
	Wet6 - Dry6	1.943	11	.078

Appendix 4.30: Paired t test output comparing park soil samples stored wet at 0-4 oC to sample stored dry at room temperature (ICP-AES)

Bag	Pair	t	df	Sig.
Bag 1	Wet1 - Dry1	1.772	11	.104
	Wet2 - Dry2	-.346	11	.736
	Wet3 - Dry3	1.682	11	.121
	Wet4 - Dry4	-1.632	11	.131
	Wet5 - Dry5	-1.232	11	.244
	Wet6 - Dry6	1.906	11	.083
Bag 2	Wet1 - Dry1	1.971	11	.074
	Wet2 - Dry2	-1.524	11	.156
	Wet3 - Dry3	1.899	11	.084
	Wet4 - Dry4	-1.881	11	.087
	Wet5 - Dry5	-1.295	11	.222
	Wet6 - Dry6	1.993	11	.072
Bag 3	Wet1 - Dry1	1.960	11	.076
	Wet2 - Dry2	1.955	11	.077
	Wet3 - Dry3	1.792	11	.101
	Wet4 - Dry4	-1.674	11	.122
	Wet5 - Dry5	-.807	11	.437

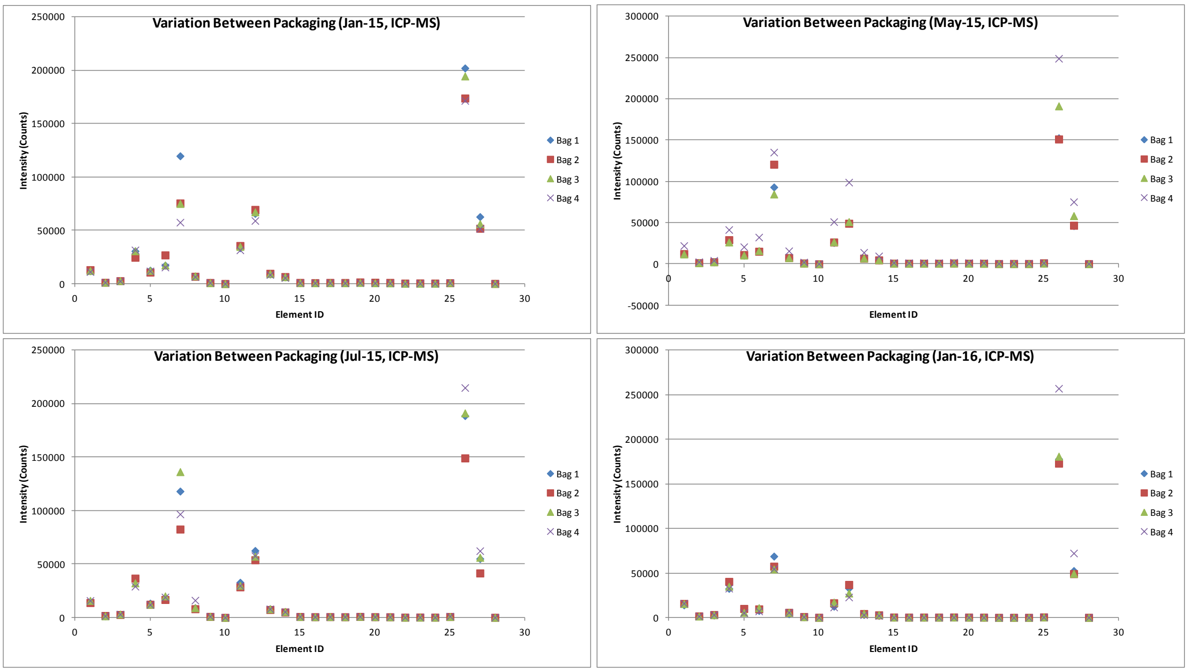
	Wet6 - Dry6	2.092	11	.060
Bag 4	Wet1 - Dry1	.219	11	.831
	Wet2 - Dry2	.895	11	.390
	Wet3 - Dry3	1.798	11	.100
	Wet4 - Dry4	-1.855	11	.091
	Wet5 - Dry5	.131	11	.898
	Wet6 - Dry6	2.027	11	.068

Appendix 4.31: Garden Sample Site ICP-MS Elemental Data

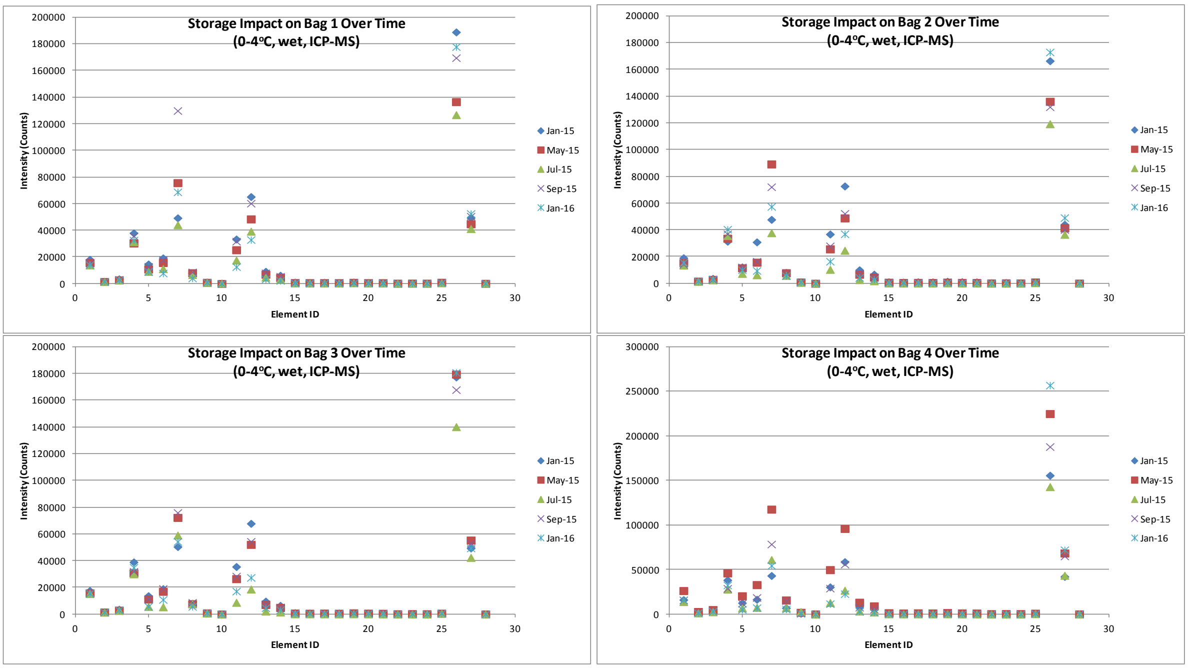
Sample	V	Cr	Co	Cu	Sr	Y	Zr	Nb	Mo	Cd	La	Ce	Pr	Nd
KCG01a	18252	1731.8	3580.6	38099	14741	19320	49432	8013.4	1181.3	323.6213	33510	65391	9240.2	6269.8
KCG02a	19175	1672.2	3733.6	31565	12299	31052	47889	8178	1217.4	332.0175	36956	72896	10165	6863.4
KCG03a	17752	1869.2	3738.8	39130	13849	19107	50626	8226.4	1011.1	348.7994	35686	68001	9771.8	6612.4
KCG04a	16370	1744.6	3305.2	38563	12878	16792	43453	7244.8	1085.6	250.4701	30670	58970	8391.8	5609.8
KCG01a	17069	1690.2	3533.6	37667	14822	19335	102260	7855.6	1276.2	260.5387	35134	67241	9473.2	6462
KCG02a	18135	1669.6	3683.4	30607	12062	31031	65467	7924	1174	308.9761	37732	74295	10315	6963.4
KCG03a	17140	1782.2	3539.2	37429	13749	18782	63538	8126.2	1035.5	257.3856	36349	69813	9794.4	6600.2
KCG04a	15754	1690.8	3275.6	37734	13313	16968	50717	7199.4	1080.1	262.474	31465	60511	8591.2	5734.4
KCG01c	15767	1560.2	2790.8	30523	10984	15852	75848	8137	932.44	93.2721	25446	48618	7012.6	4616.8
KCG02c	15538	1673.2	2973.4	33816	11653	15853	89392	7957.2	1032.2	94.6026	25837	48997	6846.2	4643.8
KCG03c	15947	1629.8	3021	31023	11404	17144	72431	7831.4	962.6	142.9875	26614	52262	7299	5032.2
KCG04c	26539	3025.2	5189.4	46400	20677	33212	117960	15994	2107.8	308.4937	50040	96281	13438	9358.2
KCG01a	15714	1643	3354.2	36337	14047	18705	53855	7578.2	1287.7	262.168	33765	66139	9225.6	6206.2
KCG02a	16831	1635.2	3501.8	29893	11901	30169	48347	7810.8	1189.1	239.8509	37044	72434	10205	7075.6
KCG03a	16186	1672.8	3443.8	36139	13577	19138	49986	7958.6	1036.5	323.8328	35258	68071	9557.4	6616.8
KCG04a	13923	1655.2	3069.4	36154	12942	16593	42488	7103.8	1131.2	224.7471	31028	58718	8276.8	5643.6
KCG01c	13763	1531.8	2631.8	28759	11052	15461	66386	7820.4	1021.2	144.8935	24856	48197	6817.8	4607.8
KCG02c	13290	1674	2868.4	31706	11324	15482	74730	7407.4	973.93	127.9121	25052	47821	6593.2	4656.2
KCG03c	13566	1564.8	2772.2	28330	10677	16387	62618	7422.6	935.98	135.9851	25778	49892	7146.2	4905.4
KCG04c	25016	2754.4	4905.8	44368	20083	33034	110000	16042	2039.2	290.086	49675	95289	13434	9412.6
KCG01d	14040	1549.4	2768	31442	9172.7	11256	44247	6841.2	934.47	236.691	17689	39379	4859.2	3362.2
KCG02d	13714	1583.8	2661.6	35808	7491.8	6474.6	37941	6020.4	811.84	222.5154	10517	24788	2803.6	1982.6
KCG03d	15458	1590.8	3000.8	30244	5843.6	5562.2	59214	7943.2	955.78	170.0112	8913.8	18840	2424.8	1688.6
KCG04d	14200	1550.8	2762.6	28177	7163.2	7706.6	61356	7332.8	3027	149.4884	13150	26930	3677.6	2569.2
KCG01e	15446	1723.4	3169.2	35869	12944	17892	130040	8741.8	1108.6	135.1081	31881	60407	8082	5524.8
KCG02e	14357	1909.8	2877.2	37127	12290	16559	72305	7869.6	1088.3	196.9108	28093	52371	7425.8	4990.6
KCG03e	15711	1656.2	3253.6	32107	11599	19250	76077	8859.4	1140.2	206.7516	28516	54525	7885.2	5401.8
KCG04e	16006	1770.2	3383.4	29084	12355	18742	78766	15326	1222.2	240.0233	29272	56230	7861.8	5609.8
KCG01a	12142	1459	2808.6	30762	12691	17393	119860	6978.8	1267.6	202.8019	33725	65871	9121.2	6357.6
KCG02a	13157	1335.2	2864.4	24832	10920	27017	75658	6967.2	1147	224.3087	35798	69606	9760.2	6716.8
KCG03a	12424	1475.6	2952.4	30886	12510	17571	75235	7434.2	1041.4	143.1766	34977	67380	9621.8	6572.6
KCG04a	11360	1484.8	2682.2	31718	12051	15619	57676	6696.2	1118.8	165.2301	31696	59221	8589.2	5747
KCG01c	12474	1292.8	2368.2	26549	10509	15304	93131	7719.2	970.78	83.2195	25896	49051	6783.8	4704.2
KCG02c	12377	1412.8	2510.8	29240	11201	15240	120660	7625.2	989.87	-9.2937	26461	49181	6871.2	4753.8
KCG03c	11998	1433.6	2483.4	26535	10664	16127	84652	7567	935.42	158.7681	26703	51163	7112.8	4975.4
KCG04c	22163	2543.2	4286	41544	20737	32408	135360	15797	2161.2	316.2594	51135	98969	13954	9633
KCG01d	13160	1543.2	2589.2	31182	9375.3	11363	47619	7139.2	955.49	170.5113	18740	41218	5078.2	3360
KCG02d	13204	1571.6	2596.2	36145	7753.5	6713.8	40286	6155.4	831.11	315.1536	11106	26427	2947.4	2064.4
KCG03d	14259	1501.8	2857.2	29975	6061.6	5758.8	53092	8480	930.64	125.3985	9263.6	19780	2518.2	1721.8

KCG04d	13436	1484.2	2497.2	27744	7250.6	7971.2	54960	7563.2	3137.5	171.0159	13868	28336	3704	2516.6
KCG01e	15109	1667.8	3025.2	35084	13456	18686	118200	9186.6	1083.6	164.4406	32950	62665	8228.8	5639.2
KCG02e	14015	1906.2	2834	36810	12417	16892	82691	8249.8	1029.2	157.098	28693	54011	7500.6	5130.8
KCG03e	16009	1639	3261.2	32462	12440	20191	136400	9250.6	1169.4	213.643	30175	57342	8131.6	5645.4
KCG04e	15990	1670.4	3275.2	29264	12200	19203	96804	16274	1207.8	249.7311	29975	57850	8141.8	5574.4
KCG01g	14211	1686	2782.6	32701	9209.3	7915.8	68901	4221.8	974.91	211.54	12738	33070	3431.4	2383.6
KCG02g	15814	1812.6	3328.2	40507	10183	9664.2	57592	5808.6	1103.9	305.9807	16550	37102	4456	3011
KCG03g	15701	1662.2	3285.8	35109	5903	11038	54455	5842.6	1006.3	295.5731	17294	27528	4840.2	3353.8
KCG04g	16149	1651.2	3359.4	32880	5482	7384	54793	5867.6	950.45	296.3961	11819	23010	3219.2	2322.2
	Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
KCG01a	1101.8	816.4	984.8	836.8	1129	819.6	753.2	339.6	447.2	369.2	806.8	189120	49571	240.4
KCG02a	1187.6	940.8	1187.8	1114.8	1577.8	1254.2	1117.4	502.6	650.4	499.4	706.8	166640	44199	217.6
KCG03a	1125.8	878.6	962.8	857	1086.2	855.8	735.2	351.2	425	346.8	717.8	177540	49544	225.8
KCG04a	932.2	756.6	829.6	733.6	939.8	712.2	642.6	314.2	364.2	325.8	719.8	156000	42440	188.8
KCG01a	1099.8	876.2	951.2	846.6	1121.8	846.2	782.6	369.8	457.4	354.6	997.4	168550	69613	262.6
KCG02a	1236.2	970.4	1208	1158.6	1573.8	1273.8	1201.8	543.4	650.2	505.6	842.8	147580	60586	260.8
KCG03a	1124.6	894.2	967.2	890.4	1093.2	846.4	737.2	360.8	448.2	351.4	906.2	163890	63255	232.2
KCG04a	948	781.2	853.6	782	967.6	699.8	667.8	289.2	369.6	307.8	901.6	144240	54889	219.2
KCG01c	754.8	687.4	712	684.4	927.8	689.2	652.2	301.8	360.4	318.8	982.2	136740	44944	190.8
KCG02c	843.8	664.4	713	645.8	914.2	696.2	631.8	307.8	373	310.4	1047.8	136230	41559	187.6
KCG03c	849.4	711.8	830.6	697.8	1002.2	773.6	670.4	318.6	430.4	345.8	769.2	179700	55494	191
KCG04c	1654.4	1333.4	1514.8	1392.8	1843.4	1423.2	1300.6	620.2	715.6	670.8	1117.2	225200	68725	353.8
KCG01a	1113.8	885.8	951.2	890.2	1087.8	893.8	832.8	369.8	462	382.2	770.8	180920	54286	295.8
KCG02a	1266.2	992.2	1238.8	1116.2	1579.6	1252.2	1137.8	570.4	645.2	528.8	731.6	157410	48860	288.6
KCG03a	1162.4	919.6	1018.2	872.8	1083.6	863.2	754.2	377.8	461.8	339.2	759.6	175030	51079	284.6
KCG04a	992.6	778	903.2	792.8	940.4	752	696.8	327.6	396.6	317.8	724.2	152130	43826	257.2
KCG01c	839.2	697.8	777.8	691.4	899.6	677.8	667.2	341.6	358.4	351.2	831.8	138800	40620	233.8
KCG02c	780.8	704.2	786	680.2	901.8	683.6	625.6	304.2	362.8	293.6	961.2	132630	41287	217.6
KCG03c	877.4	704.2	797.8	738.4	960.8	731.8	645.2	338.4	428.6	346.4	704	167030	53617	265.4
KCG04c	1617.2	1336.2	1446.2	1380.8	1798.4	1373.2	1296.4	582.2	744.2	608.6	1080.8	222930	67639	381.2
KCG01d	556.8	498.8	501.4	476.6	630	469.8	457.4	203.8	282.6	223.6	621.2	126970	41349	214.6
KCG02d	347.8	303.8	308.8	298.8	393.2	315.8	264.2	123.2	157.2	146.8	541.4	119470	36733	220.6
KCG03d	311.8	305.8	288.4	261.6	336.2	274.6	237	131.2	152.6	166	742.2	140380	42518	227.4
KCG04d	458.8	403.4	412.2	374.2	475.6	374.2	334.2	167	190.6	191.2	638.2	143240	43726	208.6
KCG01e	930.8	808.8	844.8	820.2	1070.2	790.2	744.8	358.2	427.8	393.6	896	169770	50677	274.2
KCG02e	894.2	752.8	794.2	725.6	974.4	728.4	675.2	348.8	423.8	368.2	886.8	132170	40292	257.8
KCG03e	973.8	817.2	904.8	824.6	1107.8	834.2	758.2	397.8	430.2	381.4	882.8	168060	53147	259.2
KCG04e	981.6	865	897.2	849.2	1110.2	873.4	807.2	385.2	496	384.2	1194.4	188170	65407	302.4
KCG01a	1132.4	911	1075.2	918.4	1283.8	966.8	889.8	450.2	533.8	449.6	1064.2	202160	62884	354.6
KCG02a	1214.2	994.8	1211	1135.8	1650.8	1400.8	1231.8	600.2	738.2	613.2	919	173980	51954	310.8
KCG03a	1148.8	949.2	1048.2	961.4	1232	944.8	839.2	439.6	483.2	470.8	1078.4	194670	56302	320.4
KCG04a	1014	870.2	939.8	845.6	1054.8	836.8	714.8	392.8	442.8	415.2	964.4	171670	51770	289.2

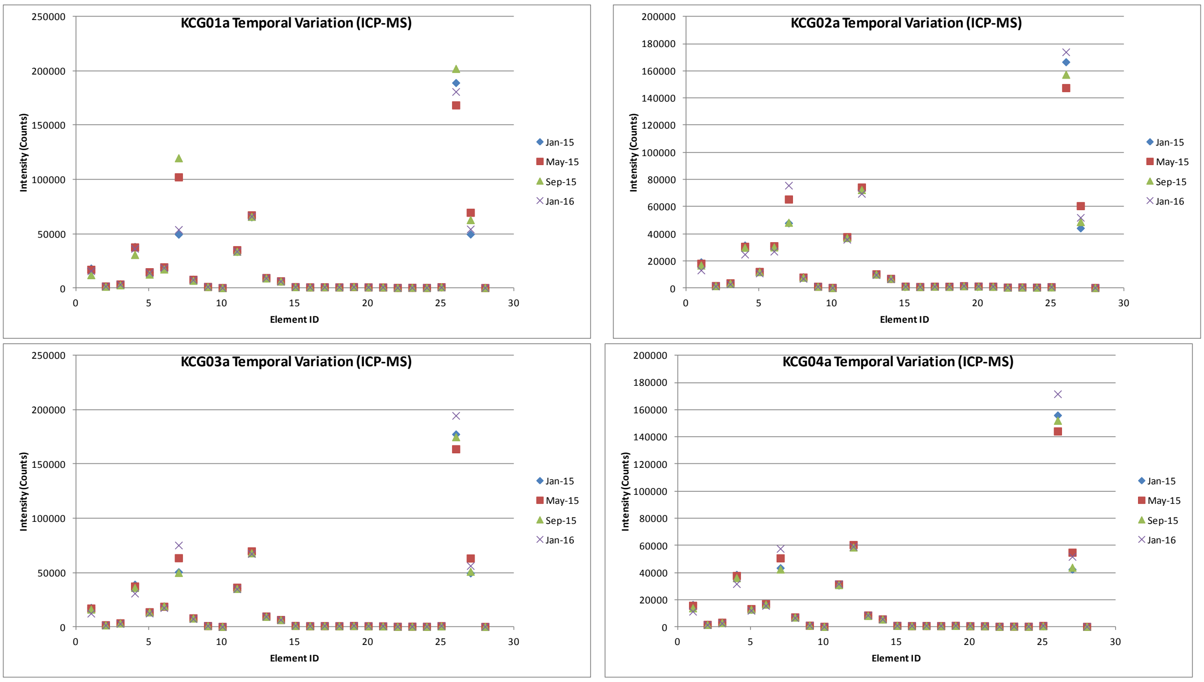
KCG01c	800.2	674.8	754.4	678.4	905.6	713.2	642.2	297.6	354.8	339.8	1082.2	152660	46284	234.4
KCG02c	821.2	690.8	723.6	683.6	963.8	749.2	684.8	296.6	397.2	342.8	1184.8	151270	46801	211.8
KCG03c	867.8	689.8	795.2	748.6	959.8	751.8	667.8	331.6	383.8	363.8	917.6	191370	58425	225.4
KCG04c	1638.2	1364.8	1505.2	1405.2	1974.6	1512.6	1377.4	644.8	774.8	718.8	1352.2	248980	75251	404.2
KCG01d	599.6	498.4	535.6	492.2	662.2	530.4	457.8	213.6	268.8	240.2	764.8	150240	42281	200.4
KCG02d	328.8	302	322.8	288.4	406.8	322.8	275.4	131.2	168.2	161.2	676.4	135460	40481	203.8
KCG03d	322.8	289.2	274.2	249.4	327.4	281.2	261.2	123.2	138.4	155.2	759.2	156950	46192	216.2
KCG04d	462	362.8	410.4	348.2	454.6	381.2	317.2	158.8	188.8	192.8	737.6	165140	46514	194.2
KCG01e	933.6	806	890.8	793.8	1063.2	787.6	771.6	369.8	433.2	404.2	927.6	188770	55132	250.2
KCG02e	941.8	780.4	840.2	727.8	1003	787.4	702.6	344.6	415.6	348.4	921.2	149200	41679	228.2
KCG03e	1023.2	864.6	956.8	832.2	1118.2	898.4	765.2	355.6	446.2	375.8	1020.8	191280	56357	242.6
KCG04e	994.2	844.2	912.6	848.8	1145.2	819.4	751.2	360.2	475.2	375.8	1331.2	214980	62476	258
KCG01g	438.8	371.8	395	358.8	487.8	361.8	339.8	166.2	214.6	176.4	685.8	178070	52671	223.6
KCG02g	533.8	437.2	487.8	444.8	570.8	452.8	404.2	206.8	230.2	211.2	665.8	173160	49227	248.2
KCG03g	598.4	522.4	550.6	509.2	659.2	520	465.8	237.8	282.8	247.8	743.2	180950	49568	235.8
KCG04g	406.6	387.8	371.8	356.8	461.2	358.4	334.8	161.2	192.8	210.2	623.2	257140	72353	236.8



Appendix 4.32: ICP-MS Elemental Variance in garden soil samples in different manufactured packaging



Appendix 4.33: Temporal variance in ICP-MS elemental concentration for garden soil samples stored wet at 0 - 4 oC.



Appendix 4.34: Temporal variance in ICP-MS elemental concentration for garden soil samples stored dry at room temperature.

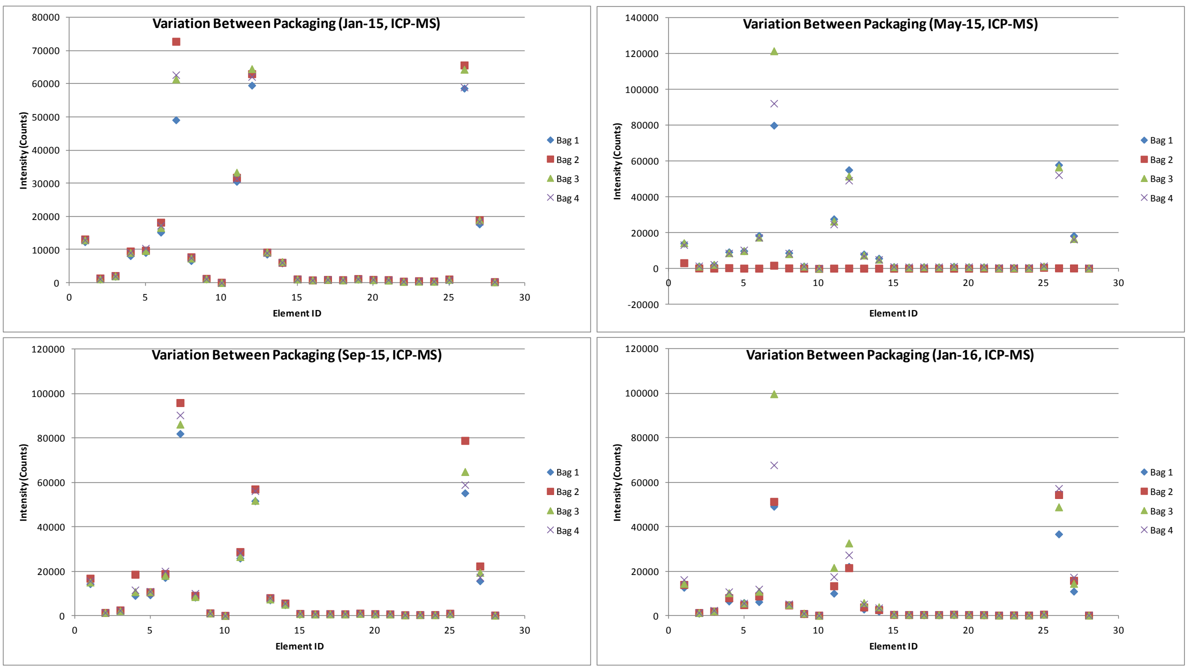
Appendix 4.35: Park Sample Site ICP-MS Elemental Data

Sample	V	Cr	Co	Cu	Sr	Y	Zr	Nb	Mo	Cd	La	Ce	Pr	Nd
KCP01a	17483	1260.2	2361.2	10202	10100	16462	58049	7300.6	1103.1	89.5782	30161	59853	8475	5657
KCP02a	18268	1648.4	2623.8	11452	10910	18951	73568	8663.2	1333.6	159.1584	30891	62457	8880	6127.6
KCP03a	17538	1462.6	2500.6	10784	10790	17910	59306	7982.8	1185.9	229.3371	32773	63597	9225.4	6203.2
KCP04a	17843	1420	2522.8	10973	10695	18813	61289	8226.2	1214.6	87.1948	30217	61748	8932.2	5883.4
KCP01a	16601	1263.8	2342.2	9883	10118	16507	47375	7332.4	1126	147.3302	31276	62005	8889.2	5998.2
KCP02a	17692	1639.2	2597.2	11244	10461	19203	71713	8607.2	1311.9	106.5426	32161	64706	9177	6343.8
KCP03a	17404	1367.6	2425.8	10797	11244	17631	60242	8012.2	1202.5	166.3306	33184	65082	9417.4	6283.2
KCP04a	17397	1378.6	2429.2	10729	10679	18807	63110	8455.6	1238.8	184.7647	32329	63800	8998.6	6357.2
KCP01c	17266	1522.8	2489.2	10436	10038	19049	76770	9128	1296.2	126.5432	27194	54310	8009.2	5423.2
KCP02c	4543	212.2	109.8	362.8	55.65	41.8	1503.8	180.8	108.87	-45.7699	57.8	105.4	36.8	28.2
KCP03c	17373	1382.8	2513.8	10019	10367	18407	109780	8541.2	1176.2	74.2292	25964	51373	7470.6	5153
KCP04c	16208	1454.2	2435.4	9631.2	10481	17583	80341	8490	1071.6	84.8622	24441	47707	6900.2	4801.6
KCP01a	15506	1180.6	2265.2	9287.4	9533.2	15949	42459	6963.4	1147.7	227.1209	29854	60086	8458	5849.2
KCP02a	15990	1578.2	2459.8	10809	10761	18810	64118	8085.4	1307.1	125.79	31217	61397	8805.8	6149.4
KCP03a	15570	1395.8	2309.8	10411	10437	17304	66965	7391	1181.4	115.261	32756	63889	9189.4	6324.2
KCP04a	15359	1277.4	2274.2	10041	10129	17944	59877	7891.2	1230	111.9286	30903	61595	8781.8	5944.2
KCP01c	15328	1366	2367.4	9546.2	9470.3	18207	105020	8435	1228.2	30.5541	26755	53516	7630.8	5333.6
KCP02c	3561.2	176.8	101.4	343	59.2	44.8	1462.2	172	103.67	-36.7891	64	104.2	46.4	28.8
KCP03c	15494	1264	2307.8	9265.6	9807	17623	75788	8096.8	1129.8	66.8552	25719	50491	7256.8	5071.2
KCP04c	14336	1378.8	2198.6	8888.4	9974.2	16838	71826	8002.6	1124.3	61.0581	23809	47107	6724.8	4729.2
KCP01d	15125	1298.6	2363.8	9887.6	5761.2	10015	64953	8116.2	1932	402.3569	14909	28739	4256.2	2940.4
KCP02d	14659	1288	2094.4	9273.2	4980.6	8037.8	93881	7791.6	959.25	129.9449	11894	22477	3546.2	2494.2
KCP03d	14174	1190.8	2176.4	9070	6054	6631.8	66643	6289.4	3639.5	120.9939	9825.4	24269	2912.6	1992.4
KCP04d	14740	1284.6	2244.2	9184	4702.7	5967.8	59703	7306.8	1124.6	149.4187	7984.6	16907	2275.4	1588.8
KCP01e	14978	1386.2	2301.2	9001.4	9514.4	16902	73034	8224.8	1180.2	147.5419	25637	50949	7133.2	4885.4
KCP02e	17352	1447.8	2577.4	18821	9975.8	18373	85736	8875.8	1180.5	-35.7089	27803	56190	7884.8	5427.8
KCP03e	15162	1431.2	2128.8	10580	10272	17239	77675	8117.8	1187.6	119.9366	25256	48870	7242.2	4900.8
KCP04e	15656	1371.8	2328.8	11500	10729	18829	80445	9413.8	1026.2	186.3589	26587	53931	7564.2	5204.4
KCP01a	12363	1077.6	1940.8	8150.8	9110.5	15244	49129	6664.6	1142.2	95.4283	30557	59572	8608.8	5956.8
KCP02a	13179	1411.4	2149.2	9549.8	9807.2	18242	72807	7804.8	1296.5	132.7705	31780	63038	9214.8	6144.8
KCP03a	12942	1178.8	2063.8	9124.4	9707	16648	61447	7427.6	1223.2	53.1717	33309	64553	9286.2	6378.2
KCP04a	12918	1186.6	2041.4	9114	10427	17297	62731	7570	1195.9	27.9316	31403	62162	9055.4	6164.8
KCP01c	13997	1298.4	2059.4	9176.8	9805.5	18344	79959	8682.4	1247.6	122.3925	27641	55096	7966.8	5610.6
KCP02c	3101	173.6	79.8	318.4	59.42	46.8	1683.2	173.2	72	-80.6778	52.8	106.4	42.8	44.8
KCP03c	14310	1147.8	2177.4	8690.4	9863.9	17400	121570	8162.4	1154.6	15.9778	26370	51563	7411.2	5072.6
KCP04c	13188	1361.2	2193.2	8522.2	10265	17231	92239	8457	1192.2	47.8801	24684	49199	6963.6	4944.2
KCP01d	14902	1321.6	2298.2	10014	5965	10323	81132	8173.8	2022.9	366.3407	15702	30591	4496.8	3065.6
KCP02d	14032	1316.2	2006.6	9224	5445.3	8384.4	98392	7969.4	1020.5	169.0182	12188	23055	3574.2	2525.4

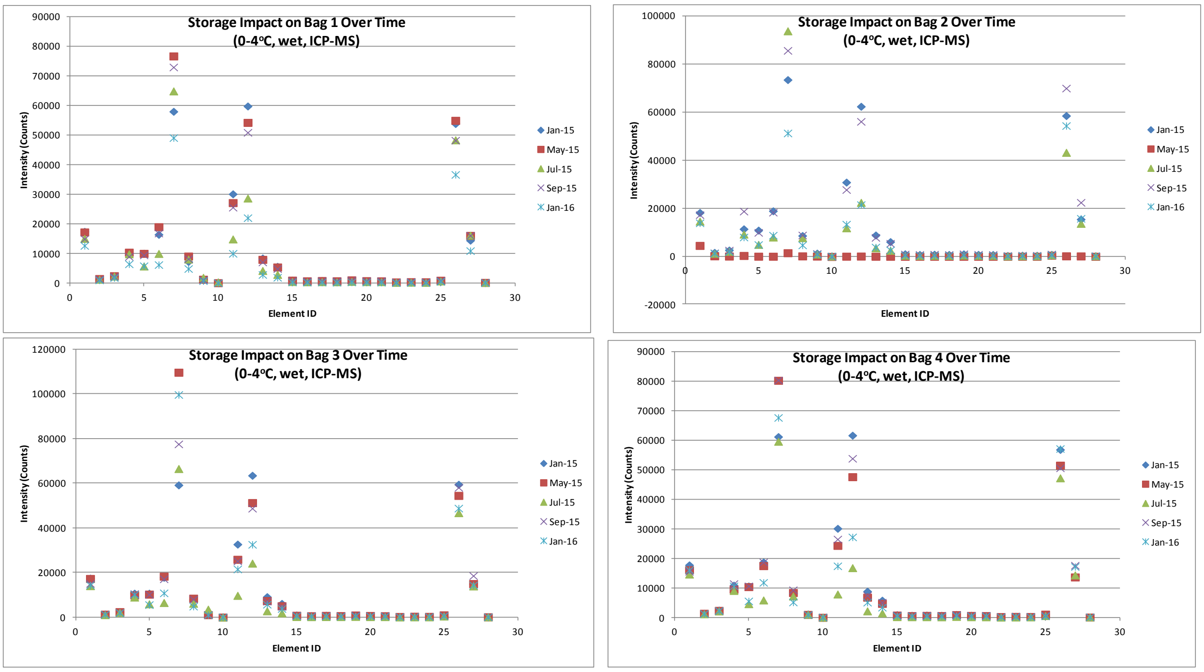
KCP03d	13588	1220.8	2085.2	8896.6	6217.2	6784.2	70634	6540.4	3579.7	123.7632	9944.6	24856	2904.8	2022.8
KCP04d	14116	1318.2	2222.8	9103.6	4818.5	6192.8	62520	7445.2	1175.4	124.992	8174.2	17481	2384.6	1661.2
KCP01e	14365	1348.6	2211.8	9058.8	9345.7	17155	81981	8313	1184.3	108.832	25892	51676	7071.2	4919.8
KCP02e	16829	1400.4	2525.6	18615	10689	18899	95917	9125.2	1209.3	81.7758	28801	57017	8054.2	5621.8
KCP03e	15133	1442.8	2217.4	10791	10821	18100	86199	8556.2	1213.2	91.1226	26576	51914	7487	5100.4
KCP04e	15639	1412.2	2364.2	11594	10975	20055	90313	10061	1111.7	14.6779	28294	56202	8010.8	5527.8
KCP01g	12710	1051.4	1843.6	6506.8	5852.1	6246.2	49161	4909.8	809.11	97.2558	10050	22093	2904.2	1955.2
KCP02g	13970	1342.8	2007.4	8036.4	4911.9	8797.6	51347	4756.8	896.49	163.1776	13402	21532	3862.2	2683.4
KCP03g	14457	1359.8	2118.2	10280	5682.5	10935	99800	4985.2	1113.7	130.2873	21642	32677	5852.2	3930.4
KCP04g	16202	1373.2	2409	10741	5635.2	11918	67758	5278.4	999.4	129.429	17517	27302	5212.8	3504.2

	Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
KCP01a	993.8	705.2	840.8	716.2	982.8	716.6	660.2	312.4	406.4	304.6	566.6	53924	14493	177.6
KCP02a	1059.2	771.8	873.8	792.2	1028.6	808.2	758.2	345.6	461.8	432.2	820.8	58592	15496	212.6
KCP03a	1023.8	705.4	884.4	775.2	1010.2	749.2	656.8	325.4	424.8	338.2	766.4	59578	15003	192.4
KCP04a	1004.2	776.6	839.6	780	1064.6	773.2	691.4	334.6	418.2	409.8	625.8	56929	13974	191.8
KCP01a	1076	735.6	890.6	775.4	955.8	757.8	676.8	341.8	415.2	334.2	611	49532	19690	196.8
KCP02a	1062.6	806.2	892.6	822.2	1108.6	844.8	791.4	393.6	498.2	408.8	1137	53816	20621	268.8
KCP03a	1061.8	765.8	890.2	801.4	1047.2	843.4	729.2	358.2	451	386.2	845.8	54363	20318	246.8
KCP04a	1087.2	826.2	900.2	825.2	1094.8	835.4	764.8	357.4	449.2	403.8	752.6	51719	19561	216.2
KCP01c	985	749.2	853.2	759.4	1073	809.4	740.4	373.6	464.4	422.6	960.2	55008	16105	220
KCP02c	27.4	32.8	31.2	27.8	29.2	35.8	27.6	29.6	38.2	30	468.2	200.2	159	27.2
KCP03c	888	675.2	831.8	734.8	1009.4	791.8	679.8	344.2	456.2	388.8	1079.4	54596	15090	211.2
KCP04c	849.4	665.8	736.2	670.4	999.2	716.4	671.2	339	386	356	1158.6	51607	13757	173.8
KCP01a	1033.2	711.4	892.4	759.8	986.6	757.4	718.8	337.8	414	338.6	530.2	51177	15671	216.2
KCP02a	1087.8	793.6	916.2	843.2	1094.4	856.4	832.2	404.2	502.8	418.8	841.8	55634	16903	284.2
KCP03a	1085.2	774.2	884.6	824.2	1076.2	783.4	707	350.4	406.6	331.2	818.4	55399	17049	241.4
KCP04a	1054.2	770.2	902.8	842.8	1055.6	791.4	700.6	361.8	467	381.2	680.8	52647	16305	253.4
KCP01c	935.2	706.2	815.8	730.8	1067.6	800.6	716.8	345.4	453.4	382.2	884.2	51408	16116	212.8
KCP02c	34	39.8	34.4	35.2	38.6	29.4	35.4	29.4	41.8	26.6	399.6	170.6	152.6	25.2
KCP03c	883.2	692.6	760.6	729.6	952.6	746.2	690.4	308.8	406.2	317.6	845.2	49303	16339	207.8
KCP04c	793.4	674.8	708.2	657.2	941.8	742.4	681.8	325.2	400.6	339	1020.2	47118	14517	206.2
KCP01d	527.6	433.6	476.8	440.6	567.6	491.8	482.4	241.2	304.6	239.8	708.4	48424	16192	221
KCP02d	439.2	350.2	398.2	384.6	498.6	418.8	391.2	197.2	257.8	286.2	650.2	43301	13751	259.8
KCP03d	357.6	300.4	337.4	322.2	398.8	320.6	312.2	160.4	209.4	210.8	581.6	46879	14049	215.2
KCP04d	320.2	292.8	298.4	261.4	387.8	293.2	269.2	159.8	196.6	231.8	681.8	47324	14450	235.6
KCP01e	896.2	707.8	816.4	743.2	1014.2	794.4	805.4	389.4	505.2	429.2	904.4	48279	16122	283.8
KCP02e	964.6	788.4	874.4	774.8	1056.2	822.4	770.6	350.2	475.8	430.8	955.6	70041	22477	256.6
KCP03e	877.4	711.2	767.8	692.2	986.4	749.2	730.8	332.2	457.6	378.4	815.8	58202	18682	208.2
KCP04e	898.2	726.8	817.4	793.2	1064.4	784.8	770.8	379.6	494.8	410	821.8	50701	17733	259
KCP01a	1040.6	847.8	921.8	813.2	1041.4	840.4	778.4	395.4	477.2	428.8	731.2	58675	17718	268.2
KCP02a	1130.6	845	974.8	908.2	1243	988.8	916	453.8	587.2	510.6	1105.2	65665	18990	318.6
KCP03a	1105.6	865.8	996.4	850.2	1143.8	900.6	772.8	391.2	449	427.2	1001.8	64374	18970	283

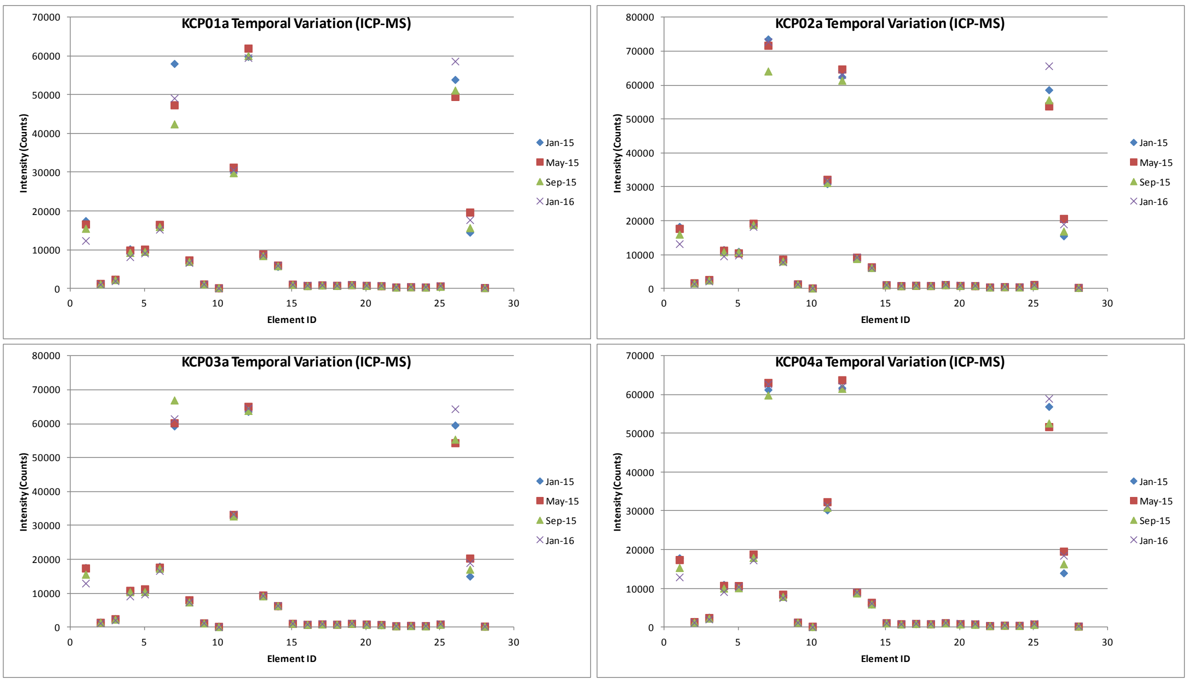
KCP04a	1102.8	805.8	980.8	869.2	1162.6	984.2	905.2	442.2	530.6	464	913.2	58998	18489	308.2
KCP01c	945.8	727.2	887.8	782.8	1121.8	853.2	825.2	386.8	476.4	433	1044.8	57887	18272	223.8
KCP02c	34.4	36.2	31.2	32.4	25.8	34.8	29.2	40.2	42.4	30.8	517.2	216.2	156.6	31.2
KCP03c	847	646.2	833.4	777.2	1013.6	818.6	760.2	360.6	424.6	396.2	1233.4	56624	16634	236.2
KCP04c	954.4	827.2	877.8	846.8	1113.8	885.2	843.4	478.8	514.8	529.8	1407.6	52214	16230	319.8
KCP01d	548.2	447.6	483	466.8	632.6	520.2	479	241.6	298.6	275.8	954.2	56657	16386	218.8
KCP02d	439	381.2	420.4	388.8	535.2	435.8	399.2	214	291.8	324.2	794.2	47720	15411	269.4
KCP03d	382.8	305.8	316.2	308.4	462.8	367.8	315.8	185.8	220.4	228.2	744.2	50963	15497	196
KCP04d	340.2	262.6	312.8	283.8	379.8	328.2	283.2	164.4	186.2	219.4	773.6	53361	15188	221.8
KCP01e	853.8	664.2	781.4	709.2	989.6	764.2	702.8	348.2	463	406.2	972.2	55262	15659	196.2
KCP02e	948.2	774.8	840.4	790.4	1082.8	843.2	752.8	376.6	429.2	437.2	1038.2	78881	22321	219
KCP03e	890.2	720.8	779.4	767.4	980.8	787.4	736.8	362.2	480.2	420.2	865	64872	19493	217.8
KCP04e	983.2	756.8	907.2	823.8	1101.2	903.4	844.2	392.6	471.8	421.6	885.8	58955	17351	227.8
KCP01g	364.2	302.8	309.8	270.4	373.2	311.2	290.8	143.8	198	177.8	590.8	36720	10964	172.8
KCP02g	493	416.8	454.8	413.8	568.2	415.2	389.4	184.4	267.6	208.2	601	54441	15821	191.2
KCP03g	678.2	520.4	557.8	474.2	653.6	556	494.8	234.8	302.4	299.8	666.2	48906	14479	220.8
KCP04g	640.2	511.2	529.8	486.8	711.8	537.8	543.2	242.2	319.8	264	566.6	57235	17296	228.8



Appendix 4.36: ICP-MS Elemental Variance in park soil samples in different manufactured packaging.



Appendix 4.37: Temporal variance in ICP-MS elemental concentration for park soil samples stored wet at 0 - 4 oC.



Appendix 4.38: Temporal variance in ICP-MS elemental concentration for park soil samples stored dry at room temperature.

Appendix 4.39: Paired t-test output for sample bag assessment (ICP-MS)

Site	Pair	t	df	Sig.
Garden	Bag 1 - Bag 2	1.323	27	.197
	Bag 1 - Bag 3	1.202	27	.240
	Bag 1 - Bag 4	1.726	27	.096
	Bag 2 - Bag 3	-.704	27	.487
	Bag 2 - Bag 4	1.899	27	.068
	Bag 3 - Bag 4	2.188	27	.038
Park	Bag 1 - Bag 2	-1.932	27	.064
	Bag 1 - Bag 3	-2.412	27	.023
	Bag 1 - Bag 4	-1.889	27	.070
	Bag 2 - Bag 3	1.138	27	.265
	Bag 2 - Bag 4	1.782	27	.086
	Bag 3 - Bag 4	1.196	27	.242

Appendix 4.40: Paired t-test output assessing temporal variation in garden soil samples stored dry at room temperature (ICP-MS)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan 15) - 1a (May 15)	-.907	27	.372
	1a (Jan 15) - 1a (Sep 15)	-1.081	27	.289
	1a (Jan 15) - 1a (Jan 16)	.373	27	.712
	1c (May 15) - 1c (Sep 15)	-.611	27	.546
	1c (May 15) - 1c (Jan 16)	1.132	27	.268
	1e (Sep 15) - 1e (Jan 16)	1.198	27	.241
2	2a (Jan 15) - 2a (May 15)	-.487	27	.631
	2a (Jan 15) - 2a (Sep 15)	.913	27	.369
	2a (Jan 15) - 2a (Jan 16)	-.568	27	.575
	2c (May 15) - 2c (Sep 15)	1.088	27	.286
	2c (May 15) - 2c (Jan 16)	-.094	27	.926
	2e (Sep 15) - 2e (Jan 16)	-.845	27	.405

3	3a (Jan 15) - 3a (May 15)	-.487	27	.631
	3a (Jan 15) - 3a (Sep 15)	.913	27	.369
	3a (Jan 15) - 3a (Jan 16)	-.568	27	.575
	3c (May 15) - 3c (Sep 15)	1.088	27	.286
	3c (May 15) - 3c (Jan 16)	-.094	27	.926
	3e (Sep 15) - 3e (Jan 16)	-.845	27	.405
4	4a (Jan 15) - 4a (May 15)	-.487	27	.631
	4a (Jan 15) - 4a (Sep 15)	.913	27	.369
	4a (Jan 15) - 4a (Jan 16)	-.568	27	.575
	4c (May 15) - 4c (Sep 15)	1.088	27	.286
	4c (May 15) - 4c (Jan 16)	-.094	27	.926
	4e (Sep 15) - 4e (Jan 16)	-.845	27	.405

Appendix 4.41: Paired t-test output assessing temporal variation in park soil samples stored dry at room temperature (ICP-MS)

Sample Bag	Sample Pair	t	df	Sig.
1	1a (Jan 15) - 1a (May 15)	.496	27	.624
	1a (Jan 15) - 1a (Sep 15)	1.329	27	.195
	1a (Jan 15) - 1a (Jan 16)	.802	27	.430
	1c (May 15) - 1c (Sep 15)	2.159	27	.040
	1c (May 15) - 1c (Jan 16)	.291	27	.773
	1e (Sep 15) - 1e (Jan 16)	-1.041	27	.307
2	2a (Jan 15) - 2a (May 15)	-.260	27	.797
	2a (Jan 15) - 2a (Sep 15)	1.517	27	.141
	2a (Jan 15) - 2a (Jan 16)	-.281	27	.781
	2c (May 15) - 2c (Sep 15)	1.915	27	.066
	2c (May 15) - 2c (Jan 16)	-.057	27	.955
	2e (Sep 15) - 2e (Jan 16)	-1.319	27	.198
3	3a (Jan 15) - 3a (May 15)	-.468	27	.644
	3a (Jan 15) - 3a (Sep 15)	-.218	27	.829

	3a (Jan 15) - 3a (Jan 16)	-.459	27	.650
	3c (May 15) - 3c (Sep 15)	.197	27	.845
	3c (May 15) - 3c (Jan 16)	-.026	27	.979
	3e (Sep 15) - 3e (Jan 16)	-.167	27	.869
4	4a (Jan 15) - 4a (May 15)	-.468	27	.644
	4a (Jan 15) - 4a (Sep 15)	-.218	27	.829
	4a (Jan 15) - 4a (Jan 16)	-.459	27	.650
	4c (May 15) - 4c (Sep 15)	.197	27	.845
	4c (May 15) - 4c (Jan 16)	-.026	27	.979
	4e (Sep 15) - 4e (Jan 16)	-.167	27	.869

Appendix 4.42: Paired t-test output assessing temporal variation in garden soil samples stored wet at 0-4 oC (ICP-MS)

Sample Bag	Sample Pair	t	df	Significance
1	G01a - G01c	1.283	27	.210
	G01a - G01e	-.538	27	.595
	G01a - G01g	1.916	27	.066
	G01c - G01e	-2.005	27	.055
	G01c - G01g	.157	27	.876
	G01e - G01g	1.943	27	.063
2	G02a - G02c	.901	27	.376
	G02a - G02e	1.318	27	.199
	G02a - G02g	1.463	27	.155
	G02c - G02e	.626	27	.537
	G02c - G02g	.317	27	.754
	G02e - G02g	.104	27	.918
3	G03a - G03c	.901	27	.376
	G03a - G03e	1.318	27	.199
	G03a - G03g	1.463	27	.155
	G03c - G03e	.626	27	.537

	G03c - G03g	.317	27	.754
	G03e - G03g	.104	27	.918
4	G04a - G04c	.901	27	.376
	G04a - G04e	1.318	27	.199
	G04a - G04g	1.463	27	.155
	G04c - G04e	.626	27	.537
	G04c - G04g	.317	27	.754
	G04e - G04g	.104	27	.918

Appendix 4.43: Paired t-test output assessing temporal variation in park soil samples stored wet at 0-4 oC (ICP-MS)

Sample Bag	Sample Pair	t	df	Significance
1	P01a - P01c	-.903	27	.374
	P01a - P01e	.327	27	.746
	P01a - P01g	2.896	27	.007
	P01c - P01e	2.988	27	.006
	P01c - P01g	3.205	27	.003
	P01e - P01g	3.094	27	.005
2	P02a - P02c	3.121	27	.004
	P02a - P02e	-1.171	27	.252
	P02a - P02g	2.664	27	.013
	P02c - P02e	-3.047	27	.005
	P02c - P02g	-2.802	27	.009
	P02e - P02g	3.032	27	.005
3	P03a - P03c	-.439	27	.664
	P03a - P03e	.356	27	.724
	P03a - P03g	.729	27	.472
	P03c - P03e	.996	27	.328
	P03c - P03g	2.898	27	.007
	P03e - P03g	1.002	27	.325

4	P04a - P04c	-.439	27	.664
	P04a - P04e	.356	27	.724
	P04a - P04g	.729	27	.472
	P04c - P04e	.996	27	.328
	P04c - P04g	2.898	27	.007
	P04e - P04g	1.002	27	.325

Appendix 4.44: Paired t test output comparing garden soil samples stored wet at 0-4 oC to sample stored dry at room temperature (ICP-MS)

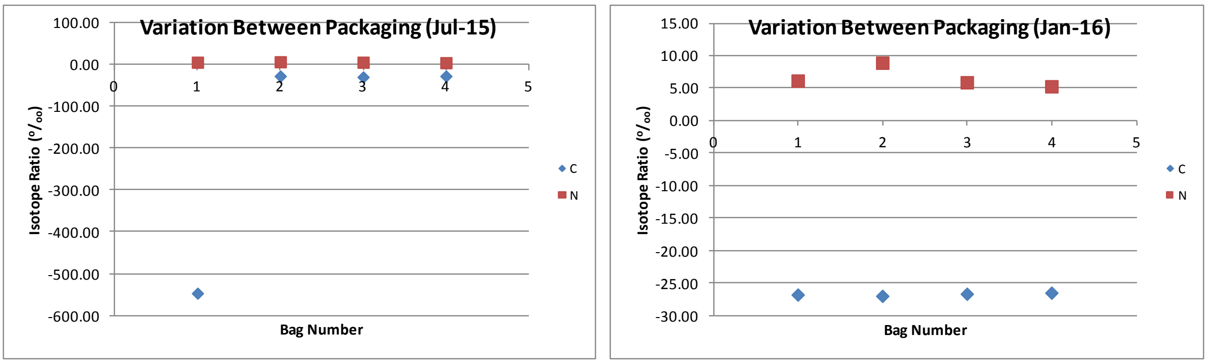
Bag	Pair	t	df	Sig.
Bag 1	Wet1 - Dry1	2.803	27	.009
	Wet2 - Dry2	-2.042	27	.051
	Wet3 - Dry3	2.550	27	.017
Bag 2	Wet1 - Dry1	1.550	27	.133
	Wet2 - Dry2	-1.835	27	.077
	Wet3 - Dry3	.865	27	.395
Bag 3	Wet1 - Dry1	.972	27	.340
	Wet2 - Dry2	-2.493	27	.019
	Wet3 - Dry3	1.954	27	.061
Bag 4	Wet1 - Dry1	-2.742	27	.011
	Wet2 - Dry2	3.211	27	.003
	Wet3 - Dry3	1.100	27	.281

Appendix 4.45: Paired t test output comparing park soil samples stored wet at 0-4 ^{o}C to sample stored dry at room temperature (ICP-MS)

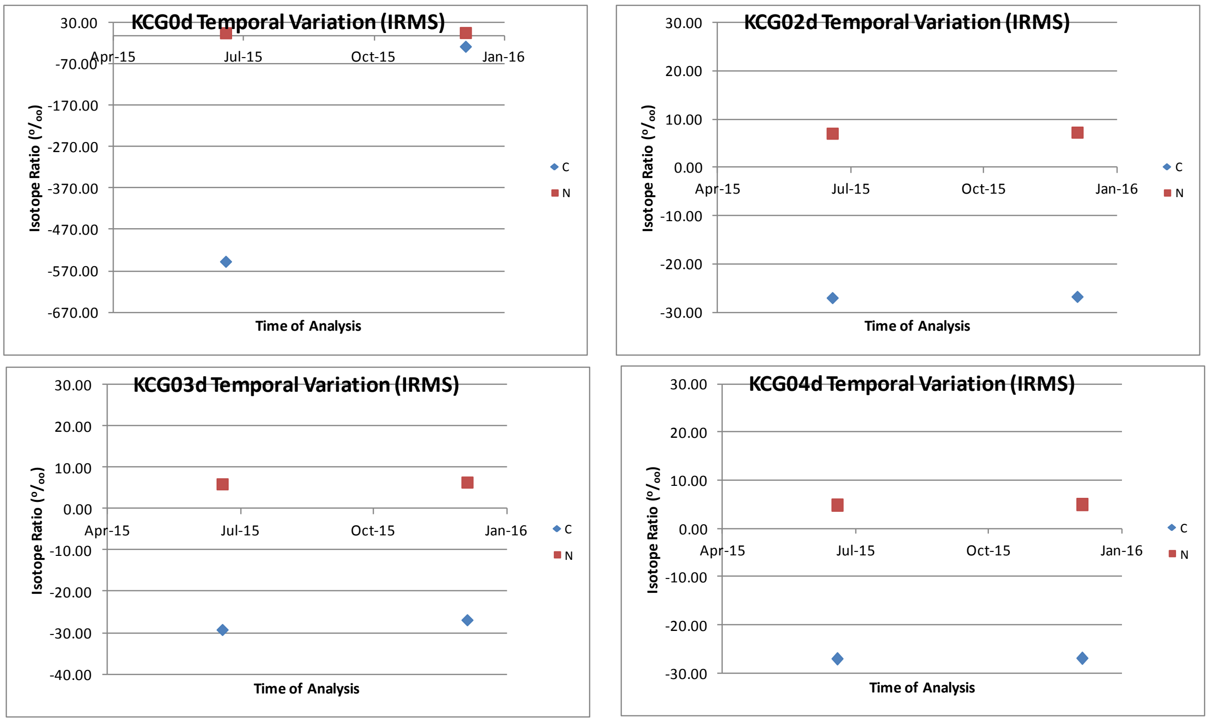
Bag	Pair	t	df	Sig.
Bag 1	Wet1 - Dry1	-.779	27	.443
	Wet2 - Dry2	1.312	27	.201
	Wet3 - Dry3	2.923	27	.007
Bag 2	Wet1 - Dry1	3.186	27	.004
	Wet2 - Dry2	-3.056	27	.005
	Wet3 - Dry3	2.909	27	.007
Bag 3	Wet1 - Dry1	-.373	27	.712
	Wet2 - Dry2	-1.278	27	.212
	Wet3 - Dry3	1.818	27	.080
Bag 4	Wet1 - Dry1	.809	27	.425
	Wet2 - Dry2	-3.120	27	.004
	Wet3 - Dry3	2.463	27	.020

Appendix 4.46: Garden Sample Site Isotope Data

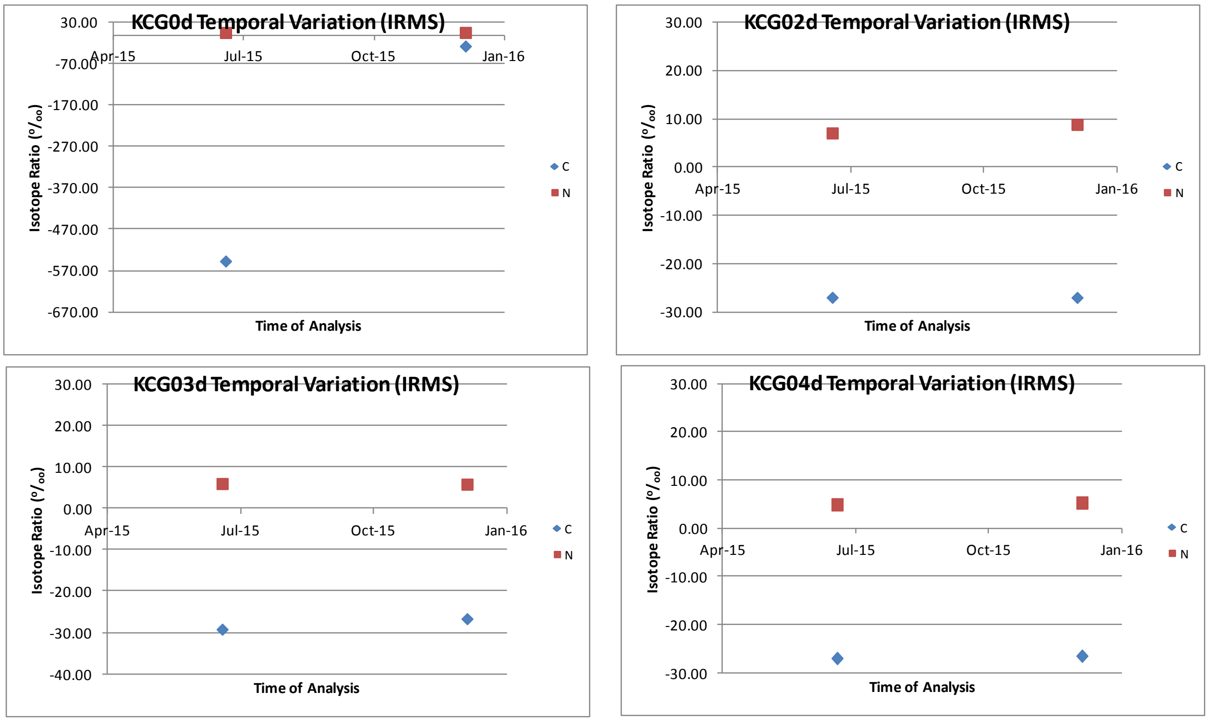
Identifier 1	Row	d^{13}C (permil)	d^{15}N (permil)	%C	%N
KCG01d	8	-546.96	6.02	21.79	1.56
KCG02d	9	-26.98	7.11	22.89	1.71
KCG03d	10	-29.23	6.02	18.39	1.49
KCG04d	11	-26.99	4.88	26.40	1.43
KCG01d	8	-26.72	6.61	16.66	1.23
KCG02d	9	-26.73	7.33	22.97	1.67
KCG03d	10	-26.87	6.44	24.38	1.53
KCG04d	11	-26.88	5.01	26.83	1.52
KCG01g	21	-26.80	6.12	25.41	1.69
KCG02g	22	-27.00	8.88	27.62	2.06
KCG03g	23	-26.68	5.87	17.60	1.01
KCG04g	24	-26.51	5.25	20.37	1.12



Appendix 4.47: Stable isotope variance in garden soil samples stored in different manufactured packaging.



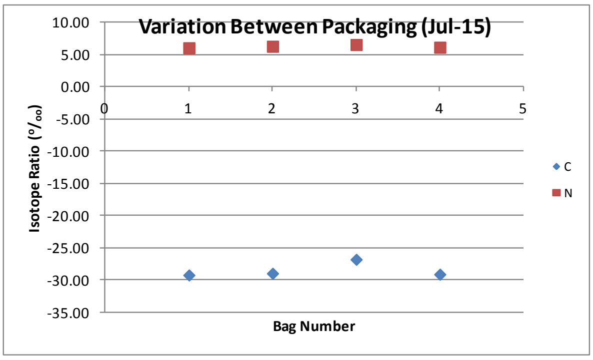
Appendix 4.48: Temporal variance in stable isotopes for garden soil samples stored wet at 0 - 4 °C.

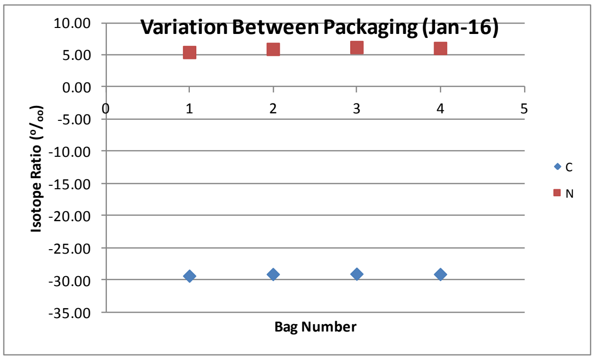


Appendix 4.49: Temporal variance in stable isotopes for garden soil samples stored dry at room temperature vs stored wet at 0-4 °C

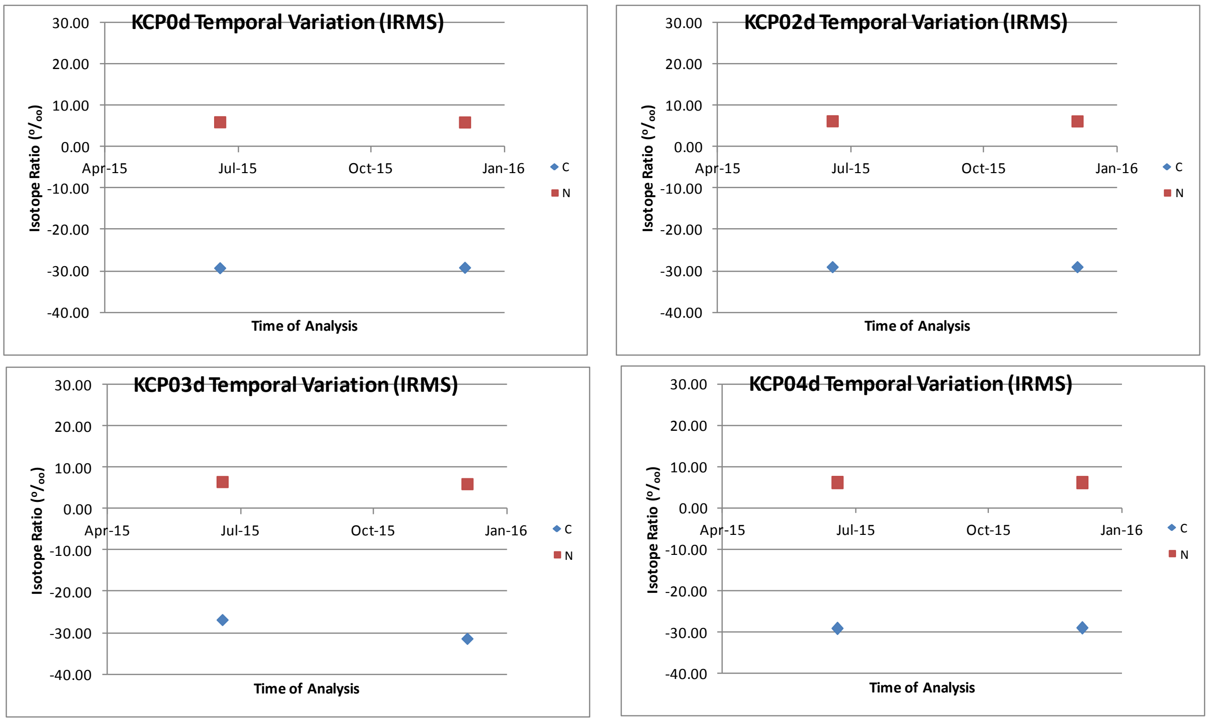
Appendix 4.50: Park Sample Site Isotope Data

Identifier 1	Row	$d^{13}C$ (permil)	$d^{15}N$ (permil)	%C	%N
KCP01d	12	-29.26	6.06	18.06	1.42
KCP02d	13	-28.99	6.30	14.61	1.15
KCP03d	14	-26.82	6.57	21.91	1.40
KCP04d	15	-29.13	6.16	19.33	1.53
KCP01d	12	-29.15	6.02	19.81	1.50
KCP02d	13	-28.99	6.28	20.18	1.60
KCP03d	14	-31.38	6.06	18.44	1.56
KCP04d	15	-28.99	6.15	17.88	1.39
KCP01g	25	-29.37	5.40	22.73	1.80
KCP02g	26	-29.11	5.89	20.03	1.56
KCP03g	27	-29.06	6.18	18.87	1.47
KCP04g	28	-29.11	6.04	18.80	1.45

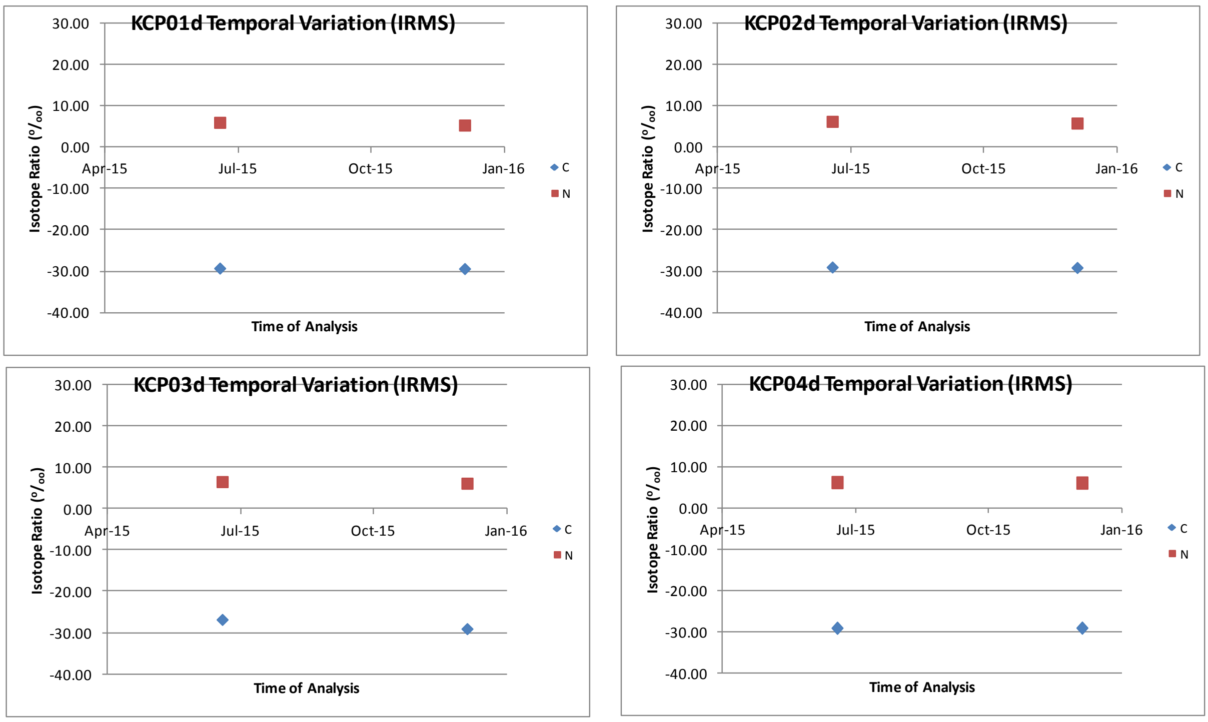




Appendix 4.51: Stable isotope variance in park soil samples stored in different manufactured packaging.



Appendix 4.52: Temporal variance in stable isotopes for park soil samples stored wet at 0 - 4 °C.



Appendix 4.53: Temporal variance in stable isotopes for park soil samples stored dry at room temperature vs stored wet at 0-4 oC

Appendix 4.54: Paired t-test output for sample bag assessment

Site	Pair	t	df	Sig.
Garden	Bag 1 - Bag 2	-1.004	1	.499
	Bag 1 - Bag 3	-1.000	1	.500
	Bag 1 - Bag 4	-.996	1	.501
	Bag 2 - Bag 3	2.879	1	.213
	Bag 2 - Bag 4	1.009	1	.497
	Bag 3 - Bag 4	-.352	1	.800
Park	Bag 1 - Bag 2	-17.000	1	.037
	Bag 1 - Bag 3	-1.528	1	.369
	Bag 1 - Bag 4	-7.667	1	.083
	Bag 2 - Bag 3	-1.284	1	.421
	Bag 2 - Bag 4	-1.075	1	.449
	Bag 3 - Bag 4	1.432	1	.388

Appendix 4.55: Paired t-test output assessing temporal variation in soil samples stored wet at 0-4 oC (IRMS)

	Bag	Pair	t	df	Sig.
Garden	1	G01d - G01g	-1.000	1	.500
	2	G02d - G02g	-.978	1	.507
	3	G03d - G03g	-.889	1	.537
	4	G04d - G04g	-7.727	1	.082
Park	1	P01d - P01g	1.400	1	.395
	2	P02d - P02g	1.828	1	.319
	3	P03d - P03g	1.422	1	.390
	4	P04d - P04g	.714	1	.605

Appendix 4.56: Paired t test output comparing soil samples stored wet at 0-4 oC to sample stored dry at room temperature (IRMS)

	Bag	Pair	t	df	Sig.
Garden	1	Wet1 - Dry1	-1.002	1	.499
	2	Wet1 - Dry1	-15.667	1	.041
	3	Wet1 - Dry1	-1.433	1	.388
	4	Wet1 - Dry1	-12.000	1	.053
Park	1	Wet1 - Dry1	-.467	1	.722
	2	Wet1 - Dry1	1.000	1	.500
	3	Wet1 - Dry1	1.252	1	.429
	4	Wet1 - Dry1	-.867	1	.545

Appendix 4.57: XRF data quality

Sample		Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	
CRM 1	Mean	290.5	12810.87	67942.5	260229.2	1083.235	3568.313	29.8375	23112.5	27814.71	4491.25	86.89474	140.5524	
	SD	9.45	266.99	855.26	2441.58	21.12	36.65	12.36	163.93	132.20	43.39	8.40	9.49	
		Mn	**Fe**	**Co**	**Ni**	**Cu**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Rb**	
	Mean	542.42	41203.64	26.55	40.83	87.437	372.25	14.62	1.33	14.37	0.93	6.38	96.08	
	SD	12.23	43.42	11.75	2.81	1.81	3.44	1.23	0.54	1.33	0.34	0.36	0.84	
		Sr	**Y**	**Zr**	**Nb**	**Mo**	**Ag**	**Cd**	**In**	**Sn**	**Sb**	**Te**	**I**	
	Mean	122.88	35.32	303.42	18.10	8.029	1.04	5.95	0.61	9.045	2.21	0.80	1.43	
	SD	0.67	0.56	8.73	3.93	2.43	0.85	1.19	0.24	0.75	0.62	0.07	0.13	
		Cs	**Ba**	**La**	**Ce**	**Hf**	**Ta**	**W**	**Hg**	**Tl**	**Pb**	**Bi**	**Th**	**U**
	Mean	2.58	323.96	20.84	38.65	6.87	4.78	3.59	1.44	1.53	144.48	1.01	8.89	31.34
	SD	0.10	7.22	3.55	7.52	3.66	0.71	0.74	0.72	0.57	1.78	0.51	0.85	8.42

Appendix 4.58: ICP-MS data quality

Sample		V	Cr	Co	Cu	Sr	Y	Zr	Ng	Mo	Cd	La	Ce	Pr	Nd
Ref	Mean	2.35	1.50	0.31	0.18	5.48	0.38	5.06	0.33	0.00	0.00	0.65	1.33	0.15	0.56
	SD	0.14	0.10	0.01	0.01	0.70	0.06	1.44	0.02	0.00	0.00	0.10	0.19	0.02	0.09
		Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
	Mean	0.11	0.02	0.10	0.02	0.08	0.02	0.05	0.01	0.05	0.01	0.08	0.02	0.60	0.07
	SD	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.10	0.01
		V	**Cr**	**Co**	**Cu**	**Sr**	**Y**	**Zr**	**Ng**	**Mo**	**Cd**	**La**	**Ce**	**Pr**	**Nd**
Blank	Mean	0.01	0.00	0.00	0.01	0.02	-0.01	0.23	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	SD	0.01	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Sm	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**W**	**Tl**	**Pb**	**U**
	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00

Appendix 4.59: ICP-AES data quality

Sample		K	Al	Be	Ca	Fe	Mg	Mn	Na	Ni	P	Ti	Zn
CRM	Mean	56.61	174.67	0.00	33.07	75.13	18.37	1.47	2.49	0.26	0.30	13.00	0.24
	SD	5.80	3.41	0.00	6.39	7.11	7.30	0.19	0.03	0.04	0.03	0.64	0.03
Blank	Mean	2.62	7.39	0.00	1.64	3.42	1.07	0.07	0.28	0.01	0.01	0.62	0.02
	SD	11.56	35.64	0.00	6.82	15.34	3.98	0.30	0.55	0.05	0.06	2.64	0.05

Appendix 4.60: IRMS data quality

Sample		$\delta^{13}C$	$\delta^{15}N$
OEA Labs Alanine (CRM)	Mean	-19.09	-4.00
	SD	0.06	0.27

Chapter 5 Appendix

Appendix 5.1: Loss on ignition sample weights

Sample	Crucible (g)	Crucible and sample (g)	Crucible and sample after oven (g)	Crucible and sample after furnace (g)
KC10NA1	6.0063	8.0286	7.2382	6.9804
KC10NA2	5.7166	7.7796	6.5825	6.1360
KC10NA3	5.5986	7.6600	6.8884	6.6412
KC10NA4	5.8475	7.9488	7.2418	7.0297
KC10NA5	5.9313	8.0564	7.2091	6.9807
KC10NB1	5.8187	7.8439	6.9845	6.6846
KC10NB2	5.7927	7.8768	6.9305	6.5786
KC10NB3	5.5413	7.6739	6.8792	6.6221
KC10NB4	5.8887	7.9318	7.2269	6.9591
KC10NB5	5.6071	7.8088	7.0141	6.6570
KC10NC1	5.9095	7.9311	7.1457	6.9018
KC10NC2	6.0033	8.1669	7.2274	6.9421
KC10NC3	5.6428	7.8322	6.8694	6.6205
KC10NC4	5.5049	7.6630	7.0630	6.8728
KC10NC5	5.4568	7.5690	6.6988	6.4349
KC10NAB	5.3909	7.4484	6.4634	6.1766
KC10NAC	5.6075	7.7955	6.7171	6.4399
KC10NBC	5.2098	7.2562	6.4537	6.1523
KC10NABC	5.4595	7.4961	6.5404	6.2219
KC10NA1	5.5029	7.5083	6.7409	6.4860
KC10NA2	5.9827	8.0119	7.0023	6.6606
KC10NA3	5.9806	8.0660	7.2320	6.9769
KC10NA4	5.7335	7.7815	6.9968	6.7638
KC10NA5	5.8085	7.9773	7.1646	6.9425
KC10NB1	5.4727	7.4846	6.6603	6.3790

KC10NB2	5.7961	7.8460	6.8988	6.5297
KC10NB3	5.6271	7.7840	7.2115	7.0061
KC10NB4	5.4843	7.5332	6.8643	6.5878
KC10NB5	5.9852	8.0892	7.2361	6.8511
KC10NC1	6.1317	8.1347	7.3753	7.1553
KC10NC2	5.7283	7.9021	7.0054	6.7084
KC10NC3	6.1471	8.3557	7.4550	7.2023
KC10NC4	5.9320	8.0185	7.2922	7.0456
KC10NC5	5.4498	7.5045	6.6531	6.3956
KC10NAB	5.7701	7.8837	6.9312	6.6371
KC10NAC	5.6367	7.7496	6.7589	6.4937
KC10NBC	5.6371	7.7144	6.9475	6.6679
KC10NABC	5.7396	7.9791	6.8751	6.5765
KC10NA1	5.3121	7.3717	6.7177	6.4998
KC10NA2	5.9784	7.9830	6.9093	6.5790
KC10NA3	5.1531	7.3011	6.4803	6.2159
KC10NA4	5.6588	7.7259	7.0495	6.8403
KC10NA5	5.9609	7.9813	7.2278	7.0251
KC10NB1	5.7726	7.8194	7.0726	6.8028
KC10NB2	5.9164	7.9286	7.0251	6.6830
KC10NB3	5.8007	7.7813	7.0118	6.7679
KC10NB4	5.4975	7.8221	7.0951	6.7854
KC10NB5	5.6522	7.7576	6.7945	6.3420
KC10NC1	5.8362	7.8625	7.0628	6.8229
KC10NC2	5.5739	7.7382	6.9747	6.7519
KC10NC3	5.7225	7.7927	6.9683	6.7378
KC10NC4	6.1490	8.3385	7.5297	7.2641
KC10NC5	5.9530	8.0911	7.1624	6.8829
KC10NAB	5.7840	7.9555	6.7897	6.4295
KC10NAC	5.9753	8.2379	7.0639	6.7480

KC10NBC	5.5896	7.8806	7.0984	6.8275
KC10NABC	4.8203	6.8505	5.9792	5.6678
KC01NA1	5.4956	7.5810	7.0105	6.8685
KC01NA2	5.6468	7.6834	7.0589	6.9175
KC01NA3	5.7322	7.8036	6.9210	6.7098
KC01NA4	5.5948	7.6677	6.7209	6.5473
KC01NA5	5.2213	7.3420	6.2182	5.9630
KC01NB1	5.8613	7.9889	6.7966	6.5431
KC01NB2	5.7516	7.8978	7.2634	7.0497
KC01NB3	6.0798	8.1145	7.0053	6.7324
KC01NB4	6.0980	8.1587	7.2944	6.9964
KC01NB5	5.8785	8.0758	7.1510	6.8984
KC01NC1	5.5088	7.5814	6.6369	6.4258
KC01NC2	4.8195	6.8775	6.1290	5.9349
KC01NC3	5.7892	7.8407	7.0003	6.8175
KC01NC4	5.6567	7.8237	6.8602	6.6417
KC01NC5	5.7899	7.9646	7.0272	6.8229
KC01NAB	6.3226	8.7444	7.6881	7.4544
KC01NAC	5.9736	8.1699	7.1766	6.9536
KC01NBC	6.2339	8.2797	7.1384	6.9011
KC01NABC	6.3004	8.5874	7.7041	7.5017
KC01NA1	6.3348	8.3770	7.5895	7.3795
KC01NA2	6.0405	8.0626	7.0849	6.8681
KC01NA3	5.3597	7.3801	6.5531	6.3530
KC01NA4	5.3327	7.3548	6.4918	6.3239
KC01NA5	5.5529	7.5947	6.5149	6.3402
KC01NB1	5.8164	7.8348	6.7097	6.4732
KC01NB2	6.4364	8.7726	8.0402	7.7899
KC01NB3	5.6188	7.7283	6.5720	6.2946
KC01NB4	6.3094	8.4127	7.5188	7.2453

KC01NB5	5.2564	7.3476	6.4623	6.2312
KC01NC1	5.6516	7.8153	6.8884	6.6847
KC01NC2	5.9846	8.1071	7.3493	7.1527
KC01NC3	5.8302	7.8355	7.0483	6.8658
KC01NC4	5.9108	8.0765	7.1432	6.9203
KC01NC5	5.7075	7.8660	6.9546	6.7571
KC01NAB	6.6042	8.8834	7.8476	7.6185
KC01NAC	5.7332	7.7968	6.9243	6.7199
KC01NBC	5.6350	7.9846	6.6530	6.3744
KC01NABC	6.1548	8.4209	7.3795	7.1748
KC01NA1	5.9768	7.9947	7.1137	6.8548
KC01NA2	5.8993	7.9071	7.0786	6.8871
KC01NA3	6.0475	8.0774	7.1089	6.8739
KC01NA4	5.3904	7.4501	6.6655	6.5155
KC01NA5	5.6733	7.8996	6.9554	6.7262
KC01NB1	5.8826	7.9112	6.8682	6.6366
KC01NB2	6.4775	8.7316	7.6802	7.4000
KC01NB3	5.7295	7.7528	6.6323	6.3519
KC01NB4	5.4254	7.5599	6.7019	6.4075
KC01NB5	5.7727	7.9354	6.9469	6.6830
KC01NC1	5.9796	8.0608	7.1923	6.9876
KC01NC2	5.3379	7.4572	6.7148	6.5207
KC01NC3	5.6065	7.7362	6.8681	6.6760
KC01NC4	5.7333	7.7939	6.9229	6.7309
KC01NC5	5.4668	7.5562	6.6638	6.4726
KC01NAB	5.7837	7.8263	6.7276	6.4828
KC01NAC	5.9177	7.9481	7.0616	6.8589
KC01NBC	5.5890	7.6014	6.5269	6.3105
KC01NABC	5.4614	7.8067	6.8331	6.6033
KC04NA1	5.7147	7.8817	7.3964	7.1578

KC04NA2	5.4963	7.6078	7.1452	6.9385
KC04NA3	5.8884	7.9934	7.4267	7.2332
KC04NA4	5.7968	7.8242	7.3241	7.0589
KC04NA5	5.7223	7.7566	7.0523	6.8271
KC04NB1	5.151	7.1813	6.6805	6.259
KC04NB2	5.3916	7.4131	6.7954	6.4767
KC04NB3	5.8185	7.8314	7.4296	7.1866
KC04NB4	5.7271	7.7736	7.2433	6.8829
KC04NB5	5.9833	7.9973	7.4622	7.0583
KC04NC1	5.9736	8.0953	7.4975	7.23
KC04NC2	5.8317	7.9389	7.3244	7.0751
KC04NC3	5.3613	7.3778	6.8094	6.5748
KC04NC4	5.6193	7.7492	7.0565	6.7373
KC04NC5	5.8802	7.9864	7.3671	7.108
KC04NAB	5.9312	7.95	7.52	7.274
KC04NAC	5.6281	7.7164	7.2685	7.0579
KC04NBC	5.594	7.6165	7.0439	6.7446
KC04NABC	5.7328	7.8671	7.3717	7.1116
KC04NA1	5.8004	8.0212	7.7411	7.6127
KC04NA2	5.9307	8.0768	7.6228	7.4057
KC04NA3	5.7213	7.8764	7.3478	7.1218
KC04NA4	6.1530	8.1959	7.6575	7.4131
KC04NA5	5.8490	8.0062	7.2572	7.0175
KC04NB1	6.0970	8.2774	7.7595	7.2785
KC04NB2	5.7035	7.7187	7.0948	6.7647
KC04NB3	5.2933	7.3180	6.8202	6.4385
KC04NB4	6.2339	8.2995	7.8068	7.3983
KC04NB5	5.5932	7.6072	7.0684	6.6739
KC04NC1	5.7634	7.7771	7.2295	6.9924
KC04NC2	5.6423	7.6677	7.0561	6.7893

KC04NC3	5.9527	8.0383	7.4614	7.2165
KC04NC4	6.1467	8.1703	7.4739	7.1562
KC04NC5	5.9788	7.9914	7.3930	7.1450
KC04NAB	6.0169	8.1061	7.6364	7.3802
KC04NAC	5.5053	7.6840	7.1835	6.9318
KC04NBC	5.7698	8.2133	7.6048	7.2518
KC04NABC	6.3237	8.3385	7.8781	7.6389
KC04NA1	5.6256	7.6685	7.1656	6.9167
KC04NA2	5.9647	8.2046	7.7253	7.5077
KC04NA3	5.9792	8.0676	7.5636	7.3549
KC04NA4	5.7164	7.7711	7.3341	7.1190
KC04NA5	5.4604	7.8301	6.9876	6.7235
KC04NB1	5.8001	7.8366	7.3392	6.9090
KC04NB2	6.0027	8.0170	7.4326	7.1245
KC04NB3	6.0483	8.0531	7.5598	7.1586
KC04NB4	5.9003	7.9413	7.4679	6.9629
KC04NB5	5.9159	8.0207	7.4580	7.0390
KC04NC1	5.5829	7.7025	7.1311	6.8751
KC04NC2	5.6366	7.7530	7.1846	6.9170
KC04NC3	5.4717	7.5124	6.9506	6.7109
KC04NC4	5.7835	7.8136	7.2233	6.9824
KC04NC5	5.7083	7.9939	7.3176	7.0459
KC04NAB	5.3386	7.3389	6.9010	6.6568
KC04NAC	5.5956	7.6533	7.1257	6.8963
KC04NBC	5.6524	7.7146	7.1725	6.8929
KC04NABC	5.5761	7.5850	7.1059	6.8001
KC07NA1	5.2949	7.3429	6.9115	6.8633
KC07NA2	5.4582	7.4834	7.0794	6.9264
KC07NA3	5.9849	8.2763	7.6519	7.5122
KC07NA4	5.8814	8.1140	7.4987	7.2974

KC07NA5	5.4749	7.5302	7.1153	6.9443
KC07NB1	5.6016	7.6749	7.1509	6.8429
KC07NB2	6.2913	7.4948	7.2502	7.0920
KC07NB3	5.6084	7.7391	7.1947	6.8765
KC07NB4	5.3621	7.3980	6.7649	6.4523
KC07NB5	5.5767	7.6112	7.1366	6.9123
KC07NC1	6.4386	7.7583	7.4352	7.3003
KC07NC2	6.0451	8.1557	7.5779	7.3671
KC07NC3	5.6352	7.8098	7.1031	6.8214
KC07NC4	5.5136	7.5236	7.0466	6.8537
KC07NC5	5.7110	7.7416	7.2136	7.0266
KC07NAB	5.7997	7.8619	7.3728	7.1316
KC07NAC	5.7851	7.7965	7.3597	7.1878
KC07NBC	5.9826	8.5063	7.8750	7.5576
KC07NABC	5.6257	7.6340	7.1548	6.9123
KC07NA1	5.7848	7.8099	7.3667	7.2281
KC07NA2	5.5962	7.8037	7.4920	7.0793
KC07NA3	5.4974	7.5015	6.8863	6.7493
KC07NA4	5.7337	7.7439	7.0683	6.8445
KC07NA5	5.6312	7.7218	7.2588	7.0509
KC07NB1	5.8632	7.8710	7.3295	7.0211
KC07NB2	5.7897	7.8380	7.3997	7.1177
KC07NB3	6.2933	8.4335	7.8191	7.4145
KC07NB4	5.9731	8.0374	7.3873	7.0499
KC07NB5	5.6041	7.6102	7.1150	6.8670
KC07NC1	6.0180	8.0229	7.5581	7.3486
KC07NC2	5.4644	7.6958	7.0921	6.8407
KC07NC3	5.5305	7.7506	7.0958	6.8203
KC07NC4	5.8513	7.9040	7.3706	7.1557
KC07NC5	5.8319	8.0796	7.4641	7.2327

KC07NAB	5.9090	7.9921	7.4859	7.2359
KC07NAC	5.8102	7.8394	7.3657	7.1582
KC07NBC	5.5956	7.6681	7.1668	6.9038
KC07NABC	5.4635	7.6615	7.1224	6.8456
KC07NA1	5.7051	7.7168	7.2986	7.1693
KC07NA2	6.1472	8.1813	7.6656	7.4627
KC07NA3	5.5185	7.5583	6.9374	6.7935
KC07NA4	5.7370	7.7863	7.1646	6.9604
KC07NA5	5.6570	7.7010	7.3047	7.1355
KC07NB1	5.2444	7.2694	6.7037	6.3851
KC07NB2	5.8859	7.8908	7.4563	7.1609
KC07NB3	5.5944	7.8216	7.2450	6.8154
KC07NB4	5.9466	8.1197	7.4376	7.0965
KC07NB5	5.2584	7.3429	6.8462	6.5858
KC07NC1	5.8190	7.9973	7.4513	7.1854
KC07NC2	5.6012	7.7406	7.1456	6.9043
KC07NC3	5.6080	7.7350	7.0716	6.4959
KC07NC4	5.9743	8.0488	7.5042	7.2688
KC07NC5	5.7645	7.9250	7.3267	7.0814
KC07NAB	5.8361	7.8386	7.3729	7.1717
KC07NAC	6.3118	8.3743	7.9144	7.7232
KC07NBC	6.0504	8.0512	7.5354	7.2672
KC07NABC	5.7687	8.0456	7.5178	7.2588
KC10LA1	5.4674	7.5878	6.3664	5.9666
KC10LA2	5.7083	7.7528	6.5160	6.0756
KC10LA3	5.7904	7.8199	6.6403	6.1908
KC10LA4	6.2346	8.3136	7.1604	6.7758
KC10LA5	5.7734	7.9662	6.5742	6.1353
KC10LB1	5.2580	7.5190	6.7524	6.5381
KC10LB2	5.8787	7.9557	7.5060	7.3382

KC10LB3	6.3021	8.3548	7.6697	7.4643
KC10LB4	5.7839	7.9866	6.7828	6.4831
KC10LB5	6.6049	8.8373	7.8006	7.5120
KC10LC1	5.4623	7.6575	6.7632	6.5021
KC10LC2	5.4622	7.5693	6.4131	6.1905
KC10LC3	6.0483	8.0921	7.3120	7.0313
KC10LC4	5.3601	7.5313	6.5996	6.3211
KC10LC5	5.7327	7.7571	6.7723	6.5355
KC10LAB	5.5830	7.6169	6.7933	6.5937
KC10LAC	5.6256	7.7144	6.6856	6.3666
KC10LBC	6.1555	8.2491	7.1219	6.7743
KC10LABC	6.3231	8.3999	7.5315	7.2520
KC10LA1	6.0653	8.2527	6.9714	6.5497
KC10LA2	6.4371	8.5679	7.2638	6.7806
KC10LA3	5.7522	8.0001	6.6278	6.1986
KC10LA4	5.9187	8.1010	6.8964	6.4790
KC10LA5	5.7343	7.7959	6.4904	6.0754
KC10LB1	5.9110	7.9659	7.3586	7.1672
KC10LB2	5.6588	7.8196	7.3328	7.1424
KC10LB3	5.4365	7.5009	6.9005	6.7213
KC10LB4	6.0424	8.0586	7.0097	6.7224
KC10LB5	5.8998	7.9523	7.0816	6.8170
KC10LC1	5.5429	7.7336	6.7922	6.5135
KC10LC2	5.3389	7.4662	6.2862	6.0581
KC10LC3	5.2923	7.3473	6.5231	6.2430
KC10LC4	5.6741	7.8853	6.7716	6.4905
KC10LC5	5.5553	7.6711	6.6573	6.4252
KC10LAB	5.2229	7.4839	6.6940	6.4901
KC10LAC	5.7297	7.9007	6.7182	6.3662
KC10LBC	5.6200	7.7808	6.8965	6.6197

KC10LABC	6.0802	8.0978	7.2734	7.0086
KC10LA1	6.0986	8.1310	6.9492	6.5502
KC10LA2	5.4259	7.5701	6.2960	5.8401
KC10LA3	6.3106	8.4166	7.2437	6.8636
KC10LA4	5.7651	7.7715	6.6341	6.2742
KC10LA5	5.5308	7.5844	6.2695	5.8533
KC10LB1	5.8831	7.9108	7.2080	7.0041
KC10LB2	5.8173	7.8876	7.3509	7.1650
KC10LB3	5.8625	7.9849	7.2714	7.0561
KC10LB4	6.4784	8.5680	7.5251	7.2310
KC10LB5	5.6471	7.6575	6.8336	6.5731
KC10LC1	5.5098	7.6554	6.7269	6.4658
KC10LC2	5.4966	7.6385	6.5211	6.2998
KC10LC3	5.9776	8.1493	7.1450	6.8477
KC10LC4	6.3354	8.5838	7.4504	7.1688
KC10LC5	5.3344	7.5914	6.6390	6.3727
KC10LAB	5.5958	7.6986	6.9211	6.7137
KC10LAC	5.8308	7.9568	6.8400	6.4743
KC10LBC	5.7899	7.9711	7.0207	6.7182
KC10LABC	5.3681	7.7089	6.6914	6.3694
KC01LA1	5.5732	7.7050	6.2574	5.7916
KC01LA2	5.9309	8.0505	6.9269	6.5429
KC01LA3	6.0643	8.1540	7.0077	6.6639
KC01LA4	5.9522	8.0287	6.7221	6.3339
KC01LA5	6.1472	8.2427	7.0085	6.6363
KC01LB1	5.4615	7.6649	6.4004	6.2021
KC01LB2	5.7357	7.8730	7.1279	6.8928
KC01LB3	5.6058	7.6355	6.7111	6.4340
KC01LB4	5.5642	7.6612	6.7908	6.5423
KC01LB5	5.7718	7.9380	6.8447	6.5747

KC01LC1	5.4961	7.5784	6.5845	6.2921
KC01LC2	6.2942	8.4244	7.4951	7.2477
KC01LC3	5.3602	7.3766	6.5064	6.2842
KC01LC4	5.7213	7.7541	6.6598	6.3920
KC01LC5	5.5287	7.6567	6.7628	6.4954
KC01LAB	5.9315	7.9572	6.6600	6.3603
KC01LAC	5.5975	7.6292	6.5672	6.2346
KC01LBC	5.7158	7.8935	6.7649	6.5198
KC01LABC	5.7502	7.8104	6.7541	6.4647
KC01LA1	5.8346	7.9216	6.5100	6.0825
KC01LA2	5.7276	7.8699	6.8553	6.5062
KC01LA3	5.4361	7.4946	6.2885	5.9254
KC01LA4	5.5809	7.6813	7.3224	6.9202
KC01LA5	5.7833	7.8340	6.6426	6.2849
KC01LB1	5.9149	8.0124	6.7414	6.5472
KC01LB2	5.4482	7.5577	6.9314	6.7020
KC01LB3	5.2088	7.2965	6.4409	6.1546
KC01LB4	5.7957	7.9639	7.2209	6.9836
KC01LB5	5.4722	7.5472	6.4494	6.1793
KC01LC1	5.7988	7.8765	7.0200	6.7514
KC01LC2	5.6000	7.6348	6.6864	6.4571
KC01LC3	5.5112	7.5946	6.6130	6.3784
KC01LC4	5.5408	7.6126	6.5775	6.3148
KC01LC5	5.9606	8.0559	7.2618	6.9981
KC01LAB	5.7260	7.7567	6.4405	6.1505
KC01LAC	5.9782	8.0989	6.9330	6.5572
KC01LBC	5.7634	7.9274	6.7324	6.4642
KC01LABC	5.7034	7.8046	6.5563	6.2702
KC01LA1	5.7982	7.8828	6.5298	6.0814
KC01LA2	5.2916	7.3556	6.3378	5.9816

KC01LA3	6.1485	8.3005	7.0375	6.6579
KC01LA4	5.4835	7.5468	6.2231	5.8004
KC01LA5	5.4589	7.6328	6.3706	6.0003
KC01LB1	5.6582	7.6900	6.7998	6.6584
KC01LB2	5.6252	7.7169	7.1174	6.8921
KC01LB3	5.3672	7.3791	6.5264	6.2492
KC01LB4	4.7445	6.8453	6.1226	5.9087
KC01LB5	5.8176	7.8437	6.7520	6.4926
KC01LC1	5.6260	7.6733	6.6789	6.3991
KC01LC2	5.5547	7.6800	6.6447	6.4005
KC01LC3	5.7147	7.7164	6.8472	6.6076
KC01LC4	5.7919	7.8347	6.7860	6.5256
KC01LC5	5.7654	7.8660	7.0256	6.7598
KC01LAB	5.8514	7.8789	6.5946	6.3112
KC01LAC	5.7697	7.8577	6.8259	6.4774
KC01LBC	5.8066	7.8999	6.6970	5.7513
KC01LABC	5.1509	7.1823	6.8372	6.5932
KC04LA1	6.1477	8.1558	7.2420	6.9453
KC04LA2	5.4362	7.4560	6.5634	6.2097
KC04LA3	5.7840	7.7932	6.9719	6.6844
KC04LA4	5.7277	7.7580	6.9376	6.5732
KC04LA5	5.5733	7.5846	6.6837	6.3249
KC04LB1	5.9091	7.9625	7.6528	7.2910
KC04LB2	5.7891	7.8129	7.6790	7.4032
KC04LB3	5.7305	7.7676	6.8967	6.5633
KC04lB4	6.3117	8.3276	7.9273	7.5515
KC04LB5	5.6598	7.7441	7.0328	6.7585
KC04LC1	5.9616	7.9765	7.6680	7.2347
KC04LC2	5.8353	7.9342	7.4749	7.1534
KC04LC3	5.7658	7.9156	7.5320	7.2156

KC04LC4	6.0830	8.1316	7.8180	7.4779
KC04LC5	6.4359	8.6903	8.2014	7.8979
KC04LAB	6.2928	8.3193	7.7399	7.3996
KC04LAC	5.6031	7.6217	7.0876	6.7807
KC04LBC	5.8848	7.8945	7.6785	7.4241
KC04LABC	5.2576	7.4828	6.9944	6.6673
KC04LA1	4.9983	7.0680	6.0353	5.6814
KC04LA2	5.3666	7.3905	6.3925	5.9927
KC04LA3	5.4256	7.5113	6.6771	6.3127
KC04LA4	5.9171	7.9235	6.9655	6.5319
KC04LA5	5.5990	7.6038	6.7401	6.4148
KC04LB1	5.9443	7.9987	7.6481	7.1882
KC04LB2	5.4734	7.4991	7.3283	7.0585
KC04LB3	4.7457	6.7863	5.9323	5.6149
KC04lB4	5.7338	7.7629	7.4105	7.0325
KC04LB5	6.0430	8.0519	7.3427	7.0637
KC04LC1	5.6764	7.9069	7.5963	7.1812
KC04LC2	5.9575	7.9577	7.4956	7.1289
KC04LC3	5.9180	7.9200	7.5348	7.2218
KC04LC4	6.3355	8.3437	8.0525	7.7080
KC04LC5	5.6609	7.9047	7.4217	7.1352
KC04LAB	5.5412	7.6192	7.0515	6.7387
KC04LAC	5.4747	7.4794	6.9344	6.5987
KC04LBC	5.6362	7.7145	7.4666	6.9767
KC04LABC	5.7516	7.8272	7.3158	6.9817
KC04LA1	5.9113	8.0540	7.2614	7.0159
KC04LA2	5.6084	7.7464	6.6614	6.2505
KC04LA3	5.2128	7.2611	6.5349	6.2816
KC04LA4	5.3126	7.3150	6.3080	5.8692
KC04LA5	5.4968	7.5229	6.7727	6.4826

KC04LB1	5.7375	7.7511	7.4020	7.0319
KC04LB2	5.7520	7.7785	7.6255	7.3586
KC04LB3	6.0646	8.0904	7.2642	6.9492
KC04lB4	5.5298	7.5581	7.2544	7.0009
KC04LB5	5.8172	7.8704	7.1689	6.8936
KC04LC1	5.8110	7.8124	7.5567	7.2067
KC04LC2	5.2240	7.4306	7.0005	6.6831
KC04LC3	5.4632	7.5191	7.1922	6.8688
KC04LC4	5.7927	7.9236	7.5502	7.2191
KC04LC5	5.5904	7.6516	7.2396	6.9604
KC04LAB	5.6331	7.7034	7.0279	6.6567
KC04LAC	5.3396	7.3747	6.8837	6.5730
KC04LBC	4.8199	6.8590	6.6508	6.3666
KC04LABC	5.7741	7.9215	7.3921	7.0959
KC07LA1	9.9601	12.0076	11.3985	10.8015
KC07LA2	6.2909	8.2981	7.5893	6.7651
KC07LA3	6.747	8.7635	7.9943	7.2433
KC07LA4	6.7033	8.7379	8.106	7.4689
KC07LA5	7.4991	9.5705	8.9625	8.3592
KC07LB1	5.9595	8.1511	7.7435	7.4036
KC07LB2	5.2581	7.3615	7.1348	6.7559
KC07LB3	5.5942	7.636	7.1601	6.8408
KC07LB4	5.3621	7.6605	7.5257	7.4213
KC07LB5	5.5134	7.5391	7.0602	6.5788
KC07LC1	5.6025	7.6836	7.3989	7.1201
KC07LC2	5.6003	7.6026	7.299	6.8637
KC07LC3	5.6084	7.9081	7.7164	7.4538
KC07LC4	5.5302	7.5313	7.2963	7.0284
KC07LC5	6.4349	8.4366	7.9261	7.5122
KC07LAB	6.5677	8.6278	8.1824	7.7922

KC07LAC	5.8569	7.9738	7.4772	7.0234
KC07LBC	5.9747	7.9879	7.7045	7.41
KC07LABC	6.0179	8.0969	7.723	7.3176
KC07LA1	9.2749	11.2797	10.7515	10.3227
KC07LA2	5.8813	7.9849	7.2683	6.418
KC07LA3	6.6987	8.7574	7.8699	7.0115
KC07LA4	6.8851	8.9327	8.3629	7.7474
KC07LA5	6.8738	8.8926	8.2778	7.6615
KC07LB1	5.6312	7.6947	7.2677	6.9068
KC07LB2	5.475	7.7286	7.4819	7.1837
KC07LB3	5.8189	7.8984	7.3668	7.0067
KC07LB4	5.7373	7.7757	7.5939	7.4098
KC07LB5	5.5959	7.7122	7.3552	6.9921
KC07LC1	5.5767	7.6426	7.3607	7.1067
KC07LC2	5.9852	8.0092	7.7346	7.3335
KC07LC3	5.4974	7.6216	7.4227	7.1088
KC07LC4	5.2424	7.3051	7.0856	6.7851
KC07LC5	5.8693	7.9444	7.5477	7.2321
KC07LAB	7.0915	9.1301	8.5615	8.0937
KC07LAC	5.6026	7.7381	7.2883	6.8423
KC07LBC	5.6566	7.6814	7.2732	6.8968
KC07LABC	5.7338	7.7606	7.2617	6.773
KC07LA1	7.6041	9.6081	9.0689	8.5269
KC07LA2	6.9216	8.9231	8.2563	7.4602
KC07LA3	9.5015	11.5243	10.845	10.2422
KC07LA4	7.8905	9.8972	9.1655	8.4326
KC07LA5	9.7503	11.8186	11.1891	10.7135
KC07LB1	5.7848	7.7944	7.3409	7.0019
KC07LB2	5.2948	7.3525	7.0907	6.7571
KC07LB3	5.705	7.7154	7.2665	6.94

KC07LB4	5.4583	7.5544	7.4153	7.2883
KC07LB5	5.6038	7.6732	7.3441	7.001
KC07LC1	5.4638	7.4725	7.2097	6.9639
KC07LC2	6.147	8.1568	7.9015	7.5001
KC07LC3	5.5179	7.5908	7.3742	7.0866
KC07LC4	5.7895	7.9429	7.7162	7.4591
KC07LC5	5.8856	7.9418	7.6266	7.3094
KC07LAB	6.9518	9.2649	8.8812	8.5385
KC07LAC	5.9734	8.0198	7.5671	7.1297
KC07LBC	5.9461	7.974	7.7016	7.3809
KC07LABC	6.2933	8.3591	7.9363	7.5561

Appendix 5.2: Sample weight for XRF analysis

Sample	**Nottingham**				**London**			
	OCT (g)	JAN (g)	APR (g)	JUL (g)	OCT (g)	JAN (g)	APR (g)	JUL (g)
A1	4.0203	4.0118	4.0002	4.0004	4.0191	4.0049	4.0043	4.0006
A2	4.0266	4.0040	4.0009	4.0001	4.0024	4.0141	4.0014	4.0268
A3	4.0070	4.0054	4.0037	4.0000	4.0061	4.0067	4.0089	4.0007
A4	4.0182	4.0069	4.0016	4.0003	4.0177	4.0203	4.0129	4.0074
A5	4.0042	4.0113	4.0023	4.0003	4.0130	4.0041	4.0052	4.0058
B1	4.0094	4.0041	4.0061	4.0001	4.0100	4.0133	4.0030	4.0010
B2	4.0059	4.0054	4.0063	4.0004	4.0057	4.0282	4.0054	4.0004
B3	4.0171	4.0075	4.0010	4.0002	4.0118	4.0094	4.0044	4.0015
B4	4.0068	4.0006	4.0006	4.0003	4.0073	4.0139	4.0011	4.0004
B5	4.0190	4.0098	4.0012	4.0000	4.0010	4.0041	4.0063	4.0014
C1	4.0154	4.0053	4.0007	4.0000	4.0111	4.0044	4.0019	4.0018
C2	4.0107	4.0018	4.0009	4.0002	4.0025	4.0025	4.0065	4.0000
C3	4.0159	4.0149	4.0011	4.0004	4.0059	4.0159	4.0036	4.0019

C4	4.0042	4.0132	4.0000	4.0000	4.0063	4.0034	4.0075	4.0002
C5	4.0089	4.0073	4.0004	4.0003	4.0012	4.0126	4.0066	4.0003
AB	4.0054	4.0705	4.0003	4.0001	4.010	4.0049	4.0129	4.0006
AC	4.0152	4.0470	4.0001	4.0003	4.0127	4.0030	4.0017	4.0016
BC	4.0080	4.0069	4.0005	4.0002	4.0106	4.0063	4.0080	4.0011
ABC	4.0183	4.0406	4.0001	4.0001	4.0151	4.0153	4.0006	4.0013
REF	2.0253	2.0253	2.1800	2.1800	2.0253	2.0253	2.1800	2.1800

Appendix 5.3: Sample weights for ICP-MS and ICP-AES Digests

Sample	Nottingham				London			
	OCT (g)	JAN (g)	APR (g)	JUL (g)	OCT (g)	JAN (g)	APR (g)	JUL (g)
A1	0.1000	0.1003	0.1000	0.1001	0.1002	0.1000	0.1000	0.1001
A2	0.1001	0.1000	0.1000	0.1001	0.1001	0.1001	0.1000	0.1001
A3	0.1001	0.1002	0.0999	0.1000	0.1002	0.1001	0.0999	0.0999
A4	0.1000	0.1000	0.1000	0.1000	0.1003	0.1001	0.1001	0.1001
A5	0.1002	0.1000	0.1000	0.1001	0.1001	0.1000	0.1001	0.1001
B1	0.1000	0.1001	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
B2	0.1003	0.1000	0.1000	0.1001	0.1001	0.1000	0.1000	0.1001
B3	0.1002	0.1001	0.0999	0.0999	0.1002	0.1000	0.1001	0.1000
B4	0.1002	0.1000	0.1000	0.1000	0.1000	0.1000	0.0999	0.1000
B5	0.1002	0.1001	0.1000	0.1001	0.1001	0.1000	0.1001	0.1000
C1	0.0999	0.1001	0.1000	0.1000	0.1000	0.1001	0.0999	0.1001
C2	0.0999	0.1000	0.0999	0.1000	0.1002	0.1001	0.0999	0.0999
C3	0.1002	0.1000	0.1000	0.1001	0.1003	0.1001	0.0999	0.1001
C4	0.1000	0.1000	0.0999	0.1000	0.1000	0.1000	0.1000	0.1000
C5	0.1000	0.1000	0.1000	0.0999	0.1003	0.1000	0.0999	0.1000
AB	0.1000	0.1001	0.1001	0.1000	0.1002	0.1000	0.1000	0.1000
AC	0.1001	0.1000	0.1000	0.1001	0.1003	0.1000	0.1000	0.1001
BC	0.0999	0.1000	0.1000	0.1001	0.1001	0.1000	0.0999	0.1001
ABC	0.1002	0.1000	0.1001	0.1001	0.1002	0.1000	0.1000	0.1001
REF1A	0.1002	0.1000	0.0999	0.1000	0.1002	0.1000	0.0999	0.1000
REF1B	0.1002	0.1000	0.1000	0.1001	0.1002	0.1000	0.1000	0.1001
REF1C	0.1002	0.1000	0.1001	0.1000	0.1002	0.1000	0.1001	0.1000
REF2A	0.1002	0.1001	0.1000	0.1000	0.1002	0.1001	0.1000	0.1000
REF2B	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
REF2C	0.1001	0.1000	0.1000	0.1001	0.1001	0.1000	0.1000	0.1001

Appendix 5.4: XRF Raw Data for Nottingham Samples

Element	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Rb	Sr
Dimension	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
BR-S 2g/a	270	13330	68270	258900	1064	3644	68.9	23500	27340	4472	99	143.9	550	41530	28	39.5	88.2	386.1	13.8	1.5	14.5	0.7	5.4	96.9	125.4
BR-S 2g/a	290	12800	69350	260400	1090	3573	82.7	23350	27510	4509	92	112.8	558	41560	21.3	41.8	84.9	379.7	14	1.2	12.6	0.9	5.3	98.5	124.5
BR-S 2g/a	270	13090	69080	263800	1123	3608	88	23260	27960	4540	94	117.4	569	41430	33.7	42.8	87.9	385.3	14.6	0.6	13.1	1.2	4.8	96.5	124.3
KC10NA1	290	13760	51480	211800	1207	1449	64.5	29520	12630	3991	67	96.3	583	30400	9.6	35.5	30.3	109	13.7	2	7.3	0.5	12	93.9	93.6
KC10NA1	290	15410	55800	226000	1259	1555	59.2	29730	12750	4038	78	101.5	588	30400	13.1	34.5	33.8	109.6	14	1.9	6.2	0.4	12.6	95.3	93.3
KC10NA1	270	15980	56150	227900	1304	1557	58.9	29690	12870	4052	95	93.6	605	30720	27.8	35	32.8	111.8	14.9	2.5	6.9	0.6	11.8	95.2	93.5
KC10NA2	270	14120	51610	215000	1266	1736	108.4	28810	12380	3908	66	63.3	561	28520	11.8	31.2	30.6	96.1	12.3	2	6.9	0.5	11.4	89.1	87.7
KC10NA2	270	14640	53350	220700	1279	1817	99.5	28840	12470	3835	56	65.3	562	28410	13.9	32.3	30.3	94	12.3	1.5	6.7	0.2	11.6	89.3	88.2
KC10NA2	250	14810	53510	220500	1299	1832	99.3	28560	12430	3868	68	52.8	566	28400	26.4	28	28.1	97.5	12.9	1.1	5.5	0.5	11.6	88.7	87.4
KC10NA3	260	15280	56690	230400	1261	1438	20.2	30520	13700	4247	65	86.2	645	29940	9.1	33.5	31	106.9	14.4	1.7	6.6	0.4	12.3	96.9	92
KC10NA3	270	15400	57670	234200	1316	1483	21.2	30770	13730	4228	75	90.3	649	30080	13.5	35.4	32.5	109.8	12.9	2	7.9	0.4	12	96.3	92.1
KC10NA3	260	15740	57370	235000	1327	1501	18	30600	13830	4245	87	94.1	645	30170	11.3	34.1	30.4	107.1	13.7	1.8	5.8	0.2	11.1	95.1	93.4
KC10NA4	280	15500	57980	239100	1136	1266	2	31990	17980	4367	89	87.4	815	30720	10	36.5	29.8	90.7	14.2	2.5	7.2	0.2	10.3	98.1	96.6
KC10NA4	270	16230	59300	244900	1169	1302	2	31770	18040	4303	107	70.9	849	30710	11.5	35.1	33.3	90.3	14.4	1.5	6.8	0.2	11.1	97.9	98
KC10NA4	250	15950	59130	245400	1198	1293	2	32040	17910	4392	80	83.7	840	30820	22.6	33.4	31.3	92.6	13.7	1.5	6.8	0.4	10.5	97.9	97.6
KC10NA5	3380	16200	54640	223900	1185	1397	36.1	30470	20180	4098	94	85.8	653	29500	24.3	31.9	32.9	90.6	13.6	1.2	7	0.3	11.9	96.3	92.1
KC10NA5	260	15410	55440	227200	1153	1440	38	30410	20150	4183	99	87.5	669	29640	13.9	32.1	31.1	87.5	13.8	1.3	7.1	0.2	12.5	96.8	92.5
KC10NA5	260	15570	55820	229900	1173	1478	38.1	30630	20530	4251	87	75	666	29920	33.3	31.2	28.6	89.9	13.1	1.7	5.9	0.2	12	97.2	94.2
KC10NB1	200	13470	49220	212100	1538	2114	40.2	27320	12240	3807	78	92.1	539	27610	13.6	29.5	31.4	127.4	12.8	1.4	7	0.4	14	89.4	79.9
KC10NB1	240	12720	49280	215100	1588	2151	40.5	27420	12340	3803	78	83.4	549	27560	15.5	32.8	30.8	126.2	11.5	2.1	7.8	0.4	14.2	88.5	78.7
KC10NB1	270	12780	49610	215900	1587	2168	42.2	27600	12190	3801	70	94.8	543	27640	17.5	29.5	30.1	127.3	12.3	1.7	7.1	0.7	14	89.4	78.6
KC10NB2	260	12270	49530	211700	1427	2029	66.8	26910	10990	3779	83	88.1	645	27690	23.9	31.9	33.5	113	13.1	1.2	9.5	0.6	13.6	88.6	73.1
KC10NB2	200	13770	49570	217200	1431	2086	61.8	27540	11150	3810	86	86.7	631	27760	15.9	32.8	29.8	112	13.3	1.3	10	0.6	14	87.8	73.9
KC10NB2	250	12520	49620	218000	1477	2124	71.9	27390	11170	3791	70	82.9	635	27960	13.5	30.5	34	113	13.4	1.8	9.5	0.4	14.1	89.5	73.9

KC10NB3	250	13640	52760	220700	1614	2091	59.9	29510	11190	3880	83	87.1	615	28320	9.2	34.4	30.7	109.8	12.6	1.8	8.6	0.2	13.4	92.4	80.4
KC10NB3	270	13820	52750	223900	1641	2110	68.5	29540	11290	3929	82	91.5	629	28360	19.5	29.9	31	106.2	12	1.9	8	0.3	14	91.2	80.4
KC10NB3	260	14180	53130	224000	1663	2137	71.1	29480	11400	3881	81	82.9	619	28350	27.6	32	31.1	109.7	12.8	1.4	7.2	0.3	13.4	93	80.4
KC10NB4	270	11980	48350	211700	2421	2069	51.1	26950	16590	3744	78	88	580	27730	9.1	34.4	36.6	137.1	12.3	3	9	0.3	13.8	85.7	78.7
KC10NB4	190	13520	48990	214900	2398	2101	47.9	26670	16700	3734	79	78.2	562	27670	9.2	30.5	36.4	137.5	10.6	2	6.8	0.3	13.6	86.7	78.8
KC10NB4	260	12540	48930	215800	2420	2141	54.2	26720	16790	3735	70	87	590	27660	9.2	33.8	37	138.4	12.5	2.1	7.3	0.5	13.1	86.4	78.9
KC10NB5	270	12100	52730	231600	1252	1709	2	29100	8595	4108	86	77.9	543	28170	9.3	29.6	33.3	105.7	13.8	2	5.8	0.4	12.8	94.7	82.9
KC10NB5	260	12850	52860	233800	1319	1699	2	29230	8753	4150	64	79.7	533	28290	36.8	31.9	30.6	104	13.7	2.3	7.8	0.4	12.4	94.2	81.9
KC10NB5	2410	13710	52890	235400	1276	1721	2	29430	8629	4108	76	90.7	532	28440	15.2	32.7	29.8	101	13.3	0.8	8	0.7	11.5	95.2	82.9
KC10NC1	5740	17240	61300	238400	856	1467	2	31760	7978	4394	95	87.2	626	32890	32.7	33.2	33	86.2	15	1	6.1	0.2	11.9	105.5	80.5
KC10NC1	250	16160	61240	240000	839	1458	2	31660	7914	4368	94	76.5	640	32990	31.5	32.6	27.9	84.7	15	2.3	7.7	0.6	12.5	102.7	79.3
KC10NC1	270	16320	61180	239400	876	1450	2	32260	7994	4385	84	94.9	649	33110	13	34.9	31.5	87.2	15.4	1.2	7.9	0.2	12	104.9	80
KC10NC2	250	15290	59080	232900	904	1458	2	31230	6622	4202	65	79.5	581	31800	31.5	31.1	26.3	86.7	13.6	2.4	6.2	0.2	12.3	99.1	74.2
KC10NC2	270	15200	59570	235100	902	1499	0.8	31310	6552	4191	89	94.8	570	32020	10.5	33.1	31.6	87.7	14.6	1.7	8.6	0.4	12.2	101.5	75.2
KC10NC2	260	15420	59400	235800	929	1497	2	31480	6659	4275	86	96.9	583	32040	34.3	36.4	30.4	89.7	13.7	1.8	7.8	0.2	12.1	100	75.5
KC10NC3	260	15330	59740	232300	922	1503	2	31610	6521	4259	84	88.4	670	32380	10	32.5	32	88.2	14.9	2.3	7.2	0.2	12.6	101.4	77
KC10NC3	270	14800	59120	233100	917	1546	2	31570	6628	4216	82	69.8	660	32340	9.2	32.2	29.5	88	12.8	1.8	7.9	0.2	11.9	101.9	76.4
KC10NC3	260	15830	59720	234900	924	1533	2	31360	6644	4287	62	78	656	32380	11.8	32.4	29.6	91.9	13.4	1.8	7.2	0.3	11.7	102.8	76.8
KC10NC4	250	15490	60850	232200	857	1480	0.6	31700	6915	4220	80	80	632	32590	17.6	38.4	31.2	89.7	14.9	2.5	6.9	0.4	14.5	101.9	80.5
KC10NC4	270	15100	60770	234300	895	1513	2	31840	7006	4201	102	93.8	624	32830	15.4	33.6	29.9	89.7	14.2	2	6.3	0.4	14	105.2	80.1
KC10NC4	280	15280	60730	235400	859	1495	2	32190	7146	4262	92	92.3	629	32930	10	34.5	30.3	89	13.6	2.2	6.4	0.5	13.8	104.9	80.8
KC10NC5	250	15220	60360	233900	904	1566	2	31910	6413	4255	98	93.2	630	32580	9.8	33.8	33.6	87.4	13.3	2.1	8.5	0.2	12.6	102.8	72.4
KC10NC5	240	15800	59770	235000	929	1573	2	31880	6421	4298	85	80.8	645	32610	29.9	33.3	28.5	87.9	15.4	2.4	7.1	0.2	12.7	101.3	71.4
KC10NC5	260	14780	60440	236000	941	1560	2	31940	6529	4265	101	79	625	32750	24.8	36	27.8	87.8	14.7	2	8.4	0.5	12.8	103.2	72.8
KC10NAB	270	13100	51290	221900	1408	1935	25.2	28230	12010	3831	79	90.9	531	27990	19.7	32.9	28.7	117.5	13.1	1.5	7.4	0.4	13.1	90.5	82.5
KC10NAB	270	12980	51750	222600	1460	1928	17.7	28080	12040	3899	51.4	70.1	540	28080	24.2	33.9	32.5	116.5	11.9	1.1	6.1	0.3	12.5	90.5	82.7
KC10NAB	270	13470	52290	225500	1421	1951	26.6	28400	12110	4001	60	97.1	543	28090	20	31.4	32.9	117	13.3	1.9	8.2	0.4	13.5	89.8	82.3

KC10NAC	1980	17080	59970	231700	1029	1507	33.2	31420	9354	4156	81	91.3	631	31830	23.2	35.7	33.5	97.4	15.1	2.4	8.1	0.3	13.2	100.2	83.3
KC10NAC	250	15550	60130	233700	1044	1488	37.5	31630	9456	4189	96	89.8	638	31900	13.6	32.1	30.2	95.5	15.2	2.1	7.3	0.3	12.7	100	82.6
KC10NAC	270	15720	59760	235800	1041	1544	42.1	31780	9480	4222	101	92.6	656	32060	11.1	35	32	98	14.9	2	6.8	0.2	12.8	101.7	83.8
KC10NBC	240	14020	54760	222000	1272	1865	75.9	29710	9391	3986	76	84.2	606	29820	19.2	29.5	31.6	104.4	12.9	2.3	6.2	0.3	14.1	94.9	78.4
KC10NBC	250	14010	55440	223600	1312	1905	76.9	29680	9503	3957	73	118.5	618	29890	13.9	33.7	32.4	110.1	13.6	2.8	7.5	0.5	14.1	95.3	79
KC10NBC	260	14820	55390	225400	1352	1895	70.6	29660	9456	3931	90	98.5	610	29950	27.3	33.2	32.2	104.6	12.9	1.6	7	0.4	14	96.4	77.8
KC10NABC	260	13410	53120	214800	1458	2060	89.2	28500	11700	3853	82	74	646	29120	16.2	31	31.1	111	13.6	2.2	7.3	0.6	12.9	92.4	83.3
KC10NABC	270	12680	53010	217200	1558	2073	78.1	28420	11790	3930	65	103.3	655	29220	29.9	30.8	31.3	115.3	14.4	1.4	7	0.5	13.7	91.3	82.7
KC10NABC	270	14170	52560	218000	1545	2095	96.9	28940	11780	3883	68	94.2	648	29220	31.8	30.9	27.1	114.8	12.4	1.8	7.4	0.5	13.3	90.4	84.1
BR-S 2g/a	260	4470	20480	75160	272.5	1060	259.5	4825	5358	938.2	30.6	29.3	117.1	9049	9	28.8	18.7	75.8	4.1	0.2	1.7	1	1.2	21.3	28
BR-S 2g/a	270	10640	58530	225000	908	3106	73.2	20690	24340	4120	79	134.4	541	40190	11	43.5	86.8	381.4	14.8	1.6	14.6	1	5.4	95.8	122.8
BR-S 2g/a	290	10020	58800	228000	943	3183	77.5	20980	24880	4193	109	120.1	541	40920	20.3	41	87.3	388.3	15	1.4	14.9	1.1	6	100.8	128.7
KC01NA1	260	11940	46810	203300	1017	1278	2	26780	11190	3841	81	86.2	624	28620	12.8	33.7	35.2	107.4	13.8	2.3	5.9	0.7	13.3	97.9	91.7
KC01NA1	260	12100	48530	209700	1034	1361	2	27320	11240	3952	75	71.7	640	28850	13.9	33.5	29.9	104.5	14.9	2.6	6.1	0.8	13.5	97.7	91.7
KC01NA1	270	12050	48100	209700	1057	1378	2	27080	11160	3872	89	93.5	626	28950	16.1	31.7	29.6	104.1	14.8	1.6	4.8	0.2	13.2	97.9	92.8
KC01NA2	270	13550	53950	213400	890	1113	16.6	29150	13830	4094	68	97.3	712	31030	9.9	36.5	36.5	101.4	14.6	1.8	6.7	0.2	12	104.1	93.6
KC01NA2	3690	15310	55500	220400	918	1120	13.2	29410	13990	4260	71	83.3	747	31190	12.1	37.8	35.5	103.2	14.6	1.8	8.5	0.5	11.2	105.1	92.7
KC01NA2	820	14950	54780	216100	931	1103	0.3	29450	13760	4184	77	82.1	746	31160	22.6	39.2	37.2	99.5	15.8	2.5	7.7	0.4	11.5	105.1	93.3
KC01NA3	1820	13010	49330	210600	994	1341	2	27430	12280	4022	68	91.9	579	28440	15.9	35.1	31.6	99.7	15.4	1.2	7.5	0.2	10.5	98.2	88.5
KC01NA3	260	12510	48910	213800	1057	1348	2	27510	12250	4036	74	83.9	558	28650	20.8	35.3	32.7	98.1	13.9	1.3	5.2	0.2	10.5	99	89.5
KC01NA3	250	12850	48890	210300	1033	1324	1.1	27510	12490	3982	65	62.7	583	28610	24.6	31.1	33.1	102.4	12.7	1.4	6.5	0.4	11	99.3	89.2
KC01NA4	250	13280	50120	205800	938	1201	17.1	27140	17370	3946	72	83.5	594	27870	9.1	31.4	29.1	88.8	14.6	1.2	7.1	0.2	10.1	93.7	88.4
KC01NA4	270	13220	51780	218100	1010	1253	2	28620	18600	4155	66	74.3	675	29450	9.6	31.5	33	99.8	13.9	2	7.7	0.2	11.5	98.1	92.1
KC01NA4	270	13600	51650	215000	963	1221	0.6	28240	18280	4043	83	79.7	670	29600	15.4	34.4	30.1	97.7	12.7	1.3	7	0.4	11.1	99.4	92.4
KC01NA5	2030	12750	47880	199700	1039	1359	0.2	25380	8737	3616	71.6	77.2	541	27420	16.4	30.3	29.3	96.9	13.4	1.9	5.1	0.5	12.2	93.4	81.3
KC01NA5	270	12100	48730	209200	1071	1403	5.9	26610	9045	3831	64.7	102.9	582	28770	21.2	32.3	29.7	100.9	13	1.4	6.5	0.3	12.9	97.5	85.5
KC01NA5	3400	13300	49020	208100	1061	1385	11.5	26370	8948	3754	60.7	72.5	598	28680	11.4	33.6	30.5	100.3	13.4	1.2	6.9	0.6	12.2	97.5	84.5

KC01NB1	220	11320	42610	181300	1323	1737	53.9	23950	10890	3289	59	77.8	536.6	26320	15.3	31	31	120.5	13	2.1	7.9	0.6	13.4	90.1	80.7
KC01NB1	210	12570	44900	189900	1390	1864	52.4	25210	11390	3506	58.6	88.3	564	27710	23.6	30.1	32.7	134.5	12.1	1.5	7.5	0.7	13.3	94.1	84.9
KC01NB1	210	12100	45210	190000	1382	1889	49.1	25050	11510	3513	67.8	91.1	576	27710	21.4	31.6	33.4	131.7	12.5	1.8	7.5	0.4	13.9	94.3	85.9
KC01NB2	220	7560	29520	132700	719	1040	51.7	15070	5504	2140	66.6	45.3	274.4	15880	17	20.4	17.1	57.4	7.8	0.8	4.2	0.2	7.5	55.9	51.4
KC01NB2	990	11720	45020	199200	1089	1485	28.2	25670	7196	3644	66.6	66.3	459.1	27540	14.2	29.2	29	101	12.8	1.8	6.7	0.2	13	96	86.2
KC01NB2	280	10480	44960	202500	1097	1518	8.5	25850	7370	3690	68.4	88.2	443.6	27550	8.4	33.6	28.9	99.3	12.7	1.4	7.2	0.2	13	95.8	86.2
KC01NB3	190	7810	26380	118400	903	1239	198.5	13350	6641	1975	59	55.2	311.6	14760	14.1	16.1	18.6	68.4	6.4	1	4.5	0.3	8.9	50.4	46.9
KC01NB3	270	9640	40080	182800	1465	1958	42.4	23360	11720	3488	91.7	60	557	26280	25	32	31.9	119.5	12.3	0.3	8.2	0.6	14.1	89.8	82.1
KC01NB3	270	10370	40340	183000	1478	1946	39.7	23250	11510	3508	83.3	78.5	571	26270	22.1	31.4	36.1	122.5	12.7	1.9	7.2	0.9	14.7	89.3	81.9
KC01NB4	220	6800	28580	121300	838	1126	141.5	13590	7172	2005	60.6	53.6	295.1	15020	14.8	18.4	19.2	63.5	7.3	1	3.6	0.1	8.1	51.9	44.3
KC01NB4	270	10370	42290	184700	1322	1767	93	24030	13070	3383	59.6	67.7	550	27080	16.2	32.3	33.4	120	13.5	2	6.2	0.6	14.5	91.4	77.9
KC01NB4	210	10920	42370	186600	1324	1780	100.1	24340	13010	3424	84.4	70.9	549	27290	26.2	30.5	32.3	123.1	12.1	2.1	7.5	0.9	14.3	91.1	78.2
KC01NB5	760	5010	18870	80150	358.1	614	121.6	7168	2218	999	34.2	29.6	125.8	7453	3.7	24.7	8.9	26.9	4	0.6	0.5	0.1	3.4	27.5	24.1
KC01NB5	270	10720	46640	207100	1086	1567	10	26590	8006	3848	48.9	106.2	497.4	27660	16.1	32.3	31.1	98.9	13	1.2	7	0.9	12.8	97	80.9
KC01NB5	250	12000	46780	208200	1092	1571	2	26650	8005	3793	69.6	65.3	510	27700	12.4	30.2	31.9	100.9	13.4	1.7	7.4	0.4	12.7	96.3	80.9
KC01NC1	1400	6620	20650	72020	290.4	566.3	145.3	7525	2390	1005	32.3	33.2	136.6	9011	11.3	26.9	8.4	23.2	4.3	0.5	1.8	0.3	4.1	30	25.4
KC01NC1	2950	15470	51930	193500	829	1410	29.1	27810	9285	4008	110	85.6	538	33840	17.6	37.5	26.7	93.5	14.6	1.9	8	0.3	15.7	109.7	86.3
KC01NC1	3400	15600	51910	194100	842	1406	28.6	28100	9222	4011	88	109	524	33830	10.1	38.2	30.4	92.9	15.5	1.6	9.1	0.6	15.9	111.5	87.7
KC01NC2	200	6270	21510	78500	268.8	536	154.6	7940	2252	1087	30.9	27.8	142.1	9507	9.1	27.2	9.9	22.1	4.6	0.3	1.6	0.3	4.1	31.3	26.4
KC01NC2	270	14650	52520	199800	752	1308	2	27990	8309	3833	71	103.6	515	33550	16.9	33.9	30	80.6	15.5	2.6	6.2	0.6	15	109.7	87.8
KC01NC2	270	13950	52110	200100	757	1275	6.3	27550	8265	3884	82	77.5	530	33480	12.5	35	31.1	83.3	14.6	1.8	8.5	0.4	14.3	109.7	86.1
KC01NC3	1410	7270	20900	70100	252.6	542.5	99.2	7362	2571	958.1	25.6	32.1	124.4	8762	5.2	28	8.4	21.3	3.4	0.3	0.9	0.1	3.7	29.3	24.1
KC01NC3	260	15320	54820	197500	793	1256	30.4	28750	10670	4119	95	73	493	34720	10	36.5	30.3	90.1	16.1	2	7	0.2	14	112.1	87.6
KC01NC3	260	15940	54780	197800	806	1294	12.6	28920	10870	4167	85	77.9	526	34840	15.3	36.5	30.9	89.2	15.2	3	7.4	0.6	13.7	113.4	86.9
KC01NC4	2810	6570	21200	72640	249.6	555.9	111	7198	2254	957.2	32.8	21.1	154.3	8582	8.7	29	7.6	21.1	4.5	0.4	1.6	0.1	3.2	28.3	23.1
KC01NC4	280	14580	54640	203900	755	1213	2	28780	9548	4046	67	72.9	641	34460	35.3	37.9	31.7	90.9	15.1	1.9	8.4	0.2	12.9	111.7	86.3
KC01NC4	260	14840	55110	205700	780	1218	0.5	28870	9553	4072	83	90.9	639	34510	21	39.2	34.1	91.1	16.2	2.9	6.7	0.2	13	112.4	87.3

KC01NC5	1170	6880	21200	71630	255.5	523.4	96.3	7488	2557	984.4	33.2	32.5	121.5	8636	15	29.9	8.3	19.3	4.6	0.2	1.5	0.3	3.2	29	24
KC01NC5	4220	16700	53790	197700	709	1214	2	28510	10530	3981	77	78.3	504	34090	9.8	34.4	31.2	86.8	16.2	1.9	7.9	0.2	13.2	111.3	87.9
KC01NC5	280	15580	54230	199100	713	1231	1.9	28490	10490	3987	67	67.3	486.1	34020	16.7	37.6	29.5	85.8	16.1	2.3	8	0.2	13.2	111.4	87.8
KC01NAB	1630	5460	19580	76290	368.4	697.6	144.8	6871	2795	954.8	32.9	32.8	138.9	7399	8.9	29.9	7.6	27.7	3.3	0.7	1.4	0.1	4	26.6	25.9
KC01NAB	260	11820	46960	201800	1140	1516	32.7	25740	10940	3755	78.4	94.5	586	28200	9	31.5	32.9	111.9	15.1	1.3	6.6	0.5	13.3	94.8	88.1
KC01NAB	1470	12910	47260	203600	1127	1518	19.5	25910	10960	3737	70.8	85.3	580	28400	28.5	34.2	31.5	109.4	13.2	2.3	6.5	0.2	13.4	95.8	88.4
KC01NAC	2540	6390	21680	75050	326.9	692.4	127.4	7294	2573	949.4	28.3	33.1	148.1	8222	10.3	31.8	9.3	24.3	4.6	0.2	1.9	1	3.7	28.3	25.5
KC01NAC	270	13280	51200	198900	945	1399	21.6	27620	9836	3780	66.7	95.3	605	31770	25.1	31.1	32.4	97.1	14.4	2.2	6.8	0.2	15.1	103.3	88.4
KC01NAC	260	13650	51640	201600	953	1419	13.2	27790	10080	3836	76	83.6	597	32030	9.8	35	31.3	101.8	16	2.2	5.8	0.4	14.7	105.9	88.5
KC01NBC	170	5500	18530	67280	357.4	655.6	125.7	6436	2618	855.4	32.2	20.6	117.7	7610	5.5	27.1	9.5	28.8	4.4	0.5	1.7	0.1	3.9	26.3	24.2
KC01NBC	210	13900	48130	191500	1139	1756	20.4	26230	10890	3823	88.1	81.9	554	30190	18.6	34.9	31.8	112.9	14.2	2.2	8	0.4	15.1	98.2	86
KC01NBC	210	13040	47950	192700	1156	1715	53.3	26120	10960	3883	80.4	91.6	531	30220	26.6	34.7	29.8	115.6	13	1.8	7	0.2	15.6	101	85.7
KC01NABC	1060	6040	20410	76140	357.8	661.3	153.5	7133	2620	974.8	30.7	39.4	141.6	7959	4.7	28.1	7.3	27.9	4.2	0.6	1.6	0.2	4	27	25
KC01NABC	260	13040	48800	193800	1035	1442	38.4	26210	10160	3669	84.2	81.2	553	29190	24.7	32.7	30.1	100.2	13.3	1.9	7.2	0.3	13.9	96.2	84.8
KC01NABC	260	12920	50080	201900	1095	1495	44.8	27490	10490	3824	72	90	582	30410	11.3	33.2	32.8	107.3	14.5	1.1	7.8	0.4	14.3	100.9	88.8
BR-S 2g/a2	300	12890	72060	265600	1159	4133	7.2	23750	27710	4556	104	146.9	558	41620	27.5	42.1	85.9	410.4	14.5	1.1	18.2	0.6	4.5	96.5	124.5
BR-S 2g/a2	6650	14190	72360	267100	1154	4042	2	23820	27980	4623	87	157.4	551	42010	31.5	44.7	90.4	410.9	15	0.9	13.5	0.9	5.6	95.9	125.3
BR-S 2g/a2	300	13470	71940	267500	1151	4086	11.7	23470	27820	4629	76	115.1	559	41920	12	41.3	88.1	410.9	13.5	1.6	14.2	1.3	6.1	95.9	125.1
KC04NA1	270	14940	55860	230100	1126	1427	18.8	30390	11580	4227	85	94.5	816	30790	21.2	34.3	34.9	110.6	13.3	1.7	7.8	0.5	11.3	95.6	86.5
KC04NA1	280	16480	61250	244300	1188	1498	6.5	30980	11920	4332	83	80.9	798	31100	16.1	37.6	31.6	114.1	14.4	1.6	8	0.5	11	96.7	86.8
KC04NA1	260	16600	62310	249900	1277	1558	2	31320	12060	4388	88	64.6	837	31440	12.8	32.3	35.9	115.1	13.9	1.8	7.7	0.2	11.3	98.2	87.1
KC04NA2	3810	16650	61190	239300	1023	1317	2	31810	12220	4382	82	105.5	866	32600	18.6	36	31.3	110.9	15.1	1.7	7.1	0.3	11.1	102.2	89.7
KC04NA2	270	16280	62170	244900	1046	1322	2	32280	12140	4543	96	83.5	901	32780	26.4	38.4	32.4	108.2	14.5	1.9	8.6	0.5	10.8	103.3	88.9
KC04NA2	280	16100	62550	245600	1061	1362	2	32510	12260	4453	104	110.3	904	32860	23.8	37.1	35.3	109.3	14.1	0.9	6.6	0.5	10.7	103.7	90.8
KC04NA3	270	16090	62060	246100	1023	1237	0.5	31910	18500	4406	90	80.1	1138	31890	21.4	39.8	33.7	96.1	13.8	2	7.6	0.2	9.9	101.5	99.1
KC04NA3	280	15250	63920	249100	1055	1211	2	32420	18410	4513	82	80.6	1080	32040	28.3	38.3	34.6	100.8	14.4	2.2	8.1	0.4	9.1	101.9	97.2
KC04NA3	250	16000	63130	249500	1041	1223	0.6	32280	18490	4492	88	86.9	1065	32160	27.2	37.8	37	98	14.6	2.5	5.9	0.2	9.6	102.2	98.4

KC04NA4	270	16370	60400	236700	1183	1470	2	30830	13550	4435	74	100.9	648	30230	31	32.3	33.4	100.2	14	1.8	6.8	0.4	11	96.8	92.3
KC04NA4	280	16070	59810	237900	1183	1467	2	31130	13560	4326	87	69.2	641	30170	35.5	29.5	32.1	104.2	13.9	2.4	8.4	0.2	11.1	96.8	90.9
KC04NA4	5110	17740	60190	239700	1183	1490	2	31330	13560	4334	102	76.3	663	30300	32.3	35.3	32.1	100.8	15.2	1.7	6.8	0.2	11	97.4	94.3
KC04NA5	280	15430	58260	235100	1056	1436	2	31270	19160	4380	80	71.4	723	30310	18.7	35.2	32.7	92.3	13.5	1.5	7.2	0.2	11	97.7	88.5
KC04NA5	270	15490	58730	237700	1098	1446	2	30830	19130	4366	104	85.5	706	30350	31.5	32.3	31.3	93.6	15.3	1.6	6.7	0.2	11.4	98	89.5
KC04NA5	3300	16880	58880	238900	1109	1476	2	31140	19300	4394	95	82	711	30430	19.6	32.2	28.7	92.6	13.4	1.3	7.8	0.2	10.8	96.9	88.3
KC04NB1	260	12550	49450	207800	1778	2340	2	26990	16420	3711	88	70.4	700	28070	16.4	33.1	34.8	113.2	12.3	1.6	6.5	0.5	14.2	87.8	83.2
KC04NB1	270	13110	49430	209100	1788	2370	18.2	27210	16560	3732	84	80.1	714	28160	13.6	32.4	34.8	114.8	12.7	0.8	8.6	0.8	14.6	88.2	82.9
KC04NB1	250	13320	50470	211200	1806	2391	28.2	27100	16660	3683	69	88.9	716	28170	23.2	27.8	33.6	114.7	11.7	1.9	8.4	0.6	13.9	89.1	83.2
KC04NB2	260	12160	49290	201800	2055	2445	29.3	25690	17430	3571	74.9	71.4	632	27040	17.4	30.2	34.8	129.8	12	1.7	8.4	0.7	15.4	85.1	83.3
KC04NB2	200	13120	49570	203300	2098	2466	29.5	25610	17880	3850	87.2	74.9	668	27420	17.2	31.7	33.3	127.9	12.3	1.7	7.7	0.3	15.3	87.7	84.3
KC04NB2	270	12980	48650	204900	2099	2558	24	25690	17890	3658	72.4	65.4	679	27440	9	31.1	36.7	129	10.4	0.8	8.9	0.2	15.8	87.5	84.7
KC04NB3	260	12510	49560	214900	1732	2327	26.1	27020	12100	3839	70	70	596	27510	18.8	32.8	35.5	125.2	13.3	0.8	7.1	0.2	13.8	87	81
KC04NB3	260	12450	49700	215100	1748	2320	18.4	27380	12130	3753	67	75.2	609	27450	19.8	30.7	33.2	124.8	12.1	1.9	7.2	0.2	14.1	86.9	80.3
KC04NB3	260	12550	49570	217000	1774	2382	15.6	27290	12300	3826	69	76.4	598	27490	15.2	31.5	36.4	123.1	12.8	2.2	6.3	0.7	14.6	88	81.1
KC04NB4	190	14190	50080	212600	2501	2134	43.4	26920	13820	3775	87	85.6	639	27500	18.5	30.4	34.6	124.4	12	1.8	6.5	0.2	13.3	88.6	98.2
KC04NB4	200	14050	50290	216300	2568	2208	2	27400	13760	3760	91	97.4	635	27740	31.6	31.2	30.5	128.8	12.6	1.3	5.6	0.5	13.2	88.8	98.9
KC04NB4	270	12560	50840	217200	2573	2210	2	27270	13960	3856	79	97.5	628	27740	15.5	31.9	30.5	125.9	11.9	1.8	5.8	0.4	13.1	89.4	98.3
KC04NB5	270	12190	50330	208300	1692	2352	30.9	27400	13850	3691	78	99	709	29460	36.8	30	35.2	124.3	12.9	2.3	9.4	0.3	15.2	92.3	83
KC04NB5	260	13150	50660	209600	1711	2382	41.7	27500	14110	3708	79	87.5	686	29560	29.7	34.9	33.8	124.1	12.8	2.2	10.2	0.8	15.8	92.6	82.5
KC04NB5	260	12680	51410	211000	1704	2399	33.5	27790	14050	3750	72	87.9	686	29680	28.5	33	33	121.8	12.5	1.8	10.5	0.6	15.3	92.1	83
KC04NC1	270	15850	61570	232000	969	1676	2	31920	7612	4386	96	78.2	600	33440	10	39.3	30.7	92.1	15.2	2	7.7	0.2	14.1	102.1	71.6
KC04NC1	270	16420	62370	234700	970	1708	2	31890	7590	4403	82	79	597	33590	11	37.3	29.7	94.6	15.1	2.1	8.3	0.2	14.2	103.4	73
KC04NC1	260	16480	61980	235200	979	1723	2	31600	7642	4338	89	83.2	583	33500	32.4	33.2	29.3	92	14.7	2	8.3	0.2	12.8	105.2	74.1
KC04NC2	270	17440	64060	229100	960	1629	12.2	32080	9487	4433	76	74.6	598	34910	20.6	36.8	30.1	91	14.3	2.8	6.5	0.2	14.2	106.9	82.3
KC04NC2	240	18110	64360	230300	994	1640	0.8	32960	9440	4491	81	78.5	617	34990	26.3	38.3	31.3	91.2	15.7	2.4	7.4	0.6	15.4	106.3	82.3
KC04NC2	260	17970	64270	230500	972	1622	0.5	32780	9500	4464	88	98.6	617	34940	32.3	35.9	29.3	92.3	14.9	2	8.1	0.4	13.4	107.6	83.3

KC04NC3	280	15370	58820	229300	929	1602	2	30820	7972	4208	107	87	582	32790	32.9	33.2	30	90.8	13	2.4	7.5	0.2	13.3	103.2	77.4
KC04NC3	270	16480	59680	232700	957	1639	2	31020	8076	4260	75	68.3	619	33000	16.6	36.2	27.1	89.5	13.1	2.2	8.7	0.3	13.8	102.3	78.1
KC04NC3	270	16490	59450	232300	955	1652	2	31230	8200	4215	88	79.9	613	33020	14.7	33.4	29.6	91.9	13.9	1.9	6.4	0.2	13.3	99.9	77.1
KC04NC4	260	17260	60930	233100	1139	1800	47.9	30850	9834	4144	84	78	655	32030	18.2	34.5	30.3	91.2	14	2.3	6.3	0.2	13.1	97.5	88.4
KC04NC4	3380	17810	60400	232500	1096	1775	11	30980	9767	4224	87	92.9	654	31920	18.3	34.6	33	93.4	15.2	1.4	7.8	0.4	12.1	97.8	88.6
KC04NC4	240	17460	60650	232200	1124	1783	19.4	31010	9847	4253	77	80.1	621	32080	23.8	30.9	31.5	91.8	13.4	1.7	8	0.6	13.4	98.8	88.4
KC04NC5	270	17960	63860	233100	915	1567	13.5	31870	9128	4345	73	88.2	677	34340	15.3	35.4	27.4	93.4	14.3	1.8	7.5	0.2	13.5	105.4	79.4
KC04NC5	270	18360	63840	234400	937	1571	2	32110	9110	4397	68	70.2	684	34500	15.2	34.2	33.5	94.3	14.8	1.6	8.4	0.4	12.8	106.5	79.6
KC04NC5	270	17970	64220	236400	946	1623	2	32310	9208	4446	60	71.1	696	34640	28.6	36.8	32.4	94.6	15.1	1	8.3	0.6	13.1	106.7	79.8
KC04NAB	260	15340	57310	230100	1452	1868	13.8	29810	14170	4047	81	85.8	774	29680	11	33.1	32.2	104.9	13	2.2	7.1	0.2	12	92.7	85
KC04NAB	260	15270	57860	233100	1439	1875	2	29660	14070	4131	78	83.8	784	29720	19.5	30.7	27.5	108	12.7	1.7	6.7	0.4	12.5	93.3	85.2
KC04NAB	280	15300	57010	233700	1481	1871	13.6	30090	14330	4126	81	83.2	756	29780	18.2	33.1	30.5	109.4	13.2	2.4	8.3	0.6	12.8	93	85.3
KC04NAC	270	15940	60930	240100	1080	1659	26.8	31260	10250	4342	65	80.8	712	31770	19.3	32.7	31.2	97	12.9	1.7	6.1	0.6	11.9	98.5	80.3
KC04NAC	270	16190	61680	242200	1084	1614	25.7	31400	10230	4420	71	78.5	703	31880	32	33.1	31.9	98.3	13.6	1.9	8	0.3	12.5	99.2	81.8
KC04NAC	3030	17650	61910	244300	1124	1647	13.7	31310	10320	4309	88	86.3	718	31930	9.9	35.2	32.1	97.1	16	2	7.4	0.2	12.8	99.6	83.1
KC04NBC	270	14580	57570	227100	1326	2027	2	29730	11960	4017	68	107.3	642	30610	23.5	36.3	35.5	101.4	14.1	2.5	9.3	0.8	13.7	94.2	77.2
KC04NBC	1200	16140	58180	229400	1353	2036	6.1	29860	12120	4107	85	80.6	626	30660	9.6	31.5	31.2	102.4	14.6	2.1	9.1	0.4	13.8	94.5	77.2
KC04NBC	270	15080	57500	230100	1384	2061	13.2	29970	12230	4106	87	79.5	646	30820	25.1	34.3	33.4	102.1	14.4	1.7	8.2	0.2	13.8	95.6	77.6
KC04NABC	4730	17010	59400	234400	1287	1815	8.7	30540	11870	4156	99	81.2	729	31050	9.9	35.7	29.2	103.5	13.2	1.9	5.7	0.2	13.1	96.3	81.1
KC04NABC	280	15200	58580	233500	1249	1814	6.1	30190	11710	4123	80	88.5	738	30950	32	33.6	29.6	100.3	12.1	1.4	7.8	0.5	13	96.3	81
KC04NABC	1550	17000	58740	234600	1283	1837	8.9	30490	12090	4179	101	89.4	704	31100	31.6	34.2	30	104.3	13.6	2.3	8.2	0.2	12.9	96.8	80.9
BR-S 2g/a2	290	11940	68370	261100	1098	4009	2	23390	27570	4492	91	138.1	538	41310	22	45	89.3	402.9	15.8	1.1	14.7	0.5	5.2	95.9	123.3
BR-S 2g/a2	290	12340	67720	262100	1085	3913	2	23320	27620	4486	88	127.3	537	41290	12	41.6	85.7	410.4	15.5	1.9	12.9	0.8	6.5	97	123.4
BR-S 2g/a2	5520	13980	68690	262000	1073	3879	2	23260	27660	4519	93	134.4	542	41270	12	43.2	86.5	408	14.6	1.6	14.1	1.2	5.2	95.2	123.2
KC07NA1	280	12360	52130	229100	1121	1430	51.1	30530	11500	4316	83	106.6	658	30150	14.9	33.8	29.6	109.5	14.4	1.4	8.1	0.6	11.4	96.4	86
KC07NA1	260	15140	59490	245200	1155	1456	35.9	31150	11740	4444	90	87.3	693	30240	9.8	33.6	27.5	110.3	12.5	2.1	8	0.2	11.3	95.2	84.1
KC07NA1	250	15220	57210	241400	1116	1480	2	30810	11600	4310	71	85.2	693	30290	17.9	29.8	31.7	108.3	14.6	2.2	7.4	0.6	11.6	96.4	83.8

KC07NA2	280	15320	59180	233100	1081	1259	0.5	32700	13940	4433	69	91.8	772	32150	20.2	37.3	31.9	100.6	16.1	1.2	6.9	0.4	9.5	101.7	100.6
KC07NA2	290	17440	65010	246300	1092	1314	2	33170	14300	4430	91	108.5	795	32300	11.9	37.4	33.8	99	15.7	1.7	8.5	0.2	9.9	101.9	101.9
KC07NA2	280	17140	64320	247800	1163	1338	2	33340	14280	4520	89	90.3	762	32540	11.8	36.5	32.4	101.7	13.5	2.2	7.3	0.5	10.5	102.9	100.8
KC07NA3	280	14910	58640	239500	998	1262	2	32480	15740	4511	70	95	764	30700	9.9	37.5	35.2	97.4	13.2	1.7	8.7	0.5	9.7	99.3	92.9
KC07NA3	3710	17550	62180	249900	1042	1293	2	32700	16190	4594	80	87.7	741	30820	31.3	37.4	35.6	96.2	14.1	1.7	8.2	0.3	9.4	101.7	92.2
KC07NA3	270	16600	61650	250900	1030	1293	2	32680	16210	4607	66	79.5	756	30920	26.3	33.3	32	99.7	14.1	1.9	6.9	0.3	9.8	100.4	94.1
KC07NA4	1370	15570	58120	238500	1113	1398	27.5	31350	11690	4309	90	71.9	648	30090	11.4	34.3	32.4	100.7	14.1	2.1	7.2	0.5	12.4	98.2	84.2
KC07NA4	270	14990	60170	244800	1111	1450	21	31400	11760	4372	92	81.1	632	30180	25.8	34.4	29.2	97.5	11.7	0.8	7.5	0.5	12.3	98.1	83.4
KC07NA4	280	15630	60470	246500	1105	1456	38.1	31710	11630	4359	79	79.5	647	30300	12.7	32.6	29.9	101	12.4	2.2	6.4	0.2	12.5	98	83.8
KC07NA5	280	15470	60980	243300	954	1279	2	32000	22200	4431	82	88.2	980	31030	14.8	36.7	31.3	88.2	12.7	1.6	7.7	0.2	9.4	98.6	90.7
KC07NA5	270	17220	62640	248800	997	1299	2	32110	22320	4372	78	81.7	953	31130	14.1	32.4	29.1	86	11.8	2	7	0.2	10	98.3	90.4
KC07NA5	270	16720	62760	248600	979	1277	2	31990	22400	4457	73	92.8	967	31170	36	33.2	29.4	88.6	13.4	1.6	7.1	0.2	10.1	99.8	90.1
KC07NB1	260	12980	53190	224800	1423	2044	2	28560	12980	3963	97	84.5	621	29180	14.8	33.5	32.1	131.1	11.4	1.7	7.4	0.8	13.3	92.7	79.3
KC07NB1	250	13420	53960	228900	1422	2093	0.5	28820	13010	3940	96	77.7	626	29400	23.5	29.9	31.5	128.8	12.8	1.8	8.4	0.2	13.4	92.9	78.9
KC07NB1	250	13360	53580	229400	1456	2055	0.8	28800	13100	3966	93	75.9	624	29430	16.7	31.3	32.7	128.9	12.8	2	8.7	0.2	13.2	93.7	78.7
KC07NB2	270	12930	51070	219700	2174	2172	2	28400	12760	3980	81	92.5	596	27660	15.1	31.6	30.5	114.2	11.6	0.7	5.7	0.2	12.8	89.4	96.3
KC07NB2	260	13500	51970	223100	2196	2143	2	28170	12950	3985	80	86.9	614	27790	21.4	32.1	33.2	115.4	11.9	2.1	5.6	0.4	12.8	90.4	96.2
KC07NB2	230	13570	51500	222800	2224	2175	2	28440	12910	3940	77	79.1	606	27710	9.9	32.2	31.3	115.9	12.1	1.7	6.5	0.4	12.7	89.8	95.6
KC07NB3	250	12090	47650	207600	1719	2481	28.1	26440	14010	3663	71.6	83.4	647	27010	21.3	31.7	31.8	119	11.5	1.3	8	0.4	14	86.4	84.9
KC07NB3	240	12420	48020	209500	1739	2512	21.1	26560	14190	3679	68.4	52.2	663	27100	17.5	30.7	33.7	120	12.4	1.5	7.1	0.4	14.3	86.3	85
KC07NB3	190	13900	48460	210600	1728	2461	29.4	26490	14260	3696	80	80.6	653	27180	17	30.9	32.1	118.7	10.8	1.8	8.8	0.4	14.2	86.1	86.5
KC07NB4	260	12140	46360	208200	1831	2425	21.3	25780	18270	3553	72.6	94.1	582	26780	11.9	31.5	33.8	127.4	11.5	2	7	0.3	13	84.6	88
KC07NB4	200	13830	46780	209700	1830	2427	22.4	25350	18370	3495	68.9	71.1	597	26700	32.6	28.6	34.7	125.7	12	2	6.7	0.6	13.4	84.1	87.9
KC07NB4	280	11960	47080	209600	1862	2470	26.6	25530	18340	3551	69	79.9	601	26820	8.8	31.6	32.2	127.5	11.6	1.8	7.3	0.2	13.5	82.8	88.3
KC07NB5	250	13930	55550	235700	1280	1833	2	29800	10710	4157	91	90.1	736	30130	9.7	34.4	34.4	107.1	12.1	1.4	8.1	0.2	13.5	95.2	79.3
KC07NB5	3180	15010	56220	238200	1294	1904	2	29620	10670	4140	67	83.3	736	30130	17.4	36	30.9	105.3	14.3	1.8	9.1	0.5	13.7	94.8	77.7
KC07NB5	1740	15450	55770	236900	1282	1864	2	29720	10690	4130	72	104.6	712	30330	36.1	36.5	34.7	105.7	13.5	2.2	8.1	0.6	13.5	96.5	78.4

KC07NC1	260	15520	57550	235100	925	1652	2	30120	7465	4190	74	89.2	592	31350	36.4	30.6	32.4	85.1	14.3	2.1	7.9	0.3	12.5	98.2	79.1
KC07NC1	270	15890	58110	237200	913	1675	2	30100	7463	4214	86	94	594	31370	29	33.5	31.6	86.2	13.4	2.1	7	0.3	12.6	97.9	78.4
KC07NC1	260	16020	58450	237900	917	1681	2	30150	7432	4249	90	93.7	610	31490	19.5	33.8	28.8	88	14.5	1.5	7.3	0.3	12.3	98.9	79.1
KC07NC2	270	14900	59240	230200	888	1643	2	31080	7641	4388	75	76.9	615	33010	17.2	34.5	32.4	87.3	14.3	2.2	7.1	0.2	12.8	100.4	79.9
KC07NC2	270	15320	59850	232200	912	1689	3.2	30850	7718	4507	81	64	625	33020	20.4	36.4	27.2	89.2	13.4	2.4	7.7	0.2	13	101.9	78.7
KC07NC2	270	15310	59570	231400	940	1663	2	30820	7624	4386	79	83.9	603	33040	13.6	37.7	33.1	87.4	14.8	2.2	8.1	0.7	13.2	102.2	79.1
KC07NC3	3550	16070	59110	235100	953	1685	3.4	30290	6619	4252	99	82.4	585	31690	32.4	29.5	31.2	90.2	13.6	2.4	6.4	0.2	12.5	98.6	75.1
KC07NC3	270	15430	59150	237000	937	1705	2	30070	6621	4280	79	69.7	574	31630	22.7	36.8	31.3	88.9	13.7	2.5	8.8	0.6	13.3	97.8	76.1
KC07NC3	5580	16400	58720	236200	892	1711	2	30470	6781	4300	81	74.3	592	31850	30.9	32.8	31.3	90.6	13.7	1.5	7.2	0.2	13.7	97.2	75.5
KC07NC4	270	16230	62100	240800	926	1635	2	31370	6859	4458	95	86.8	600	32790	18.1	35.4	30	89.5	14.1	2	5.8	0.4	12.6	102.4	73.4
KC07NC4	270	15990	62310	242000	892	1614	2	31600	6992	4445	76	84.1	607	32940	25.8	33.2	34	88.6	13.8	1.6	6.7	0.4	12.3	100.1	73.7
KC07NC4	260	16010	62320	242700	928	1651	0.6	31330	6881	4475	67	63.5	598	32800	10	35.4	29.6	87.1	13.8	2.3	7.7	0.2	13.5	100.2	74.2
KC07NC5	2820	17680	61370	243800	908	1570	2	31870	7262	4431	74	77.9	559	32410	14.6	33.8	30.4	86.2	13.7	1.5	7.9	0.3	11.9	99	76.6
KC07NC5	280	16200	61110	245500	928	1621	2	31740	7359	4503	73	93.7	548	32450	14.6	32.1	27.5	86.4	13.3	1.7	6.3	0.2	12.4	100.1	76.9
KC07NC5	3980	16760	62430	246400	924	1619	2	32090	7373	4517	89	93.9	576	32430	17.6	36.6	32.4	86.6	16.4	2	8.5	0.2	12.4	99.8	77.8
KC07NAB	260	14690	56570	235900	1324	1817	5.3	30060	12390	4140	74	110	614	29650	9.6	33	31.9	116.7	12.3	1.5	8.4	0.6	12.8	94	80.4
KC07NAB	270	14660	56350	237500	1337	1830	10.6	29970	12250	4158	60	107.7	620	29660	29.7	35.4	34.4	115.1	13.6	2.3	7.2	0.4	12.5	95	81.3
KC07NAB	260	14740	56740	237500	1332	1833	3.9	29910	12410	4078	88	92.2	649	29680	18.6	36.1	31.4	117.3	13.1	1.3	6.8	0.2	12.4	94.3	81.2
KC07NAC	4420	17680	60760	243700	1023	1639	2	30530	9289	4240	86	73.6	625	30810	18.2	28.7	30	94	14.5	1.4	7.6	0.2	12.1	97.3	80.7
KC07NAC	270	15860	59670	244900	1037	1632	9.7	31020	9336	4324	71	67	607	30810	33.5	30.5	27.5	97.5	13	1.6	6.5	0.2	12	96.8	79.8
KC07NAC	250	15880	60790	246200	1033	1658	3	30730	9320	4362	66	82.1	639	30880	20.9	33.4	30.5	96.6	14	1.3	7.4	0.6	11.5	96.6	80.4
KC07NBC	359	14830	56840	232800	1213	1841	2	29690	10560	4151	95	91.6	591	30110	18.1	33.3	29.8	102.4	13.5	2	7.7	0.4	12.7	94.8	77.9
KC07NBC	270	14350	56770	234000	1214	1867	2	29580	10540	4124	88	105.8	611	30180	18.2	32.5	29	103	11.8	2.4	6.2	0.5	12.9	94.6	78.6
KC07NBC	280	14340	56610	235000	1212	1864	2	29500	10590	4079	79	93.7	616	30090	23.6	31.7	30.3	104	13.5	2.3	8.9	0.4	12.4	94.9	79.4
KC07NABC	270	14860	57460	237400	1209	1743	3.7	29890	11070	4045	98	95.8	622	30150	27.4	34.6	33.5	106.6	13.5	1.5	7.9	0.3	11.9	94.8	80
KC07NABC	260	15110	57270	238900	1147	1791	0.6	30050	10980	4214	67	110.6	596	30120	22.4	33.8	34.2	105.1	12.9	1.2	7	0.2	12	94.3	78.4
KC07NABC	260	14790	57570	239200	1196	1814	2.7	29990	11140	4163	75	104.6	608	30220	9.6	31.5	30.8	106.3	11.9	1.2	7.3	0.4	12.4	95.2	79.6

	Y	Zr	Nb	Mo	Ag	Cd	In	Sn	Sb	Te	I	Cs	Ba	La	Ce	Hf	Ta	W	Hg	Tl	Pb	Bi	Th	U	
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	
BR-S 2g/a	37.1	292.8	9.3	4.1	2.3	4.4	0.6	10.1	3.1	0.9	1.8	3.1	374.8	28.3	65.5	7.7	4.5	3.2	2	1.8	146.9	0.3	9	5	
BR-S 2g/a	37.7	298.1	15.5	7.8	2.4	5.1	0.6	9.8	2.5	0.9	1.7	3.1	364.8	24.4	32.4	4.6	4.5	4.5	1.1	0.9	148.2	0.7	9.9	5.5	
BR-S 2g/a	37.3	307.3	15.7	4.8	0.6	4.6	0.6	10.3	1.9	0.9	1.7	3.1	350.6	21.3	51.8	4.2	4.5	3.2	1.6	1.2	149	0.8	9.6	5.6	
KC10NA1	32.7	280.5	23.4	9.3	0.8	8.5	0.6	10.8	1.6	0.8	1.6	2.5	314.2	24.8	43.7	5.5	2.8	1.8	0.6	1.4	51.2	0.9	8.4	16	
KC10NA1	32.5	270	15.1	7.3	0.8	4.5	0.6	8.7	1.6	0.8	1.5	2.5	333.3	25.8	31	4.7	3.6	3.3	0.6	1.4	52.1	0.5	9.2	16.2	
KC10NA1	33.7	285.8	17	7.6	0.8	4.2	0.6	9.6	0.6	0.8	1.5	2.5	333.6	19.9	32.1	7.2	2.8	2.1	0.6	0.6	52.9	0.9	8.9	13.4	
KC10NA2	30.4	254	17.3	7	0.7	3.8	2.3	7.4	0.6	0.8	2.1	2.3	272.2	16.4	31.8	3.3	2.9	1.9	0.5	0.7	49.5	0.4	8.8	5.4	
KC10NA2	30.5	242.1	14.4	6.1	0.6	3.1	0.5	6	0.6	0.8	1.4	2.4	288.3	24.2	34.8	3.4	2.7	1.9	0.3	1.5	47.9	1.4	7.7	5.5	
KC10NA2	30.8	248.3	12.5	5.9	0.5	2.7	0.5	6	0.4	0.8	1.3	3	283.3	19	21.6	3.4	2.6	4	0.5	1.5	50.5	0.7	8.2	4.9	
KC10NA3	33.7	283.3	17.4	5.5	0.7	4	0.5	7.5	1.1	0.7	2.8	2.5	317.3	20.4	44.8	6.3	2.8	1.4	0.5	0.7	55.7	0.5	11.2	5.4	
KC10NA3	34	267.5	12.3	6.2	0.6	2.5	0.5	7	1.2	0.8	1.3	2.5	328.9	17.7	32.6	6.2	2.8	2	0.6	1.2	54.5	0.5	9.3	4.4	
KC10NA3	33.9	270.6	16.2	4.6	0.6	1.9	0.5	6.8	0.5	0.8	2.6	2.4	331.4	25.9	25.5	4.3	4.1	2	1.1	1	56.8	0.5	8.8	4.7	
KC10NA4	33.1	250.7	14.8	6.5	0.6	2.9	0.5	6.7	0.6	0.8	1.4	2.5	343.7	19.9	46.1	6.5	2.8	2	0.6	1.1	58	0.5	9.3	5.4	
KC10NA4	33.5	266.2	12.9	5.4	0.6	2.2	0.5	6.6	0.5	0.8	1.4	2.5	347.2	31.2	32.1	5.8	2.9	4.5	0.6	0.7	58.8	0.3	9.5	4.8	
KC10NA4	34	267	16.2	3.8	0.6	2.6	0.5	8.2	0.6	0.8	1.5	2.5	352.8	19.2	33.5	4.9	2.8	2	0.5	1	58.1	0.5	9.1	5.5	
KC10NA5	32	282	15	4.9	0.6	2	0.5	9.4	1.5	0.8	1.7	2.5	323.2	17.8	34.7	4.5	2.8	2.2	0.5	1.2	66.5	0.7	8.8	5.6	
KC10NA5	32.7	283.2	14.1	5.4	0.6	1.7	0.5	8.5	1	0.8	1.4	2.5	326.8	25.5	32.6	6.3	2.8	1.9	0.6	0.9	67.9	0.5	9.9	4.9	
KC10NA5	33.1	278.4	15.4	4.1	0.6	1.4	1.4	9.4	0.6	0.8	1.6	2.5	326.5	18.7	51.9	6.7	2.8	1.9	0.6	1.7	68.5	0.5	8.8	5.4	
KC10NB1	30.7	244.2	12.4	4.3	0.6	1.4	0.5	6.8	1.3	0.8	1.4	2.5	273.3	17.6	32.6	8.2	2.7	3.8	0.5	0.7	75.8	0.6	7.9	4.9	
KC10NB1	30.4	249.3	12.1	1.8	2.2	1.3	0.5	6.8	1.6	0.8	1.4	2.5	287.3	22.3	32.7	4	4.7	2	0.5	1	76.4	0.5	8.5	4.8	
KC10NB1	30.8	253.6	12.8	1.7	0.5	2.4	0.5	6.2	1.4	0.7	1.4	2.5	289.2	22.3	31.3	4.6	2.6	2	0.5	1.1	78	0.4	8.1	4.7	
KC10NB2	30.3	246.8	12.4	2.6	0.5	1.6	1.1	9.7	1.4	0.8	1.6	2.5	275.8	22.3	27.5	2.3	2.7	3.6	1	0.3	79.1	0.9	7.3	4.7	
KC10NB2	30.3	254.5	10.4	4.6	0.6	2.8	0.5	8.4	1.2	0.8	1.4	2.7	282.7	24	29.8	6.3	2.7	2.4	1.4	1.5	78.1	0.5	8.3	5	
KC10NB2	30.5	250.2	13	4.7	1.6	1.6	0.5	8.1	1.2	0.6	1.5	2.5	288.4	21.1	31	5.7	2.8	3.8	0.4	1.4	79.1	0.5	8.9	4.9	
KC10NB3	30.7	256.5	14.1	5.4	0.6	2.1	0.5	8.2	1	0.8	1.4	2.5	293.8	18.8	23.6	4.8	2.2	2.1	0.6	1.2	66.8	0.5	8	5	

KC10NB3	29.6	254.3	12.4	3.3	0.5	1.7	0.4	8.2	1.2	0.8	1.4	2.4	293.2	20.4	28	6.7	2.7	1.8	0.5	1.3	67.9	0.3	7.9	4.6	
KC10NB3	31.2	256.4	11.7	4.1	0.6	2.2	0.5	7.6	1.1	0.7	1.4	2.5	288.9	16.7	43	5.6	2.7	2	0.8	0.8	70.8	0.3	8.6	5.2	
KC10NB4	30	254.5	13.4	4.9	2.1	1.5	0.5	8.8	0.6	0.8	1.1	2.3	279.7	20.1	32.9	4.2	2.9	2.1	0.6	1.8	116.6	0.6	9.1	5	
KC10NB4	29.9	241.1	11	4.4	0.6	2.1	0.5	7.7	0.6	0.8	1.5	2.5	280.9	18.6	24.5	5	2.9	1.6	0.6	1.3	121	1.3	7.9	5.3	
KC10NB4	30.2	249.1	10.7	2.5	0.6	2.4	0.5	7.8	0.5	0.8	1.7	2.5	279.5	18.8	50.4	10.1	2.9	2.1	0.6	0.9	118.3	0.5	8.1	5.1	
KC10NB5	32.8	302.9	11.2	4.9	0.5	1.4	0.5	6.4	0.6	0.8	1.4	2.5	316.1	23.3	32.9	6.6	2.8	1.9	0.5	1	65.4	0.3	10.1	4.6	
KC10NB5	33.3	319	10.9	2.3	0.6	1.6	0.5	7.4	0.6	0.8	1.5	2.6	329.4	25.5	30.6	5.9	2.7	2.7	0.6	0.5	66.3	0.5	8.9	5.2	
KC10NB5	33	305	14.9	5.2	0.6	2.3	0.5	6.4	0.6	1.6	2.6	2.6	325	25.3	37	8.1	2.7	4.9	1.2	1.7	66.2	1.3	9.1	5.5	
KC10NC1	34	282.8	14.3	3.7	0.6	0.9	0.5	4.5	0.5	0.8	1.4	2.5	303.6	21.6	34	1.9	2.8	1.7	0.7	0.7	52.3	0.5	9.3	5.7	
KC10NC1	34.8	282.5	12.8	2.6	1.8	2.2	0.5	5.7	0.6	0.8	1.5	2.1	303.2	21.6	54.7	6.3	2.6	2	0.6	1	51	0.3	10.2	5.4	
KC10NC1	33.3	281.8	12.7	4	0.6	1.8	1.1	5.8	0.6	0.8	1.6	2.3	309.7	22.3	52.8	6.6	2.8	2.4	1.1	2.1	52.9	0.4	9.7	5.8	
KC10NC2	32.7	265.5	13.2	3.8	0.6	1.4	0.8	6.1	1	0.8	1.4	2.4	286.4	23.7	49.5	5.2	3	1.6	0.6	1	47.5	0.4	9.1	5.2	
KC10NC2	33.2	265.6	11.5	7.2	2.1	1.6	0.4	5.4	0.6	0.9	1.4	2.5	288.8	21.3	46.6	1.9	2.8	2.5	0.7	0.9	45.9	0.7	9.3	4.9	
KC10NC2	32.9	274.2	11.2	2.5	0.6	1.8	0.5	4.9	0.6	0.4	2.2	2.5	291.4	26.4	35.9	2.5	2.7	1.5	0.6	0.5	47.4	1	8.3	5.8	
KC10NC3	33.6	259.9	15.4	2.1	0.6	1.9	0.5	5.3	1.1	2.3	3.3	2.5	283.4	21.3	33.5	6	2.8	1.5	0.6	1.1	46.7	0.5	9.2	5.3	
KC10NC3	33.8	249.9	11.1	3.6	0.5	1.7	0.5	4.7	1.1	0.7	2.1	2.4	287	22	34.9	7.2	2.7	1.9	0.3	0.7	46.7	0.8	8.6	4.4	
KC10NC3	33.1	258.3	11.3	7	0.6	2.1	0.5	4.7	1.9	0.8	1.6	2.5	286.7	18.5	47.3	7.4	2.8	1.9	0.6	0.9	46.1	0.5	8.8	4.6	
KC10NC4	33.9	258	11.3	4	0.6	0.9	0.9	4.8	0.6	0.8	1.4	2.5	292.2	24	39.6	3.2	2.8	1.9	0.6	0.9	42.8	0.3	8.1	5.3	
KC10NC4	32.6	253.9	10.5	3.1	0.5	1.2	0.5	4.4	0.6	0.7	3	3.5	289	21.7	30.6	4.3	2.6	1.9	0.6	0.6	44.1	0.4	9.7	4.1	
KC10NC4	34.7	253.8	13.1	3	0.6	1.2	0.5	5.1	0.6	0.8	1.9	2.6	285.7	16.3	34.4	5.3	4.7	2	0.3	1.1	44.4	0.5	9.1	4.9	
KC10NC5	31.5	260.5	11.7	3.5	1.4	2	0.4	6.4	0.6	0.7	2.6	2.5	280.1	23.9	51.2	5.2	2.8	1.9	0.6	0.6	46.2	1.1	8.2	5	
KC10NC5	32.9	250.4	11.5	3.2	0.6	1.7	0.4	5.6	0.6	0.7	1.4	2.1	280.7	20.1	29.1	5	2.5	2.1	0.6	1.3	47.3	0.5	9.5	4.4	
KC10NC5	32.8	260.8	11.9	4.7	2.4	1.7	0.5	5.5	0.6	0.8	1.4	2.1	281.6	23.7	26.4	6.2	3.4	1.9	0.6	0.7	48.6	0.5	8.5	5.3	
KC10NAB	32.2	260	13.7	2.4	0.5	2.1	0.5	6.3	1.8	0.8	1.7	2.5	291.7	23.2	29.3	4.7	2.7	3.2	0.8	0.7	75.9	0.4	7.7	5	
KC10NAB	32.3	266.9	14.2	3.9	0.6	1.5	0.5	6.5	1.3	0.8	1.7	2.6	282.7	14	50.3	7	2.7	1.6	1	1.5	76.6	1	7.4	5.1	
KC10NAB	32.7	257.5	12	2.6	1.7	2.1	0.5	6.4	1.2	0.8	1	1.9	291.1	20.4	43.6	3.6	2.7	2	0.5	0.9	75.4	0.5	8.9	4.9	
KC10NAC	31.9	271.1	12.7	3.9	0.5	1.6	0.5	4.8	0.5	0.7	2	2.5	301	21.4	22	3.7	2.9	2.1	0.5	0.7	49	0.4	8.6	4.8	

KC10NAC	33.2	272	15.3	3.7	0.6	2.4	0.5	5.4	0.6	0.8	1.4	2.5	296.6	22	27.4	3.9	2.7	2	0.6	1.2	47.8	0.4	9.3	5	
KC10NAC	33.2	276.2	15.2	2.4	0.6	1.7	0.5	4.9	1.6	0.8	1.5	2.5	302	21.5	22.7	6.9	2.8	3.2	0.6	0.8	49.8	0.4	9.8	5.1	
KC10NBC	30.8	252.2	10.6	4	0.6	2.2	0.5	6.1	1.6	0.8	1.4	2.5	269.2	18.7	28.7	5.8	2.7	2.4	0.5	1	59.2	0.5	8.7	4.8	
KC10NBC	31.5	239.3	12.1	1.9	0.5	1.7	1	5.6	1.1	1.2	1.4	2.5	267.5	17.3	31.1	6	2.8	2	0.6	0.8	58.9	0.8	8.3	5.1	
KC10NBC	31.3	241.8	10.3	3	0.5	2	0.4	5.8	1.9	0.8	2.9	2.4	266.7	23.1	31.4	5.7	2.8	4.5	0.5	1.1	58.2	0.6	8.8	4.4	
KC10NABC	29.8	253	12	2.3	0.5	1.8	0.5	5.6	0.6	1.3	2.2	2.5	298.3	21.4	32.7	7	2.8	1.9	0.8	0.9	60.7	0.5	8.6	5.2	
KC10NABC	31.2	260	11.4	3.5	0.6	2.4	0.5	6.8	0.6	0.7	1.4	2.4	295.6	18.6	30.8	3.5	2.8	3.1	0.8	0.6	60.8	0.6	8.2	5.2	
KC10NABC	30.9	253.4	13.5	2.8	1.7	1.5	0.5	5.4	1.4	0.8	2	2.5	300.2	17.2	34	8.8	4.3	1.7	0.6	1.5	61.5	0.5	8.2	5	
BR-S 2g/a	11.6	140.7	7.7	3.5	0.4	3.1	0.4	5.3	0.6	0.7	1.3	2.6	229.5	13.6	27.5	2.7	1.5	1.3	1.3	0.6	31	0.3	1	5.3	
BR-S 2g/a	34.1	310.8	19.2	8.3	0.8	5.4	0.6	12.2	3.1	0.9	1.8	2.9	460.7	39.3	42.3	9.3	4.4	3.3	1.7	1.5	141.8	1	8.6	15	
BR-S 2g/a	36.3	333.7	18.2	8.2	0.8	6.6	0.7	13	3.5	1	1.9	3.5	502.6	34.4	85.8	8.1	4.4	3.2	0.5	1.4	148.1	0.6	10.1	6.1	
KC01NA1	31.5	380.6	24.5	5.4	0.8	5.6	0.6	8.8	0.6	0.8	1.3	2.7	414.6	21.3	62.4	8.4	2.8	3.8	0.6	2.3	53.1	1.3	9.1	54.3	
KC01NA1	33	363.6	20.6	8.6	0.7	5	0.6	6.3	0.9	0.8	3.5	2.6	425.5	21.4	60.2	9.2	2.7	1.5	0.4	0.9	53.1	1.3	9.2	23.6	
KC01NA1	32.5	390	21.3	4.6	0.7	3.1	1.5	7.3	0.6	0.8	1.7	2.7	435.6	23.3	61.5	7.4	2.5	2.7	1	1.2	56.1	0.5	10.2	26.9	
KC01NA2	33.6	329.6	21	9.2	0.7	3.5	0.5	8.4	0.6	0.8	2.2	2.7	437.8	19.2	62.6	7.8	4.4	2.8	0.6	1.7	71.9	0.7	9.4	24.3	
KC01NA2	34.1	322.3	21.6	7.8	0.6	2.7	0.5	8.6	1	0.8	1.4	2.6	448.1	28.7	71	7.4	4.9	3.4	0.6	1.3	70.8	0.6	9	17.2	
KC01NA2	33.8	333.8	19.3	3.1	0.7	2.3	1.2	8.3	0.6	0.8	1.4	2.7	459.5	30.2	67	8.1	3	3.5	0.6	0.6	71.8	0.5	10.2	17.5	
KC01NA3	33.3	332.1	17.7	5.5	3.7	3.3	0.5	9.2	0.6	0.5	1	2.6	395.1	23.1	54.5	7.5	2.8	3.6	0.6	1.2	62.2	0.7	9.6	12.5	
KC01NA3	33.7	338.4	15.8	7.3	0.6	2.8	0.5	8.9	0.9	0.8	1.4	2.6	413.3	33.3	64.9	8.1	2.9	2	1.2	1.1	61.8	1.3	9.6	10.1	
KC01NA3	32.3	323.3	17.9	5.2	0.6	2.2	0.5	7.3	2.3	0.8	1.2	2.6	405.4	30.6	73.5	10.2	2.8	3.6	0.6	0.9	61.5	0.6	9.7	15.7	
KC01NA4	31.5	329	18.9	5.7	0.6	2.8	0.5	6.9	0.7	0.8	1.5	2.6	380	23.3	37.4	8.3	2.7	3.4	0.6	0.6	58.2	0.5	9.5	6.6	
KC01NA4	31.8	313.6	16.8	6.3	0.6	2.3	1.6	9	1.7	0.8	1.5	2.6	397.8	24.6	45.2	6.8	2.8	1.6	0.6	0.6	61.8	0.5	9.9	10.8	
KC01NA4	31.5	351.5	18.7	4.9	0.7	2	0.6	10	1.7	0.8	2.6	2.7	404.6	30.1	68.1	11.8	2.8	3.4	1.1	1.1	61.4	0.8	9.9	11.8	
KC01NA5	29.8	325.9	16	6.1	0.6	2.6	0.5	6.9	1.2	0.8	3.3	2.8	399.8	31.1	61.7	4.7	5.6	1.9	1	0.6	50	0.4	7.8	10	
KC01NA5	31.1	314.3	17.1	5	0.6	3.1	0.5	6.8	0.7	0.4	1.5	2.7	407.8	31.6	39.9	9.3	3.5	1.5	1.2	1.6	51.5	0.3	10.2	12	
KC01NA5	31.2	313.2	14.5	5.5	0.6	2.6	0.5	8.7	1.2	0.8	1.5	2.7	411.2	29.4	41.4	8.5	3.3	1.8	1.7	0.9	53.2	0.5	9.1	20.3	
KC01NB1	28.3	312.5	15.5	5.1	0.6	2.5	0.5	9.3	0.6	0.7	1.4	2.5	313.5	26.2	31.2	6.3	2.6	2.7	0.5	0.9	76.7	0.5	8.6	4.9	

KC01NB1	30.3	302.3	17	3	0.6	3.1	0.5	8.9	0.6	0.8	1.4	2.5	335	16.2	49	5.6	2.7	3.5	1.2	1.4	79.9	0.5	9	5	
KC01NB1	30.7	307.3	17.3	5.5	0.6	2.3	0.5	9.9	0.6	0.8	1.4	2.6	337.9	22.7	56.2	7.1	2.5	2	0.8	0.9	80.8	0.6	8.3	5.7	
KC01NB2	20.2	230.7	11.8	3.8	0.5	2.3	0.4	6.6	1.3	0.7	1.3	2.3	289.5	17.4	51	7.1	1.8	1.4	0.7	1.3	36.5	0.3	4.2	6.7	
KC01NB2	30.2	325	17.9	2.3	0.6	2.7	2.1	6.7	1.9	0.8	1.5	2.6	352.9	25.6	55	7.8	2.7	3.6	0.6	0.5	62	0.5	9.2	13.6	
KC01NB2	30.5	321.5	15.1	4.2	2.5	2.7	0.5	6.7	0.6	0.8	1.5	2.7	365.8	23.2	48.9	5.3	2.6	2.7	1.4	2	61.2	1.5	8.8	11.8	
KC01NB3	18.9	216	9.9	1.6	0.5	1.9	0.4	8.3	0.7	0.7	1.5	2.3	292	16.7	44.4	6	1.8	1.1	0.4	1.3	49.3	0.3	4.1	6.9	
KC01NB3	28.9	287.8	15.1	6.9	0.6	2.3	1	8	0.9	0.8	2.4	2.6	341.8	19.2	55	8.8	2.7	7	1.2	1.9	89.9	0.8	8.5	5	
KC01NB3	29.5	303.4	13.1	4.9	0.6	2.8	0.5	9.9	0.6	0.8	1.5	2.6	349.9	30	58.3	8.1	2.8	4	0.3	1.1	93.5	0.5	8.3	7.9	
KC01NB4	18.8	204.3	10.4	5.8	0.4	1.7	0.4	11.7	0.5	0.7	1.6	2.3	287.9	21	50.2	6.4	1.4	2.6	0.4	0.7	61.5	0.4	5.4	4.6	
KC01NB4	28.6	297	14.3	5.6	0.6	2.4	0.6	13.7	1.8	0.8	1.4	2.7	355.8	27.4	56.6	6.6	2.7	2.9	0.5	0.5	114.2	0.9	7.3	11.5	
KC01NB4	29	296.5	15.4	2.8	0.6	3.3	0.5	14	0.6	0.8	4.4	2.4	360.2	28	31.7	8	4.7	2	1.4	1.3	113.3	0.6	9.4	10.5	
KC01NB5	11.6	211.4	8.8	2	0.4	1.5	0.4	5.5	0.6	0.4	1.2	2.3	268.9	18.7	29.8	3.1	1.4	1.1	0.5	0.4	20.2	0.2	1.6	6.5	
KC01NB5	31.2	356	15.9	4.1	0.6	2.6	0.5	7.5	1.7	0.8	1.1	2.7	378.2	27.7	55.8	8.2	2.7	5.5	0.5	0.6	68.2	1.1	8.8	12.8	
KC01NB5	32	346.3	16.5	3.9	0.6	3.5	0.5	8	0.7	0.8	1.6	2.8	386.2	28.9	63.2	8.5	2.7	3.4	0.5	1.1	67.4	0.6	9.6	5.7	
KC01NC1	11.2	181.7	14.1	3.3	0.4	1.8	0.4	4.1	0.4	0.7	1.2	2.2	237.7	17.4	31.3	2.6	0.7	0.8	0.5	0.7	11	0.2	2	4.3	
KC01NC1	31.4	287.3	16.9	4.7	0.6	2.9	0.5	5.3	1	0.8	1.1	2.6	334.1	21.7	53.5	7.5	3.8	1.8	0.5	0.8	41.4	0.4	9.8	5.1	
KC01NC1	31.4	294	18.1	3.7	0.6	2.5	0.5	5.8	0.6	0.8	1.5	2.8	340.7	28.7	65.9	8.6	2.7	3.1	0.6	0.6	41.2	0.9	10.1	16.4	
KC01NC2	12	177.2	9.6	3.1	0.4	1.5	0.4	5.1	0.4	0.6	1.2	2.2	256	23.5	48.1	2.4	1.3	1.1	0.3	0.8	13.8	0.2	2.2	9.5	
KC01NC2	31.7	306.6	14.7	3.2	0.6	2.7	0.6	5.9	0.6	0.8	1.5	3.5	367.1	30.5	48.5	5.9	2.7	5.3	0.6	1.2	45.3	0.5	9.8	12.8	
KC01NC2	32.7	312.9	15.2	4.5	0.6	2.8	0.5	5.1	1.6	0.6	1.5	2.7	365.4	26.8	65.6	6.1	2.8	3	0.6	1.2	44.9	0.5	10.4	12.5	
KC01NC3	11.1	177	10.1	1.2	0.4	1.3	0.3	3.8	1.2	0.6	1.2	2.2	230.7	17.2	28	2	1.4	0.6	0.3	0.5	10.8	0.2	2.1	8.1	
KC01NC3	32.4	303.7	16.8	4.9	0.6	2.8	1.6	5.4	1.3	0.8	1.5	3.5	337.3	26.9	55.8	5.2	2.8	1.9	0.6	1.1	41.1	1.1	9.3	11.6	
KC01NC3	32.5	301.2	15.1	4	0.6	2.4	0.5	5.5	0.7	0.8	1.9	2.6	339.6	22.8	56.4	6.9	2.8	1.9	0.6	1.3	41.9	0.6	10.4	13.2	
KC01NC4	11.4	172.5	9.4	2.4	0.4	1.9	0.3	3.4	0.3	0.5	0.7	2.2	239.9	18.6	47.4	2.1	1.3	1.1	0.3	0.3	11.5	0.3	1.5	3.5	
KC01NC4	33.8	304.6	18.4	5.4	0.6	2.5	1.7	6.2	0.6	0.8	1	2.6	350.8	27.1	60.1	5.1	2.8	1.9	0.6	0.9	44.6	0.9	9.3	11.8	
KC01NC4	33.4	298.9	17.3	5.9	0.6	1.8	0.5	5.8	0.6	0.8	2.4	2.6	360	27.7	65.4	5.2	2.9	2	0.6	0.6	45	0.4	8.3	7	
KC01NC5	10.9	190.2	10.6	2.3	0.4	1.5	0.4	2.9	0.4	0.6	1.2	2.2	229.4	15	28.4	2.4	1.3	1	0.5	0.3	11.6	0.6	1.3	2	

KC01NC5	32.5	285.8	16.5	3.7	0.6	2.6	0.6	5.3	0.9	0.8	1	2.6	347.1	24.8	43.9	6	2.8	2.8	0.6	0.9	45.6	0.7	9.2	9.5	
KC01NC5	32.8	291.7	17.6	5.9	0.6	2.8	0.6	5.5	0.9	0.8	1.5	2.8	354.3	35.6	66.6	5.2	2.7	1.8	0.4	1.8	44.8	0.5	10	6.4	
KC01NAB	11.2	205.1	10.6	4.2	0.4	2	0.4	4.4	0.5	0.6	1.2	2.2	269.2	15.8	29.3	3.3	1.4	2.2	0.3	1	16.7	0.2	1.9	3	
KC01NAB	32.1	314.9	16.3	6.9	0.6	2.5	0.5	9.4	0.6	0.5	2.6	2.6	385.8	22.9	60.5	4.2	2.7	3.2	0.8	0.6	64.7	0.5	9.1	5	
KC01NAB	31.9	326.3	17.2	4.1	0.6	2.6	0.5	8.5	1.5	0.6	2.1	4.4	398.5	24.2	58.9	7.3	3.8	2.8	0.6	0.9	63.7	0.6	9.9	10.5	
KC01NAC	11.1	177.2	11.2	1.6	0.4	1.8	0.4	3.8	1	0.7	1.2	2.2	253.9	21.4	42.1	2.2	0.9	2.1	0.9	0.3	12.3	0.3	1.8	7.1	
KC01NAC	33	310.7	20	5.9	0.6	2.6	1.5	5.6	0.6	0.8	1.5	3.5	354	23.5	51.7	3.7	2.7	3.1	0.6	0.8	50.4	1.1	9.5	6.5	
KC01NAC	31.7	327.3	15.9	4.8	0.6	3.1	0.5	5.5	1.1	0.8	2.2	2.6	354.3	18.3	57.8	3.6	2.7	1.6	0.4	1.1	51.8	0.8	9	12.2	
KC01NBC	10.4	185.6	8.9	4.8	0.4	1.8	0.3	6	1.1	0.6	1.2	2.2	223.2	18.6	23.5	2.4	1.3	1.1	0.7	0.3	16.3	0.2	1.4	3.4	
KC01NBC	30.6	293.1	14	7.3	0.6	2.9	0.5	6.8	0.6	0.4	2	2.5	319.9	19.8	43.2	4.9	2.7	2.8	0.6	1.3	61.6	0.6	9.5	7	
KC01NBC	30.6	304.4	17.1	4.5	0.6	2.1	0.5	6.8	2.1	0.8	3.1	2.6	328.8	26.9	49.6	9.4	2.2	4.5	0.4	0.6	62.9	1	8.1	10.6	
KC01NABC	11	192.7	10.9	1.7	0.4	1	0.4	4.3	0.6	0.7	1.2	2.2	257	20.6	35.5	3.4	1.2	2.2	0.4	0.5	16.3	0.3	1.7	6.7	
KC01NABC	30.9	296.2	16	5.2	0.6	2.3	0.5	6.7	0.6	0.8	1.4	2.6	350.5	23.2	52.5	7.2	2.7	2.3	0.5	1.6	51.3	0.8	7.3	14.1	
KC01NABC	31.6	305.8	15.5	6.9	0.6	2.8	0.5	5.4	1.3	0.8	1.5	2.6	356.6	27.2	63.8	5.2	2.8	3.2	1	0.7	55.9	0.8	9.2	5	
BR-S 2g/a2	35.8	325.9	14.4	5.5	0.7	5.1	0.6	10.9	2.7	0.9	1.7	3.1	353.5	26.8	34.5	6.6	5.2	3.4	2.5	1.5	148.8	0.7	9.1	6.4	
BR-S 2g/a2	36.8	299.5	9.5	8.6	0.7	5.5	0.6	11.8	3	0.9	1.7	3	356.4	24.1	58.2	5.6	4.6	3.9	0.4	0.6	151.5	1.1	8.4	7	
BR-S 2g/a2	37	316.9	18.7	11.3	0.8	5.8	0.7	11.5	0.8	0.7	1.7	3.2	356.7	22.3	53.7	13.5	4.6	3.3	0.7	1.6	149.4	0.5	9.8	6.3	
KC04NA1	34	293.9	14.4	2.6	0.6	2.7	0.5	6.9	0.6	0.8	1.5	2.6	336	19.2	29.7	6.2	2.8	2.1	1	2	55.5	0.7	8.9	18.6	
KC04NA1	33.7	299.2	20.8	5.1	0.7	4	0.6	5.9	1.1	0.8	1.7	2.5	333.1	26	58.5	8.9	2.9	2.1	1	1.3	55.8	0.5	9.6	17.8	
KC04NA1	33.8	298	21.2	7.6	0.8	3.6	0.5	6.8	0.6	0.8	1.5	2.5	330.9	17.4	32.7	6.9	2.9	4.2	0.4	0.9	56	0.4	9.7	14.2	
KC04NA2	34.6	283	15.1	6.3	0.6	2.8	0.5	6.1	1.5	0.8	1.5	2.6	393.7	23.9	64.3	8	2.9	2.1	0.6	1.8	51.6	0.4	9.9	5.4	
KC04NA2	35.7	300.8	17.5	2.7	0.6	3.2	0.5	5.9	1.3	0.8	1.5	2.6	396.4	24.7	60.9	7.4	3.2	1.9	0.7	0.4	50.9	0.5	9.7	12.3	
KC04NA2	34.6	286	19.5	4.7	0.6	2.6	0.5	5.2	0.6	0.5	1.5	2.6	397.5	28.1	35	5.9	3	2.1	1.6	0.5	52.6	0.5	9.7	9.6	
KC04NA3	35.1	303	16.2	3.6	0.7	3.1	0.6	7.9	0.9	1.2	1.5	2.6	385.6	23.2	65.4	6.7	3	2	0.6	1.2	78.5	0.6	10.4	5.6	
KC04NA3	34.8	295.2	16	8.1	0.6	2.9	0.6	10.8	0.9	0.8	1.5	2.6	385.6	20.4	34.1	6.3	3	1.7	0.6	1	74.6	0.5	9.7	8.8	
KC04NA3	35.2	299.2	18.5	2.2	0.6	2.3	0.5	10.9	0.6	0.8	1.5	2.6	382.7	21.5	61.9	8.6	3.1	1.6	0.6	1.4	76.8	0.5	10.3	16.3	
KC04NA4	33.3	280.4	11.2	6.7	0.6	2.1	0.5	5.5	0.6	0.8	1.4	2.5	321	22.8	30.4	8.3	2.9	4.2	0.6	1.1	50.3	0.5	9.6	5.2	

KC04NA4	33.1	280.2	15.9	7.6	2.7	2	0.5	5.3	0.7	0.8	1.4	2.5	319.1	18	32.6	6.2	3.2	2	0.5	0.8	48.6	0.5	9.1	4.5	
KC04NA4	33	271.5	12.9	4	2.9	2.3	0.5	4.7	0.6	0.8	1.4	2.5	318.8	21.3	44.8	4.3	2.9	1.7	0.6	0.9	51	0.5	9.8	4.9	
KC04NA5	33	272.8	14	2.4	0.6	1.6	0.5	6.2	0.6	0.4	1.4	2.4	307.6	18.6	35.4	3.6	2.8	4	0.6	1.2	65.7	0.4	9.4	6.7	
KC04NA5	33.2	284	14.6	6.2	0.7	2.4	1.7	5.8	0.6	0.8	1.5	2.5	313.2	21.1	38.5	5.3	2.9	2	0.6	0.6	65.5	0.5	10.1	6.1	
KC04NA5	32	272.4	14.4	3.6	0.6	1.8	0.5	5.3	1.3	0.8	2.9	3.2	312.7	25.4	26.4	5.7	2.8	1.9	0.6	0.8	65	0.5	10	5	
KC04NB1	28.8	241.4	13	3.8	0.5	1.8	0.5	8.8	1.6	0.8	1.4	2.5	275.8	18.1	27.9	5.6	2.8	3.8	0.9	1.3	112.9	0.7	7.3	4.3	
KC04NB1	29.5	256.5	13.5	4.5	0.6	2.4	0.5	9.1	1.6	0.6	1	2.5	276.8	14	40	5.3	2.8	2.9	1.1	1.6	112.4	1.4	7.4	4.6	
KC04NB1	29.5	243.5	12.3	2.6	0.6	2.1	0.5	7.1	0.9	0.8	2.3	2.4	276.4	19.3	37.6	6.4	2.8	1.9	1.1	1.5	112.3	0.3	8.7	4.7	
KC04NB2	28.9	216.9	11.1	3	0.6	2	0.5	8.1	0.6	0.7	1.9	2.4	267	16.5	39.8	3.2	2.8	3.9	0.5	1.5	121.7	3.9	7.9	5.1	
KC04NB2	29.1	212.5	10.9	2.5	0.6	1.7	0.5	8.2	0.9	0.8	1.6	2.4	259.1	16.4	28.4	6.8	2.7	1.7	0.5	1.2	124.3	3.9	9.6	5.1	
KC04NB2	29.5	234	13.7	1.8	0.6	2.7	2	8.1	0.6	0.3	0.8	2.4	260.5	22.2	31.4	4.4	2.8	3.3	1.1	1.6	124.8	4.3	7.4	8.4	
KC04NB3	29.7	257.6	14.1	2.8	0.6	2.2	0.5	6.4	0.6	0.5	1.6	2.4	272.7	20.1	29.1	7.5	2.8	3.3	1	0.9	80.6	1.3	6.8	5.1	
KC04NB3	29	257.7	15.7	5.5	2.3	2.1	0.5	6.8	1.5	0.8	1.4	2.5	272.2	13.2	26.3	4.7	2.7	2	0.5	0.9	79.3	0.5	9.3	5.2	
KC04NB3	29.9	260.6	15	3.2	0.6	2.6	0.5	7.9	0.6	1	1.4	2.5	279.8	21	28	6.9	2.9	2	0.5	0.3	80.4	0.5	8	4.9	
KC04NB4	29.2	266.1	14.1	5	0.6	2	0.5	7.4	0.6	0.8	3.5	2.5	291.4	15.4	42	6.6	2.7	3.1	0.5	1.7	75.3	0.5	9.7	4.7	
KC04NB4	29.7	258.3	12.8	4.7	0.6	2.3	0.5	7.5	2.3	0.8	1.4	2.6	296.2	22.5	28.2	7.7	2.9	2	0.4	1.6	78.2	0.5	8.4	5	
KC04NB4	29.9	267.8	14.2	2.6	0.6	2.2	0.5	6.8	0.6	0.8	1.4	2.5	300.5	21.8	33.9	7.8	2.7	1.9	0.9	1.2	77	0.5	10	5.7	
KC04NB5	29.6	246.6	14.5	7	0.6	2.4	0.9	8.8	1.4	0.6	2.3	2.5	295.9	18.2	29.2	5.9	2.8	3.5	0.7	1.3	102.8	1.2	7.9	5.3	
KC04NB5	30.8	250.7	13.6	3.7	0.6	3.1	0.5	8.3	0.6	0.8	1.4	2.5	296.2	17.1	43.5	3.3	2.8	4	0.6	2.1	104.2	0.5	8.7	5.3	
KC04NB5	31.3	254	14.9	4	0.6	2.5	0.5	8.7	1.3	0.8	1.9	2.5	291.6	15	28.4	7.2	2.7	2.9	0.6	1.7	104.8	0.6	8.8	5.6	
KC04NC1	33.6	256	12.4	2.5	0.6	2	0.5	5	2.2	0.7	1.4	2.5	267.2	22.5	35.7	5.3	3.8	1.7	0.5	0.8	45.1	0.5	9	5.1	
KC04NC1	34.3	272.5	15	5.3	0.6	2.2	0.5	4.9	1	0.8	3.2	2.5	270.3	20.4	45.6	4.8	2.8	2.7	0.6	1.5	44.4	0.4	9.7	5.1	
KC04NC1	33.5	276.6	13.1	4.9	0.6	2.7	0.5	4.9	1.3	0.8	1	2.5	261.9	17.5	50.2	4.7	2.7	2.1	0.4	0.9	43.8	0.5	9.7	5.3	
KC04NC2	33	272.1	15.1	2.9	0.6	1.4	0.5	5	1.8	0.8	1.4	2	257.2	16	26.7	9.6	5.9	2	0.6	1	46.7	0.5	10.1	4.4	
KC04NC2	33.8	273.1	17.8	3.9	0.6	2.2	0.5	5.2	0.6	0.8	1.4	2.4	263.4	21.4	22.3	7.2	2.8	2.4	0.6	1.4	44.4	0.6	8.8	4.9	
KC04NC2	33.8	279.5	13.5	3.4	0.6	1.8	0.5	5	0.6	0.8	1.4	2.4	258.5	19	47.6	7.4	2.8	2	0.4	0.7	43.9	0.5	9.6	9.6	
KC04NC3	32.5	267.3	18.2	2.4	0.6	1.9	0.5	4.9	0.9	0.8	3.3	2.5	267.9	27.2	37.4	8.3	2.8	3	0.6	1.1	44.4	0.5	9.7	5.3	

KC04NC3	33	273.6	17.5	7	0.6	2.6	0.5	4.7	0.8	0.8	1.2	2.5	263.1	26.1	49.2	7	6.7	2	0.6	1	43	0.9	8.6	5.8	
KC04NC3	33.9	276.1	16.3	5.2	0.6	2	0.5	4.9	0.6	0.8	1.4	2.5	265	21	53	5	3.3	1.4	0.5	1.3	44.6	0.5	9.3	5.1	
KC04NC4	32.8	246.9	16.4	7.5	2	2.6	0.5	4.2	0.5	1	1.1	2.8	254.5	19.9	26.6	7.1	2.7	1.9	0.6	0.4	44.3	0.5	9.7	5.2	
KC04NC4	32.4	252.3	12.6	2.3	0.6	1.9	0.5	4.8	1.4	0.8	1.2	2.4	250.2	11.6	49.4	3.3	2.8	1.9	0.5	1.6	41.4	0.6	8.7	4.8	
KC04NC4	32.3	262.6	13.7	3.6	0.6	2.8	0.5	5.1	1.2	0.8	1.4	2.4	267.9	20.6	40	5.6	2.5	1.5	0.5	0.7	43.3	0.4	9.4	5.4	
KC04NC5	33.5	267.4	14.1	3.2	2.7	2.7	0.5	4.1	0.9	0.8	1.7	2.5	280.9	16.6	53.2	5.3	6.9	2	0.6	0.6	46.8	0.4	10.2	5.1	
KC04NC5	32.8	265.5	13.9	2.3	0.6	3.6	0.5	4.7	1.1	0.8	1.4	2.5	281.3	17.2	30.8	5.9	2.4	1.9	0.6	1.1	44.7	0.5	10	5.1	
KC04NC5	33.8	254.6	16	3.8	0.7	1.8	0.5	4.8	0.5	0.8	1.4	2.8	281.5	20.7	27.5	6.2	2.8	2	1	0.8	46.4	0.5	10.1	4.6	
KC04NAB	31.9	268.2	13.9	6.9	0.6	2.7	0.5	7.6	1.6	0.8	1.4	2.5	297.5	16	30.8	7.5	2.8	2	1.2	1.7	77.3	0.5	9	5	
KC04NAB	32.1	269	15.2	4	0.6	2.4	0.5	6.7	1.5	0.8	1.4	2.5	299.5	15.6	47.6	9.4	4.6	2	0.9	1.2	77	0.5	9.5	7.3	
KC04NAB	31.5	275	16.1	4	0.6	2.6	0.5	7.3	0.6	1	1.6	2.5	305.1	17.8	46.6	5.8	2.8	1.9	0.7	0.8	78.4	0.5	10.1	5.4	
KC04NAC	34.9	274.5	17.8	3	0.6	2.6	0.5	5.9	0.6	0.8	1	2.5	303.4	21.3	32.7	6.8	4.7	2	0.8	0.8	51.3	0.5	8.5	4.8	
KC04NAC	34.9	276.4	13.8	4.6	2.8	2.7	0.5	4.7	0.7	0.6	2.4	2.5	298.8	19.5	33	4	2.8	2	0.6	1.1	50.9	0.6	8.8	5.4	
KC04NAC	34.1	273.9	13.6	1.8	0.6	1.9	0.5	5.2	1.6	0.8	2.3	2.5	305.5	18.2	28.3	5.8	2.9	2.1	0.6	1.4	51.1	0.5	9.7	5	
KC04NBC	31.6	249.2	8.9	5.2	0.6	2.1	0.5	6.2	0.6	0.8	1.4	2.4	252.3	22.5	50.3	3.3	2.9	1.9	0.6	0.5	82	0.6	7.6	5.3	
KC04NBC	31.6	242.8	15.1	6.5	0.6	2.7	0.5	5.9	1.1	0.8	1.4	2.4	256.7	18.3	32.2	6.7	2.8	1.8	0.6	1.7	79.5	0.7	10.1	5.5	
KC04NBC	31.9	244.4	17.5	11.4	0.6	2.7	0.6	5.5	1.3	0.9	1.5	2.5	257.4	18.5	29.4	5.2	2.9	1.9	0.6	1.2	80.5	0.7	9.1	6.1	
KC04NABC	32.4	269.2	15.2	4	0.6	2.3	0.5	4.9	1	1.3	1.4	2.5	281.7	18.7	44.8	8.1	3.2	2	0.5	1.5	67	0.5	9.8	5.3	
KC04NABC	32.3	277.1	18.2	5.4	0.6	2.5	0.6	5.5	0.6	0.8	0.9	2.5	288.6	24	34.7	7	7.6	2	0.9	1.6	66	0.5	9.6	5.2	
KC04NABC	32	273.7	14.7	4.2	0.6	2.3	0.5	5.1	1	0.3	1.1	2.5	291.4	19.9	27.4	6.1	2.8	2	0.7	1.7	67.2	0.6	8.8	5.2	
BR-S 2g/a2	36.2	303.5	12.3	6.5	0.6	4.5	0.8	10.8	2.3	0.9	1.6	3	370.8	25.5	63.8	6.4	4.5	3.6	0.3	1.6	146.9	0.6	8.8	5	
BR-S 2g/a2	34.9	309.8	16.3	7.4	0.7	4.6	0.6	11.4	2.7	0.9	1.7	3	364.7	16	38.7	4.7	4.5	3.3	0.6	1	150.2	0.7	8.4	5.4	
BR-S 2g/a2	35.8	313.4	12.2	6.1	1.4	4.4	0.6	10	1.6	0.9	1.1	2.4	369.4	21.8	51.7	5	4.5	3.3	0.6	1.3	151	1.6	7.5	4.7	
KC07NA1	32.1	337.5	28	12.3	0.9	8.3	0.7	13.3	0.7	0.9	1.5	2.6	344.4	17.1	37.8	4.1	2.7	2	1	0.9	55.4	0.6	9.6	12	
KC07NA1	33.8	306.2	16.4	6.5	0.7	4.4	0.6	11.5	0.6	0.8	1.6	2.5	321	21	32.2	10.5	6.5	2	0.6	1.8	54	0.5	9.5	18.2	
KC07NA1	33.5	307.5	21.9	3.2	0.6	2.1	0.5	10.9	1.2	0.8	1.5	2.5	332.8	23.2	30.9	5.4	2.8	3	0.3	1.1	53.9	1.2	9.4	17.1	
KC07NA2	33.2	278.9	15.8	5.4	0.7	3.7	0.6	8.9	0.6	0.8	1.7	2.6	375.6	19.8	34.7	6.7	2.8	2	1.1	0.9	46.7	0.8	9.7	20.7	

KC07NA2	33.6	272.7	17.8	6.6	0.7	2.3	0.6	8	1.6	0.8	1.5	2.6	368.7	20.4	57.1	3.2	2.9	2.1	0.4	0.5	45.1	1.1	9.4	8.9	
KC07NA2	34.5	256.2	17	5.8	0.6	1.3	0.5	8	0.9	0.7	1.4	2.4	357.5	24.7	52.7	6.9	2.9	2.1	0.6	1.3	47.2	0.5	9.4	4.9	
KC07NA3	33.9	305.2	17.1	3.5	0.7	2.8	0.5	6.2	0.6	0.8	1.7	2.7	359.9	25	51.9	6.7	2.9	1.5	0.9	0.8	74.3	0.9	10	7.4	
KC07NA3	33.7	289	15.7	3.1	0.6	1.7	0.5	5.3	0.5	0.8	1.4	2.4	358.6	19.7	36.8	4.9	3	2	0.6	1.9	74.7	0.5	11.1	4.7	
KC07NA3	34.6	309.5	19.5	7.7	0.6	2.5	0.5	5.8	0.8	0.8	1.6	2.3	362	23.2	53.7	7.7	2.9	1.9	0.9	1.1	75.3	0.5	9.4	5.6	
KC07NA4	33	303.7	17.9	4.8	0.6	2.8	0.5	7.3	1.3	0.8	1.4	2.5	328.1	22.9	34.7	3.3	2.6	1.9	0.7	0.6	54.4	0.5	8.7	4.9	
KC07NA4	32.8	298.2	15.4	7.5	2.9	1.7	0.5	6.7	1.5	0.8	1.4	2.5	331.3	22.6	39.6	8.6	3.7	2	1.6	0.6	51.9	0.8	9.2	6.4	
KC07NA4	33.1	300.1	14	4.9	0.6	2.1	0.5	7.4	0.6	0.8	1.4	2.5	326.2	23.9	54.8	6.1	3.1	2	0.5	1.2	56.1	0.5	9.8	5.3	
KC07NA5	33.4	270.9	16.3	3.8	0.6	1.8	0.5	8.7	0.5	0.8	2.1	2.8	344	26.5	33.5	3.8	2.6	2	0.8	1.1	59.9	0.5	9	5.5	
KC07NA5	32.4	265.1	12.7	5.2	0.6	1.7	0.5	9	0.6	0.8	1.4	2.5	340.2	22.9	47.9	7	6.6	2	0.6	1.9	60.2	0.5	10.4	5.1	
KC07NA5	33.2	272.7	15.3	2.9	1.9	2.6	0.5	8.1	0.6	0.8	2.5	2.5	329.5	14.9	49.7	6.2	3.2	1.9	0.6	1.7	61	0.4	8.9	5.4	
KC07NB1	31.1	283.5	15.3	4.7	0.6	2.4	0.5	7.7	0.6	0.8	1.4	2.5	303.2	25.2	40.7	9.2	2.9	2.1	0.9	1.5	93	0.5	7.8	5.3	
KC07NB1	31.7	281.8	13.3	4.2	2.4	2.5	0.5	9.1	1.4	0.8	2.1	2.5	297.8	19.6	22.8	7.1	2.7	4.3	0.6	0.5	93.1	0.9	9.1	6.9	
KC07NB1	31.1	274.4	14.8	3.1	0.6	2.1	0.5	7.9	1.1	0.8	1.4	2.5	300.7	20.6	48.7	7	2.6	2.7	0.7	0.9	92.2	0.5	8.1	4.7	
KC07NB2	30.1	260.6	14.7	4.2	0.5	1.5	0.5	5.9	1.3	0.7	1.3	2.4	278.6	20.8	21.7	4.8	6.1	2	1.8	0.6	63.5	0.4	9.2	5.2	
KC07NB2	30.1	274.1	10.3	3.6	0.5	1.9	0.5	5.8	0.6	0.5	1.8	2.5	280.6	16.4	28.6	6.8	2.8	2	0.6	1.4	63.4	0.5	9.1	5	
KC07NB2	29.6	273	13.7	2.3	0.6	1.4	0.5	5.8	0.6	0.8	1.4	2.5	285	17.2	39.3	9	2.7	5.3	0.6	0.9	64	0.4	8.9	5.3	
KC07NB3	28.5	254.8	13.5	2.8	0.5	1.9	0.5	6	0.6	0.8	1.4	2.4	287.4	17.8	35.3	5.1	2.6	4.2	0.3	1	83.8	0.5	8.2	4.4	
KC07NB3	28.8	254.1	13.3	2.7	0.5	1.9	0.4	6.5	0.6	0.8	1.4	2.4	290.3	11.7	25.4	5.3	2.7	4.7	0.5	1.3	84.5	1.1	7	4.3	
KC07NB3	28.3	247	11.3	4.5	0.5	1.6	0.4	5.5	0.6	0.7	3.4	2.4	288	20	24.2	5.9	3.9	1.8	0.6	1.3	84.6	1.1	7.8	4.7	
KC07NB4	29.1	235.4	12.7	2.1	2.2	1.9	0.4	8.6	0.6	0.7	2.9	2.4	275.9	21.4	23.4	6.5	2.8	1.9	1.3	1	103.6	0.7	8.4	6.5	
KC07NB4	29.1	238.9	10	5.1	0.5	2.2	0.5	9.6	0.6	0.7	2.7	2.4	270.5	12.6	31.6	4.5	2.7	1.9	0.5	0.7	103.3	1	7.1	5	
KC07NB4	29	222.1	11	5.2	0.5	2	0.5	8.8	0.9	0.8	1.4	2.4	273.5	15.3	22.9	7.3	3	2.4	0.5	1.1	102.9	0.8	7.2	4.6	
KC07NB5	31.5	263.6	11.4	5.8	0.6	1.3	0.4	7.4	0.9	0.8	1.4	2.5	307.3	19.2	33.4	2.4	2.5	2	0.5	1.4	82.5	0.6	8.6	4.9	
KC07NB5	32.2	259.4	13.2	5.6	0.5	2.2	0.5	7.2	1.1	0.8	1.4	2.5	312	23.2	34.3	10.6	2.8	1.9	0.6	0.9	80.5	0.5	9.3	4.7	
KC07NB5	32.1	255.4	12.3	4.8	2	1.5	0.4	6.6	1.5	0.8	1.4	2.5	311.3	16	37.5	3.5	2.8	3.1	0.3	2.2	80.2	0.8	8.1	4.6	
KC07NC1	32.5	292.5	10.8	5	0.6	1.3	1.1	5.9	1.3	0.8	1.4	2.5	280.1	17.9	54.1	2.8	2.8	1.8	0.6	1	41.8	0.3	8.4	4.9	

KC07NC1	32.9	295.8	13.7	3.9	0.6	1.9	0.5	5.7	0.8	0.7	0.8	2.4	286	21.8	33.6	5.5	2.7	2.3	0.6	1.3	43.3	0.5	9.6	4.7	
KC07NC1	33.1	285.1	15.3	4.4	0.5	1.2	0.5	5.4	0.6	0.8	1.4	2.5	283.4	19.9	36.3	4.9	2.7	3.8	0.8	1	43.5	0.4	9.9	4.9	
KC07NC2	32.5	277	11.6	1.8	0.6	1.6	0.5	5.1	1.2	0.7	1.4	2.4	280.9	23.7	51.2	5.7	2.6	2	0.6	1.3	41.4	0.5	9	9.6	
KC07NC2	32.3	261.7	11.9	3.3	0.6	1.3	0.5	4	0.6	0.8	1.8	2.5	276.5	23	49.8	7.2	3.7	2	0.6	1.3	41.2	1.1	8.4	5.1	
KC07NC2	33.1	268.4	14.5	4.4	0.6	1.8	0.5	4.4	1.8	0.8	1.9	2.6	281.8	25.5	41.5	6.2	2.8	1.9	0.5	1.5	43.1	1.4	8.4	3.7	
KC07NC3	32.8	296.7	14	5.2	0.5	0.8	0.5	5.3	1.5	0.7	1.3	2.4	273.4	20.7	32.1	4.6	2.7	1.9	0.6	0.8	46.4	0.4	9.5	4.6	
KC07NC3	32.5	297.7	15.5	3	1.5	2.5	0.5	4.2	1.1	0.8	1.4	3	271.7	22.3	34.5	3.5	2.2	1.9	0.5	0.8	43.8	0.5	9	5	
KC07NC3	32.9	302.5	11.2	2.2	0.6	1.4	0.5	4.5	0.6	0.8	1.4	2.5	274.1	22.7	31.7	6.7	2.8	2.2	0.7	0.9	47.2	1	8.2	5	
KC07NC4	32.7	260.7	11	5.1	0.5	1.7	0.5	4.4	0.5	0.7	1.3	2	273.5	21.2	53.1	7.1	2.5	2.6	0.5	0.7	46.2	0.5	8.5	5.2	
KC07NC4	33.2	272.4	15.3	3.3	2.8	1.9	0.5	4.4	1.1	0.7	1.4	2.4	267.9	22.4	29.5	3.9	2.8	2	0.4	0.9	46.6	1.1	9.6	4.9	
KC07NC4	32.9	271.1	15.4	4	0.6	1.6	0.4	4.6	0.5	1	1.4	2.5	272.2	19.7	55.8	7.2	2.8	2.8	0.6	1.1	45	0.5	8.9	5.3	
KC07NC5	33.8	281.4	14.2	3.5	0.6	1.9	0.5	4.9	1.7	0.8	1.4	2.5	278.7	20.4	38.5	2.5	3.7	1.9	0.9	0.8	45.2	0.5	10.3	5.7	
KC07NC5	33.2	288.6	13.5	4.2	0.6	2.6	0.5	4.4	0.6	0.8	1.4	3.3	286.4	29.3	29.2	8.5	3	2.5	0.6	1	45.8	0.5	8.4	5.4	
KC07NC5	33.9	281.1	16.3	2.9	0.6	1.3	0.5	5.2	0.6	0.8	1.8	2.4	278.2	17.9	32.8	5	2.8	1.5	0.4	0.6	42.4	0.4	9.2	4.9	
KC07NAB	32.6	273.2	14.4	3.8	0.5	1.8	0.4	7.9	1.5	0.7	1.2	2.4	298.5	19.9	32.1	6.9	2.8	2	0.5	0.8	76.1	1	9.3	4.9	
KC07NAB	32.3	269	14.7	4.3	2	2.2	0.4	8.7	0.6	0.4	1.4	2.4	291.4	21.2	33.4	4.5	2.8	1.9	0.6	1.1	79.4	0.5	8.5	5.1	
KC07NAB	32.8	277	14.2	5.3	0.6	1.8	0.7	9.2	1.1	0.8	1.4	2.5	301.3	19.4	49.3	6.1	3.6	2	0.5	0.6	78.3	0.5	7.9	4.9	
KC07NAC	33.8	276.3	14.4	4.6	0.5	1	0.5	5.7	0.6	0.7	1.4	2.3	280	28.1	54.6	6.6	2.8	6.1	0.5	0.8	49	0.7	8.8	4.7	
KC07NAC	32.9	273.9	11.7	6.2	0.5	1.6	0.5	5.9	0.6	0.8	2	2.4	280.6	18	27.8	5	3.6	1.4	0.8	1.2	51.6	0.7	9.2	4.9	
KC07NAC	32.9	272.3	13.3	3.8	0.6	2.4	1.6	5.7	1	0.8	1.2	2.4	282.4	20.7	26.2	7.4	2.8	1.7	1	0.6	50.3	0.4	8.7	5.3	
KC07NBC	32.1	277.8	14.9	2.8	0.6	1.4	0.4	6.3	1.5	0.8	1.4	2	287.7	31.6	57.2	5.2	2.5	2.5	0.6	0.9	70.2	0.5	10	4.5	
KC07NBC	31.9	258.2	13.9	4.8	0.5	1.3	0.5	6.6	2.4	0.8	1.9	2.5	285.8	18	35.7	8.3	3.6	3.6	0.6	1	74.8	0.5	9.9	5.1	
KC07NBC	31.7	274	12	5.5	0.6	1.3	0.5	7	1.4	0.7	1.8	3.8	288.9	27.4	31.3	5.2	2.5	1.5	0.5	0.7	70.7	1.2	8.1	4.9	
KC07NABC	32.6	273.5	12.4	4.2	0.6	1.1	0.5	8.9	1.4	0.8	1.6	2.5	291.7	19.6	32.3	4.1	2.7	1.9	1.1	1.4	62.3	0.8	8	5	
KC07NABC	33.2	270.8	12.8	4.7	0.6	1.6	0.5	7.6	1.3	0.8	1.4	2.5	290	21.5	47.7	3.9	2.9	2.9	0.5	1.1	65	0.9	8.3	5.4	
KC07NABC	33.1	284	12.4	4.7	0.5	2.1	0.4	7.9	0.6	0.8	1.4	2.5	290.5	20.4	31.4	7.5	5.1	2	0.8	1.5	63.6	0.5	10	4.5	

Appendix 5.5: XRF Raw Data for London Samples

Element	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Rb	Sr
Dimension	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
BR-S 2g/a	300	12190	68110	260300	1080	3504	120.8	23290	27370	4471	108	133.8	538	41580	37.2	38.6	84.5	381.9	13.3	0.5	13.6	0.9	5.5	97.9	125.7
BR-S 2g/a	280	12250	68560	259000	1087	3545	119.6	23440	27660	4521	90	129.8	539	41470	27.3	39.9	85.5	383	15.8	1.7	15.2	0.5	5.6	96.9	124.7
BR-S 2g/a	290	12480	68010	259700	1060	3513	110.5	23490	27570	4487	93	128.8	547	41520	31.3	42.8	89.9	382.4	15.7	1.3	14.7	0.9	5.2	96.1	125.2
KC10LA1	280	2370	18130	203900	1437	2483	99	10950	5763	3233	53.1	66.3	510.2	15570	12	18.5	23.9	72.8	5.8	2.7	9.9	1.4	15	49.4	57.3
KC10LA1	260	2720	20910	220000	1611	2642	93	11660	6057	3404	68.5	65.8	504.4	15720	11.1	18.5	25.5	73.7	7.2	2.8	9.5	1.2	15	50.6	57.5
KC10LA1	260	2530	20890	221900	1599	2663	95.6	11630	6044	3387	58.7	59.5	517.8	15630	12.8	19.6	24.5	74.3	7.8	2.9	9.8	1.1	14.5	50.5	57
KC10LA2	290	2380	18440	182200	1860	3677	194.2	10100	7055	2949	62.2	51.3	410	16360	6.4	22.5	40.3	94.1	8.1	3.5	11	1.2	20.1	45	54.9
KC10LA2	230	3410	18720	181200	1823	3640	175.1	9891	7126	2969	53	47.1	427.2	16350	26.2	21.8	37.8	95.3	7.7	3.9	9.5	1.3	21.4	45.7	54.9
KC10LA2	270	2810	18950	184600	1939	3683	191.2	10160	7231	3008	69.1	61.3	423.8	16500	19.2	22	39.7	96.1	6.8	2.7	10.5	1.5	20.9	44.7	54.7
KC10LA3	270	1850	17080	216300	1555	2619	85.7	10620	5823	3293	50.2	76.5	510.5	15540	15.8	22	26.1	84.3	6.6	2.9	11.4	1	14.7	47.5	56.9
KC10LA3	280	1910	17460	213700	1570	2654	101.2	10620	6014	3316	63.2	60.5	537.4	15750	20.7	20.2	29.4	84.7	7.6	2.3	9	1.5	14.8	47.5	57
KC10LA3	270	2120	17290	212900	1616	2677	106.8	10640	5865	3406	55.9	60.1	530.6	15720	20.1	19.8	27.4	83.1	6.5	2.8	8.6	1.2	14.8	48.5	56.7
KC10LA4	270	2750	18670	198100	1563	2653	158.3	10190	7159	3016	48.2	54.8	814	14970	15.5	16.1	26.9	88.8	7	2.7	8	0.9	13.8	43.9	54.9
KC10LA4	280	1980	18930	197700	1556	2689	164.9	10300	7414	2994	60.1	35.3	816	15060	10	19.3	29.4	88.7	7.3	2.5	8	0.9	13.8	45.6	55.7
KC10LA4	260	3220	19120	199200	1613	2758	168.6	10300	7536	3034	60.7	67.1	838	15210	21.3	17.4	25.4	92.3	7.2	2.7	8.5	1.1	14.1	46.2	55.5
KC10LA5	230	2640	14940	152900	1965	4138	281.8	8578	11840	2536	53.3	65.6	1122	13680	14.1	21.5	40.4	126	6.2	2.5	8.6	1.2	19.1	37.6	57.3
KC10LA5	230	2680	15660	152700	1988	4194	271	8836	11850	2546	49.2	46.1	1112	13750	25.4	19.5	41.3	125.5	5.7	2.7	7.6	1.2	19.6	37.2	57.2
KC10LA5	300	2140	15570	153100	1990	4200	268.8	8566	11940	2533	53.8	53.5	1107	13770	20.4	20.7	43.5	126.7	5.7	2.2	6.7	0.9	20	37.1	58.1
KC10LB1	290	5880	35780	186800	2553	3483	139.1	11510	36760	2601	63.5	66.6	546	27490	22.2	37.1	79.2	235.9	8.9	2	10.2	0.9	13.2	47.1	145.7
KC10LB1	280	6900	36160	189700	2586	3525	129.9	11500	37220	2603	79.9	62.5	563	27590	21.6	40.4	77.2	237.9	8.7	2	11.5	0.4	11.7	48.7	147.6
KC10LB1	220	7120	36450	189900	2562	3561	134.7	11680	37120	2664	59.2	54.6	587	27770	26.6	38.3	80.5	238.7	9.5	1.8	12.5	0.7	12.3	48.1	149.2
KC10LB2	220	7410	35150	198600	2518	3432	107	11600	38500	2576	49.8	54.4	508	28120	24.1	37.4	83.7	228.5	7.7	2.3	9.5	0.8	12.6	48.3	146.5
KC10LB2	280	6480	35530	199100	2524	3475	96.9	11720	38330	2565	72.6	48.7	509	28090	17.4	42.9	86.3	229.1	8.3	2.2	8.5	0.7	12.5	46.5	146.9
KC10LB2	220	7490	36260	199400	2505	3479	98.7	11700	38690	2606	55.3	52.3	530	28210	25.4	43.9	83.2	232.4	7.5	2.4	9.8	0.7	12.3	47	146.9

KC10LB3	280	6040	35790	190600	2715	3611	82.3	11760	35850	2683	54.6	49	659	28730	17.8	40.4	84.7	247.8	9.3	2.3	12.7	1	13.6	47.9	141
KC10LB3	260	6640	36830	192500	2720	3634	75.3	11470	35820	2686	66.5	73	651	28820	28.3	40.2	82.7	246.1	9	2.1	15.7	0.7	13.7	48	140.2
KC10LB3	220	7120	36870	192500	2781	3564	71.6	11560	35960	2646	76.3	51.7	670	28760	26.9	45.2	83.5	250.2	8	2.6	13.9	0.7	14.2	48.8	140.1
KC10LB4	230	5490	38790	173700	2168	4514	358.1	9503	30700	2863	77	68.6	920	33830	42.2	58.7	143.2	414.1	5.7	4.4	25.9	1.1	29.7	49	132.6
KC10LB4	220	5690	38620	174200	2216	4487	357.3	9531	30550	2913	80.4	82.8	933	33690	29.2	63	141.3	417.2	7.7	4.3	25.3	1.3	30.3	49	132.5
KC10LB4	230	6150	38680	175200	2207	4522	345.4	9621	30580	2857	72.5	83.3	934	33900	34.4	65.1	139.5	422.1	7.4	4.1	25	1.2	29.2	50.7	133.4
KC10LB5	210	5040	32160	192700	2299	3378	175.1	10650	32110	2691	53.4	52	666	27850	29.4	43.2	92.3	201.4	7.7	3.5	15	0.6	16.9	47.2	118.8
KC10LB5	260	4420	31840	194900	2279	3389	171.3	10620	32210	2685	60.8	62.6	640	27810	9.7	42.3	89.1	203.6	8.4	3.2	16.2	1	16.7	46.5	118.9
KC10LB5	260	4440	31530	194900	2319	3384	162.5	10440	32170	2707	76.3	79.4	656	27870	28	43.5	88.7	202.7	8	2.9	13.4	0.8	16.1	47	118.5
KC10LC1	270	4160	40150	228600	1959	2928	81.1	10060	13840	3588	89.5	93.2	365.7	17460	27	31.9	42.7	141.8	9.1	2.2	11.2	2.5	16.5	36.1	79.5
KC10LC1	190	5490	40460	230500	1980	2929	90.3	10270	13810	3604	63.3	97.1	369.1	17420	25.4	30.5	42.6	140.7	10.1	1.9	10.6	2.7	16.5	35.9	81
KC10LC1	280	3820	39990	232600	1920	3017	84.4	10480	13830	3638	88.9	75.2	377.6	17540	11.3	36.7	42.4	142.5	9.2	2.6	11.5	2.2	16.9	36.2	79.6
KC10LC2	200	5410	41920	240700	1755	2732	45.6	10600	12460	4006	76.2	95.6	315.1	17320	23.7	32.8	40.4	120.1	10.7	3.2	11.1	2	15.2	40.2	80.9
KC10LC2	260	4340	41420	242700	1754	2740	50.1	10500	12550	3935	85.9	82.5	318.4	17300	25.2	33.2	41.3	125.2	9.5	2	9.2	2.3	16.1	39.7	81.3
KC10LC2	270	4100	41760	244400	1684	2743	48.5	10190	12200	3934	84	93.5	301.7	16560	17.1	30.9	38.4	117.1	9.1	2.5	8.5	2.1	15.5	39.1	79.6
KC10LC3	260	4920	40420	238800	1751	2732	134.6	9884	12680	3711	76	92.3	295.1	16270	23.4	32.1	37.4	466.5	7.4	2.3	6.6	2.7	16.3	37.1	76.8
KC10LC3	260	4690	40310	241600	1788	2753	124.8	10300	12690	3569	50.4	103	291.1	16300	21	28.9	39.1	466.9	9.9	2.8	8.4	2.6	17.2	37.2	77.7
KC10LC3	280	3880	40000	240900	1738	2726	132.8	10210	12760	3728	88.1	104.3	302.8	16310	20.6	33.5	38.9	474.2	7.9	2	7.8	2.9	16.8	37.5	77.1
KC10LC4	290	3100	37450	220100	1713	2765	54.1	9900	12200	3478	78.6	95.5	351.6	16970	16.2	36.9	40.3	134.1	9	2.9	10.1	2	16.4	36.5	77.1
KC10LC4	380	5840	39860	229800	1905	2952	142.3	10330	12910	3641	69	115.6	354.7	17170	22.3	34.8	40	140.5	9.2	3.2	11.3	2.5	16.8	36.5	77.5
KC10LC4	280	3400	40040	228100	1800	2826	119.4	10350	12560	3611	79.8	80.1	353.7	17190	21.2	37	40.2	135.8	10.6	3.1	10.9	2.2	17.5	37.7	78.3
KC10LC5	280	3560	39220	227300	1828	2848	82.5	10120	12770	3659	80.9	97.3	307.9	17460	21.6	33.8	41.6	126.5	8.4	2.8	8.2	1.9	16.9	38.7	77.7
KC10LC5	260	3950	39810	229200	1838	2883	76	10320	12790	3719	95.1	102.4	303.7	17400	12.4	34.4	41.8	129	8.9	2.5	8.3	1.9	16.8	37	78.7
KC10LC5	280	3620	39750	231000	1770	2918	69.9	10300	13040	3764	89.7	99.6	324.9	17770	20.1	36.7	43.6	131.2	9.1	3	11.3	2.2	16.4	38	79.5
KC10LAB	280	5230	40560	214200	2124	3023	91	11320	26480	3248	70.8	82.2	482.4	23560	8.4	38	62.2	189.5	9.7	3.2	12.2	1.3	15.1	42.6	124.1
KC10LAB	290	5610	40210	215800	2151	3033	75.3	11200	26750	3260	60.9	79.8	490.1	23600	34.6	35.2	62.6	195.7	10.4	1.9	10.7	1.2	14.9	42.9	124.4
KC10LAB	280	5790	40540	216900	2102	3060	83.4	11100	26860	3201	75.7	90.6	499	23630	26.7	36.2	63.5	193.3	9.4	1.9	11.5	1.3	14.9	44.1	124.7
KC10LAC	260	3650	37570	231700	1631	2809	53.8	10110	11660	3626	89.2	94.7	359.7	16650	6.8	33.3	38.3	123.1	8.5	2.4	7.1	1.8	16.7	37.9	74.8
KC10LAC	250	4210	37480	234800	1647	2817	0.4	10350	11730	3676	79.7	87.2	391.7	16590	13.9	31.9	39.6	125.9	8.4	2.2	8.9	2	16.9	37.1	75.4

KC10LAC	270	3480	37360	234700	1643	2807	41.1	10190	11780	3650	83.4	93.4	397.6	16660	16.9	32	41.1	125.5	9.7	2.5	8.7	2.4	17.2	37.2	75.1
KC10LBC	280	4420	29250	193500	2202	3150	115.4	11150	24080	2970	81.4	59.4	568	22780	25.8	31.1	59	177.5	8.1	2.7	11.9	0.8	14.6	48	111.6
KC10LBC	280	4400	29480	195000	2215	3131	117.2	11170	24030	3040	74.8	66	564	22840	8	32.8	56.8	174.2	7.7	1.6	11.7	0.6	15.2	48.8	112.8
KC10LBC	260	5090	28960	195700	2147	3107	111.5	11210	24390	3041	67.3	55.9	575	22850	21.4	29.8	59.4	176.6	8	2.2	12.5	1	14.5	48.6	112.4
KC10LABC	270	4130	38030	218500	2000	2968	72.4	11040	19910	3442	80.6	84	436.4	21000	21.6	37.1	55.6	169.1	8.3	2.4	10.4	1.8	15.1	42.7	105.2
KC10LABC	270	4760	37890	220400	2022	2908	10.6	11020	20060	3232	59	69.2	434	20950	20.8	35.8	53.6	170.9	8.9	2.2	10.5	1.2	15	42.4	105.9
KC10LABC	260	5020	37010	221300	1973	2955	8	11080	20020	3455	76.4	73.3	441.6	21050	31.5	34.1	55.9	173.1	9.3	2.5	8.7	1.6	15.7	42.7	106.5
BR-S 2g/a	280	10570	58530	227300	898	3146	86.3	20790	24870	4187	66	123.6	532	40950	21	41.5	92.3	391.4	13.5	1.7	14.9	0.7	5.5	100.8	129.2
BR-S 2g/a	6800	8370	42630	156600	621	2198	316.1	12770	14620	2390	50	68.8	305.2	23780	22	28.2	50.2	215.9	7.8	0.5	7.7	0.6	3.1	56.7	73
BR-S 2g/a	270	10740	59310	226400	881	3059	63.3	21090	25070	4157	100	117.8	528	41030	34.7	39.2	89.7	400.9	15.5	1.1	14	0.6	5.3	100.2	128.3
KC01LA1	220	2570	14030	139800	1594	3368	224.4	7957	7622	2501	47	58.3	673	14040	5.7	22.3	33.6	93.2	5.4	2.6	9	1.2	20.1	41.4	56.6
KC01LA1	270	1700	14640	140600	1567	3208	222	7958	7500	2505	55.6	55.8	663	14010	16.7	20.3	33.7	94.6	6.2	2.6	8.4	1.6	19.9	42.1	57.4
KC01LA1	260	2290	15880	142600	1487	3144	204.5	7989	7512	2457	49.4	57.9	674	14120	6.2	21	34.3	93.6	5.6	2.1	8	1.6	20.4	42.5	57.4
KC01LA2	230	3080	17170	181400	1390	2455	148.2	9700	5587	3093	58.6	53.5	499	16110	6.4	19.4	25.4	77.9	6.5	2.5	10.3	0.8	14.5	52.4	60.9
KC01LA2	840	2800	16820	182200	1320	2354	143.2	9398	5287	3019	55.3	54.5	499.4	15700	6.3	21.8	26	74.6	7	2.7	10.1	1.7	13.9	51.3	59.6
KC01LA2	220	2980	17780	188500	1313	2314	128.7	9949	5562	3105	52.1	62.3	526.7	16160	16	20.9	26.7	76.7	8	2.8	9.9	2	14.8	52.4	61.6
KC01LA3	290	1840	23170	215400	1155	1818	28.9	11340	2839	3715	70.3	66	257	19130	7.1	19.4	26.3	64.8	9.1	2.5	12.6	1.2	15.9	62	60.1
KC01LA3	4040	3460	23500	212700	1173	1854	2	10980	2960	3599	78.4	71.5	265.4	19030	15.3	23.5	25.5	63.5	8.5	2.6	13.9	1.2	15.7	60.8	58.9
KC01LA3	270	2310	24140	219400	1162	1830	2	11130	3006	3702	70.2	79.6	269.1	19320	7.9	22.8	26.9	65	8.6	3.5	13.9	1.1	17.1	61.5	59.7
KC01LA4	260	1740	15420	153600	1486	3014	193	8580	5542	2642	51.1	59.4	267.2	15130	6.1	21.5	35	83.4	6.1	3.1	8.1	1	20.8	45.4	55.2
KC01LA4	210	2570	15600	153300	1436	2960	187.5	8464	5401	2566	51.3	48.6	272.9	14830	13.6	20.1	33.4	83.4	6.6	3.3	8.9	1.2	19	44.8	55.4
KC01LA4	260	1870	15750	158700	1412	2947	179.2	8478	5507	2604	63.8	67.6	259.7	15090	9	22	32.9	87.8	7	3.4	8.7	0.9	20.3	45.5	56.2
KC01LA5	280	1850	16840	180200	1406	2470	124.4	9374	4915	3039	54.4	55	222.6	16940	6.5	19.1	30.9	77.9	7.8	3.3	10.4	1.1	18.1	50.4	57.1
KC01LA5	220	2870	16980	180500	1342	2387	118.6	9126	4804	3025	53.4	60.8	223.8	16370	10.6	20.4	30.5	77.7	7.3	3.7	10.2	1.1	17.9	49.5	57
KC01LA5	210	2810	17740	186300	1345	2394	110.1	9435	4951	3118	56.7	72	236	16850	10.5	23.5	29.9	80.1	7.9	2.8	9.1	0.7	17.7	52.5	57.1
KC01LB1	240	4990	31730	130800	2703	3621	121.2	9330	30040	2368	68.8	65	750	32120	29.2	53.4	116.4	375.2	9.3	2.8	19.1	1.4	23.1	52	130.8
KC01LB1	270	4600	30860	128600	2673	3501	61.3	9057	29240	2281	70.3	50.5	738	31240	14.3	49.9	115.2	362.2	9.7	2.5	17.6	1.3	23.1	50.9	127.6
KC01LB1	230	5450	31590	132400	2705	3694	124.4	9285	30350	2325	66	73.5	773	32240	22	54.1	117.9	378.6	9.8	2.7	17.6	1	23.6	53	130.1
KC01LB2	260	5340	31790	166800	2204	3083	101.1	9113	34330	2571	63	53	668	28410	24.4	44.3	89.9	247.6	9	1.5	14	0.9	16.7	48	154.5

KC01LB2	250	5020	30900	165500	2160	3044	38.8	9093	33700	2494	60	70.8	653	27760	19.7	44.6	89.6	243.5	8.4	1.9	13.6	0.9	17	46.4	153.3
KC01LB2	270	4750	31350	168800	2188	3086	92.3	9431	34750	2617	51.2	47.7	674	28460	25.5	44.9	92.6	250	7.9	2.6	12.6	0.4	17.1	47.6	157.3
KC01LB3	230	3860	26910	142900	2285	3526	151.4	7762	31150	2662	56.5	62.7	707	27810	39.2	52.5	136	461	6.3	4.8	17.6	0.4	33.7	44.7	142.7
KC01LB3	220	4110	26590	144000	2226	3415	145	7479	30620	2611	64.3	55.5	685	26820	28.4	51.6	135.1	443.4	7.3	3.1	16.9	0.9	32.8	43.8	138.2
KC01LB3	230	3970	27430	148900	2244	3443	129.3	7757	31210	2651	56.7	70.6	709	27540	20.8	58.4	131.1	458.3	7.2	4.1	16.1	1.2	34	44.1	144.3
KC01LB4	280	4730	31200	169100	2235	2967	61.8	9720	30700	2491	67.3	67.9	636	28310	18.9	40.8	88.2	246.7	7.7	2.3	13.2	0.8	14.9	48.7	141.9
KC01LB4	290	4600	29950	165800	2160	2902	57.7	9426	30090	2413	56.2	61.7	617	26960	28	41.1	85.9	231.7	8.1	2.5	12.3	0.9	14.9	46.8	138.4
KC01LB4	220	5570	31770	170700	2187	2906	12	9579	30840	2510	53	68.7	642	28210	23.2	40.5	86.6	243.4	8.6	2.4	10.4	1.1	15.3	48.8	142.5
KC01LB5	230	4860	34220	155900	1978	3516	169.6	8377	29580	2651	74.9	76.3	885	33950	25.6	56.8	130.5	378.9	7.9	3	20.2	0.4	26.5	50.5	133.8
KC01LB5	230	4650	33840	155300	1960	3492	169.6	8025	28600	2596	72.1	49.2	859	33000	48.3	51.2	125.4	365.4	7	3.2	20.5	1.1	24.6	49.9	130.2
KC01LB5	270	4180	34210	158600	2028	3520	172.1	8241	29570	2651	75.3	79.7	896	34090	31.8	59	127	382.7	6.5	3.8	20.2	1.1	27.1	50.8	132.9
KC01LC1	280	3120	34920	209900	1417	2371	17.2	8534	10660	3633	77.6	85.9	317.5	17830	21.9	34.9	46.8	165.4	9.9	3.5	12.1	2.5	18.9	40.3	85.5
KC01LC1	930	3850	34000	204900	1365	2371	0.4	8235	10520	3430	73.6	76.6	304.8	17420	33.8	37	46.5	162.2	10.2	3.2	9.7	2.5	18	38.7	83.3
KC01LC1	220	4320	34200	209300	1365	2330	18.5	8348	10580	3400	61.7	90.5	317.6	17910	14.2	36.8	51.3	164.6	10.7	3.7	10	2.7	18.6	40.1	85.5
KC01LC2	220	4460	35880	210300	1539	2429	0.6	8973	10600	3609	76	88.1	296	16530	13.7	32.7	39.6	116.7	9.9	2.9	6.9	2.1	16	38.1	80
KC01LC2	280	2930	35060	206000	1525	2420	48.3	8706	10640	3495	78	105.4	285.3	16120	17.5	30.6	33.9	113.9	9.3	2.4	7.8	1.8	15.7	37.3	76.5
KC01LC2	280	3260	35640	213300	1551	2401	39.4	8939	10830	3660	84.3	93.3	300.9	16640	28.3	29.3	35.6	114.9	10	2.5	5.5	1.6	16.3	38.7	79.8
KC01LC3	280	3090	36830	200400	1526	2456	0.6	8698	11620	3556	74.8	88.9	318.2	17950	27.2	33.2	40.8	130.6	9.7	2.8	10.3	1.8	17.4	39.5	81
KC01LC3	220	4450	36530	198100	1529	2404	2	8498	11130	3506	65.5	78	330.6	17380	6.8	33.5	37.3	122	9.3	2.7	9.1	2.1	17.1	39	77
KC01LC3	270	3530	36700	203600	1551	2401	2	8840	11490	3619	84.5	89.5	340.3	18040	33.6	33.4	40.4	127.8	9.8	1.4	9.8	2	17	39.5	80.6
KC01LC4	280	3410	34140	216400	1263	2195	2	8435	10260	3536	65.2	107	233.2	15890	22.6	33.1	36.8	212.8	9.3	2.4	7.5	2.4	15.2	40.1	80
KC01LC4	270	3250	33690	212800	1284	2140	2	8291	10350	3470	61.6	84.4	245.8	15680	29.3	28.4	32.8	210.6	8.8	2	7	2.4	15.3	39.2	78.3
KC01LC4	270	3780	34510	217700	1310	2189	0.6	8393	10440	3528	75.4	91.4	243	16000	20.1	31.8	36.6	215	9.3	2.1	7.9	1.8	15.9	39.8	80.4
KC01LC5	270	3180	34030	210100	1438	2271	2	8576	10840	3542	71.1	84	288.8	16960	7.2	33.8	36.9	126.9	8.6	1.4	6.6	1.9	16.4	38.6	82.1
KC01LC5	270	2840	33250	207600	1396	2279	2	8489	10670	3555	86.8	80.4	288.8	16740	9.2	33.4	36.9	121.7	8.6	2.2	8.9	2.2	16.7	37.1	77.3
KC01LC5	290	2860	33400	213300	1430	2264	0.8	8559	10910	3634	96.2	89.6	279.9	16950	16.1	32.3	40.1	127.9	9.8	2.3	8.4	2.2	16.7	38.5	80.7
KC01LAB	230	4220	25370	130200	2243	3595	176.9	8540	20300	2470	70.2	52.6	728	24420	15.8	40	82	248.7	6.5	2.8	12.2	0.9	21.8	47	99.8
KC01LAB	220	4050	23930	127000	2105	3379	162.4	7970	19440	2335	70.4	57.3	693	23550	22.8	37	76.3	238.7	8.3	2.5	12	0.8	20.9	45.1	97
KC01LAB	260	3790	24650	131900	2232	3557	170.6	8452	20410	2513	78.1	53.9	723	24420	19.8	38.2	77.3	244.7	6.7	2.4	15.9	1.4	21.6	47	101.5

KC01LAC	270	2650	29400	191200	1442	2542	82.5	8139	9543	3268	67.7	80.4	377.5	16700	19.3	30.8	43.8	145.2	9	3.3	10.7	2.2	18.8	40.7	79.2
KC01LAC	210	4190	29070	189700	1456	2578	77.6	7960	9435	3267	66.9	89.2	383.3	16390	16.7	34.3	43.1	148	9.5	2.9	10.5	2.2	17.7	39.1	76.9
KC01LAC	210	3570	28990	189800	1399	2535	81.2	8106	9486	3260	67.3	69.7	388.9	16810	6.8	33.5	44	146.1	7.3	2.9	10.9	2.1	19.5	41.2	79
KC01LBC	280	3600	33130	196400	1786	2618	48.2	8840	15170	3182	60.1	65.7	407.9	20440	17.9	37	56.7	196.7	8.3	2.8	11.1	1.7	18.8	43	96
KC01LBC	290	3070	33010	190200	1751	2575	49.2	8612	14760	3201	80.2	71.4	399.9	20030	29.2	35.2	60.3	193.6	8.1	2.8	9.7	2.2	18.7	41.3	92.1
KC01LBC	210	4860	32650	196600	1720	2644	41.1	8883	15030	3135	60.7	73.6	400.8	20460	35.7	39.1	61.2	200.5	9	2.2	10.4	2.1	19	42.4	96
KC01LABC	220	4530	30410	183200	1734	2822	86.1	8478	13370	3169	71.1	75.6	430.3	19500	21.3	34	56.8	182	8.5	3.2	10.7	1.9	19	42.3	88.3
KC01LABC	210	4010	29790	180100	1665	2763	81.2	8383	13180	3066	71.1	69	434.7	18820	16.3	35.3	55.8	175.5	8.5	2.3	10.7	2	18.6	40.9	85.7
KC01LABC	260	3410	30130	184900	1697	2759	85.8	8517	13350	3209	63.8	68.7	437.9	19450	17.2	36.3	53.2	181	9.1	2.6	10.6	2	19.1	42.9	87.8
BR-S 2g/a2	270	13800	72550	267100	1164	4195	21.8	24020	27870	4529	87	150.5	578	42040	31.9	39.8	88.8	410	14.6	2.3	15	0.7	5.9	96.2	124.5
BR-S 2g/a2	290	12870	72230	266800	1164	4140	14.7	23850	27950	4535	77	141.5	546	41930	19.5	40.2	87.9	410	15.5	1.1	15.5	1.1	4.9	96.7	123.6
BR-S 2g/a2	270	13190	71940	267700	1165	4177	2	23940	27900	4535	102	150.7	557	41840	14.1	39.9	92	409.7	15	1.7	16.5	0.4	5.2	99	124.2
KC04LA1	290	2810	23080	242000	1792	2177	97.4	12040	4386	3760	57.1	79.9	314.7	18160	6.9	18.2	22.6	69.9	7.9	1.2	9.1	0.8	11	55.4	56.3
KC04LA1	290	2420	24620	255000	1881	2251	83.1	12450	4393	3815	83.1	88.3	345.9	18270	7.8	18	22.3	71.1	7.4	2	7.8	1	11.7	55.3	56.4
KC04LA1	2290	4440	25260	258300	1900	2322	84.8	12500	4409	3846	60.8	88.8	332.2	18240	17.5	16.4	19.3	70.1	7.2	1.9	8.1	0.7	11.1	55.9	57
KC04LA2	280	2600	23100	212500	1862	2828	144.2	11560	5557	3489	75.7	63.1	351	17700	6.7	20.8	26	73.6	7.2	3	11.7	0.8	13.6	52.5	56.9
KC04LA2	270	2640	23560	218300	1858	2806	134.8	11640	5590	3566	60.2	75.9	359.5	17750	14.5	20.1	26.3	74.8	7.5	2.4	9.9	0.8	14.5	52.7	56.2
KC04LA2	190	4030	23810	220100	1886	2816	143.3	11690	5689	3581	56	73.2	343.6	17570	11.2	21.9	24.3	73.6	8.1	2.3	10.2	0.9	13.4	52.7	57
KC04LA3	300	3480	29300	281900	1784	1728	2	14460	4392	4231	84	74.6	251	16580	18.1	14.9	18.5	61.9	7.8	0.9	7.2	0.4	8.5	62.6	61.4
KC04LA3	270	3710	29370	284400	1759	1776	2	14450	4508	4270	71	88	265.9	16580	14.5	15.8	21	64.1	8.5	1.3	7.3	0.4	9	62.1	61.8
KC04LA3	290	3680	29540	284300	1756	1781	2	14490	4488	4264	56.4	85.9	251.6	16530	7	17	17.8	62	7.4	1.6	7.4	0.8	8.6	63.2	61.3
KC04LA4	280	3630	20160	229600	2112	2685	93.6	11400	10720	3048	43.8	67.8	837	12990	16.7	13.7	23.2	112.9	5.3	1.8	6	0.3	11.1	44.2	64
KC04LA4	200	4470	21160	230900	2110	2658	98.6	11400	10640	3073	47.9	74.3	840	12900	11.6	15	25.8	114.1	6.3	0.7	5.2	0.4	11	43.9	62.4
KC04LA4	290	3300	20280	232400	2072	2658	85.5	11520	10730	3106	49.1	68	842	12860	20.7	14	23.9	117.1	5.5	1	5.2	0.5	10.9	44.3	63.4
KC04LA5	300	2480	24290	262100	1612	2090	2	12940	4779	3791	65.4	88.2	467.5	15710	7.5	15.7	17.7	65.2	7.4	1.1	8	0.9	10.6	57	59.7
KC04LA5	290	2900	24660	263800	1645	2082	31.1	13150	4815	3838	69.3	74.1	462.5	15770	14	16.4	16.2	64.7	6	1.7	8	0.8	10.4	56.1	60.8
KC04LA5	290	2820	24530	264300	1649	2042	24.9	13180	4773	3882	47.4	79.6	495.7	15770	17.3	13	16.1	62.2	6.9	1.7	7.4	0.7	10.1	56.9	60.6
KC04LB1	280	9890	46820	201900	1938	2614	106	12620	35230	2724	74.8	45.4	697	31960	28	39.8	84.4	210.3	13.4	2.2	7.9	0.6	12.7	49.6	227.9
KC04LB1	260	9880	46750	203100	2002	2622	103.8	12900	35400	2688	68.9	32.4	713	32140	31.3	36.3	85.8	213	11.5	2.5	8.6	0.9	12.3	48.6	228.3

KC04LB1	701	10810	47860	205200	2034	2662	97.8	12990	36070	2786	69.3	48.8	685	32220	25.9	35.8	81.1	218.1	11.6	2	11	1	12.6	49.6	230
KC04LB2	290	6810	36410	213300	1994	2645	99.4	11530	34140	2756	60.1	62.8	601	26850	24	35	76.2	197.7	7.6	1.2	10.7	0.7	12	44.9	172.4
KC04LB2	280	7150	36560	214200	2008	2639	96.4	11570	34510	2745	59.5	59.4	612	26880	19.4	33.9	74.4	199.3	11.1	2.3	10.7	0.8	12.9	45.4	172.9
KC04LB2	210	7900	36660	215700	2014	2671	91.8	11570	34520	2845	45.6	56.3	609	26980	15.1	36.9	71.9	194.2	7.9	2.1	10.3	0.7	12.8	44.4	173
KC04LB3	230	4430	31630	164000	2506	4137	188.1	8860	30980	2892	59.9	72.2	716	27490	26.6	51.7	130.7	451.7	7.3	4.2	19.6	1.7	34.4	44.5	144.5
KC04LB3	270	3510	31440	166500	2500	4145	206.3	8794	31120	2947	70.5	61.4	739	27500	20.7	52.7	132.2	455.3	7.3	4.6	18.3	1.2	35.5	43.9	143.6
KC04LB3	230	4900	32000	167200	2514	4204	210.9	8885	31290	2925	63.4	67.5	730	27430	30.9	51.8	131.6	449.2	7.3	4	19.4	1.5	35.2	43.6	145.5
KC04LB4	290	6870	36630	207700	1974	2795	98.7	11700	33120	2765	64.8	58.1	654	28150	14.4	38	73.3	204.7	8	1.9	11.3	0.5	13.6	48.1	170.3
KC04LB4	280	6630	37840	210200	2009	2832	86.3	11920	33520	2787	71.3	53.1	645	28200	18.3	39.5	78.8	209.4	9.7	2	11.5	0.6	13.2	49	170.6
KC04LB4	290	6120	37300	211200	2029	2853	85.2	12040	33680	2777	65.4	52.9	625	28230	31.5	35.7	75.2	207	9.7	1.7	12	0.8	12.8	48.8	169.4
KC04LB5	300	4650	39230	180700	2033	4021	179.8	9596	32720	2951	85.1	75.6	916	34320	35.3	57	132	396.7	8.5	4.7	21.1	1.7	27.8	51.3	132.4
KC04LB5	230	5590	40010	182100	2001	4138	177.7	9497	33020	3009	90.9	90.5	916	34400	21.7	59.2	135.5	400.3	6.3	3.1	23.5	1.6	27.9	51.3	131.5
KC04LB5	230	5930	40210	184200	2055	4143	182.7	9552	33370	3029	88.3	80.3	916	34670	19.9	57.4	136.4	408.1	7.5	4.5	24.8	1	28.6	51	133.1
KC04LC1	290	3600	44430	251400	1385	2199	2	10680	10900	3865	60.9	90.6	274.7	17840	20.4	33.7	36.7	104.8	9.9	2.1	7.1	1.9	16.3	39.3	78.5
KC04LC1	2620	5180	44980	254300	1405	2212	2	10810	11030	4037	103.3	85.1	276.6	17880	28.1	32.2	37.3	101.2	10.6	3.2	7.3	2	16.6	41	78.6
KC04LC1	270	4220	44670	255800	1402	2208	2	10810	11050	3908	65.3	106.9	255.7	17870	23	35.5	36.6	99.6	10.4	1.9	8.1	2.2	16.9	40.6	79.2
KC04LC2	270	3570	37100	254300	1629	2395	2	10500	9964	3817	73.1	70.5	256.2	15440	16.4	29.8	33.2	102	8.5	1.9	7.8	1.5	12.2	37.9	76.8
KC04LC2	3420	4920	37120	257100	1645	2399	2	10600	9950	3861	82.2	89.5	257.2	15510	17.6	31.5	34.2	103.7	9	2.2	7.9	1.7	12.4	37.9	77.3
KC04LC2	280	3940	36620	259400	1660	2446	2	10590	10080	3971	81	109.8	251.3	15660	25.7	31.8	34.5	101.3	8.8	2.7	9.3	1.7	12.7	38.9	77.5
KC04LC3	260	4140	41020	251300	1652	2601	2	10170	11720	3988	103.5	100.7	293.6	16860	21.2	34.8	35.4	109.6	9.5	2.2	7.4	2.3	15.3	36.9	79.8
KC04LC3	250	4310	40850	252500	1614	2640	2	10450	11610	3960	85	95.2	293.6	17000	24.4	32.1	35.3	113.9	9.1	2.2	8.3	2.2	15.5	38.2	79.2
KC04LC3	280	4080	41960	255600	1658	2678	2	10350	11890	4020	96.3	85.4	294.5	17060	15.1	34	36.6	115.4	8.6	2	8.6	2	16	37.6	80.7
KC04LC4	270	4080	38830	254300	1344	2314	2	10330	10720	3738	64.4	128.1	267.9	17440	20.4	35.1	48	108	8.4	2.5	7.6	2.2	16.7	40.2	79.7
KC04LC4	270	3630	39550	257700	1381	2346	2	10600	10840	3782	65.6	103.2	280	17640	24.1	35.8	51.7	113.8	9.3	3	9.3	1.9	16.4	40.2	81.4
KC04LC4	280	3060	39490	259000	1413	2362	2	10380	10800	3848	68.9	101	280.6	17680	17.6	35.8	51.7	111.8	9.5	2.3	10.2	2.2	16.9	39.1	80.3
KC04LC5	280	4180	43960	256300	1322	2148	0.3	10480	10530	3865	41.9	99	297.8	17330	19.9	33.8	35.9	96.1	10	2.2	8.3	1.9	16.4	39.8	77.8
KC04LC5	290	3920	44670	259800	1341	2199	0.6	10420	10490	3880	64.8	105.2	293.2	17170	36.7	33	35.5	96.8	9.7	2.2	7.7	1.9	17.3	40	77.5
KC04LC5	270	4130	44550	261100	1350	2172	2	10510	10390	3878	66	75.1	294.3	17210	32.3	29	35.6	96	8.4	2.8	8.6	1.9	16.5	40.5	76.9
KC04LAB	290	6430	38300	237900	2083	2607	94	12870	20340	3124	66.7	77.4	510	24800	33.5	25.6	50.6	136.9	9.3	1.9	8.9	0.7	11.4	52	145.6

KC04LAB	300	6410	38060	239100	2069	2645	19.9	12950	20360	3402	85.1	79.4	524	25060	27.2	25.4	50.9	139.5	9.7	1.6	8.1	0.5	11.6	51.6	146.5
KC04LAB	270	6770	38810	241100	2097	2655	77.3	12960	20340	3197	61.5	70.3	512	25020	36.1	25.8	51.5	141.2	9.6	1.1	7.8	0.5	11.3	52	147.6
KC04LAC	280	3550	34530	257000	1682	2372	9.6	11530	8098	3887	62.6	95.6	303	18220	12.4	28.3	27.1	89.9	8.5	1.6	5.9	1.3	14.1	46.2	68.5
KC04LAC	290	3410	34450	258400	1684	2294	20.5	11390	8178	3815	77.8	94.3	313.2	18160	18.5	26.7	29.6	86.2	8.4	1.8	6.1	1.6	14	47.4	67.4
KC04LAC	270	3460	34820	260400	1667	2295	2	11530	8094	3829	66.3	95.2	301.2	18160	17.4	25.9	28.2	88.4	8.8	2.2	7.7	1.8	14.4	47.6	68
KC04LBC	270	7740	49250	238600	1718	2530	17.9	11930	23570	3374	78	62.5	481.8	24920	16.4	34.4	59.1	155.3	9.8	2.1	8	1.4	13.9	43	153.6
KC04LBC	300	7020	49020	239700	1778	2504	19.1	12010	23470	3363	81	63.9	479	24920	33.7	37.3	56.9	152.3	11.3	2.3	7.8	1.3	14.3	43.6	155.5
KC04LBC	290	7300	49150	242200	1803	2558	18.2	11950	23430	3415	82	63.9	480	25140	17.7	35.1	57.6	156.1	11	2.5	7.1	1.2	14.2	44	156.4
KC04LABC	310	5940	43100	254200	1771	2504	35	12160	18030	3500	75	89	429.3	22560	17.5	31.9	44.8	126.6	9.8	1.9	9.8	1.2	13.4	46.5	124.8
KC04LABC	290	5740	42890	255000	1815	2528	36.1	12220	18060	3473	83	68.4	425.6	22590	27	31.5	46.6	128.6	10.4	1.8	9	1.2	12.8	47	127.2
KC04LABC	290	5740	43510	256100	1827	2542	2	12230	18060	3508	85	85.2	433.2	22720	8.3	31.2	47.6	133.7	10.3	1.9	7.5	1.2	13.1	46.7	125.5
BR-S 2g/a2	280	13490	68350	261000	1083	3895	1.1	23110	27540	4494	101	126.1	550	41210	26.7	43.9	91	403.2	13.9	1.5	14.1	0.8	5.3	94.4	123
BR-S 2g/a2	280	13610	69300	262800	1096	3881	11.6	23850	27690	4497	82	154.1	551	41090	45.1	38.9	88.6	407.7	14.5	1.7	15.4	1	5.7	93.5	122.1
BR-S 2g/a2	280	13290	68790	262000	1090	3815	2	23330	27690	4451	106	128.8	539	41280	27.4	37.7	81.3	405.4	13.8	0.9	15.3	1.1	5.3	96.6	123.9
KC07LA1	270	2180	17950	193100	1685	3053	174.4	10260	6117	3070	54.8	67.7	527.8	15090	12.9	18.5	28.1	77.6	6.8	2.8	10.1	1.1	15.5	47.1	55.3
KC07LA1	260	2630	19570	200300	1740	3147	178.2	10420	6171	3075	68.7	42.6	521	15340	15.6	18.3	27.3	76.5	6.5	2.1	8.1	1.4	15.4	47.9	56.6
KC07LA1	200	3170	18570	199500	1720	3120	167.6	10520	6193	3145	69.7	62.2	528.9	15290	8.6	20.9	28.2	79.2	7.6	2.5	10.2	1.4	15.3	48	56.2
KC07LA2	290	1910	15190	157800	1866	4165	322.2	8849	8929	2636	55.4	52.4	759	14440	12.5	22.7	39.2	107	6.7	2.4	8.6	1.5	22.2	40.4	58.1
KC07LA2	260	2160	15670	162000	1828	4258	329.4	8971	9058	2670	65.4	51.4	757	14550	12.9	22.4	39.5	107.9	5.7	2.1	8.9	1.6	21.4	39.5	58.3
KC07LA2	300	1690	15240	161900	1864	4225	315.5	8914	8945	2624	55.6	62.2	755	14510	12.1	20.9	38.9	104.7	6.1	2.8	8.8	1.1	21.3	40.3	58.5
KC07LA3	240	3040	17540	167200	1972	4222	317.9	9626	7997	2868	60	47.6	473.4	15830	6.2	24.1	44.3	100.1	6.1	3.4	9.9	1.3	22.2	44.4	57.7
KC07LA3	290	1970	17390	169700	1937	4185	285.3	9559	7943	2886	49.8	64	460.4	15820	7.5	24.2	48.6	102.4	7	3.2	11.2	1.2	21.6	44	56.9
KC07LA3	290	1870	17550	170100	1985	4226	324.6	9746	7936	2924	69.2	60.2	455.1	15800	16.1	24.7	47.9	98.6	6.8	3.1	11.8	1.3	21.8	44	56.9
KC07LA4	210	3480	20560	200700	1483	2690	203.9	10750	8967	3148	49.2	62	1103	15810	6.4	19	27	99.1	7.5	1.7	8.4	0.9	13.1	50.8	60.1
KC07LA4	270	3000	20890	203800	1503	2683	214.6	10610	9066	3181	48.5	65	1110	15820	18.1	18.6	27.9	99.3	7.5	2.7	8.4	1.1	14.1	50.8	60.6
KC07LA4	260	3010	20850	206200	1472	2673	210.2	10520	9039	3196	74	58.5	1123	15920	10.4	16.5	27.2	96.3	6.8	1.6	9.8	1	13	50.5	61.9
KC07LA5	280	2350	19240	214700	1619	2882	135	10760	4700	3261	58.2	78.5	308	15430	18	18.7	26.5	69.5	6.3	2.7	7.9	1	13.7	50.4	54.9
KC07LA5	200	3370	20080	218400	1648	2906	155.6	10760	4654	3243	64.3	71.5	296.6	15460	12.6	17.4	23	71.7	7.1	1.5	10	1.1	12.6	51.2	54.9
KC07LA5	270	2040	20000	218600	1622	2851	146.9	10860	4754	3287	44.1	74.1	296.5	15470	20.1	18.8	25.1	68.2	7.1	2.6	7.9	0.9	13.5	50.4	54.9

KC07LB1	220	9440	42580	203700	2145	2995	155.9	12460	37440	2672	81.2	48.9	659	30890	11.3	38.5	78.8	217.8	11.1	2.1	9.5	0.9	11.4	45.7	201.3
KC07LB1	280	9190	42500	204700	2201	3001	161.9	12480	37280	2683	68.6	46.8	679	30850	19.1	36.6	82	218.3	10.6	1.3	9.4	0.5	11.5	46.4	201.7
KC07LB1	290	8330	42650	203000	2177	2959	143.6	12440	37210	2719	66.3	67.1	669	30710	9.7	37.1	80.5	212.3	11.1	2.5	11.5	0.8	11.7	46.4	200.4
KC07LB2	220	10280	43720	219400	2092	2694	99.5	12450	35440	2691	69.9	47	657	29250	20.3	37.8	73.4	200.5	11.9	1.8	9.2	0.6	10.6	45.3	200.7
KC07LB2	260	9500	43330	220800	2107	2711	101.9	12380	35840	2673	66.6	48.1	669	29350	9.6	38	77.9	200.2	10.7	1.2	10.3	0.6	11.1	44.8	199.2
KC07LB2	280	8810	42620	219000	2107	2703	88.5	12220	35490	2691	49	34.8	643	29010	23.5	38.1	73.3	196.7	9.6	1.6	7.6	0.6	10.9	43.9	198.5
KC07LB3	230	5620	38580	187900	1936	3875	196	9751	33030	2879	69.7	57.9	882	34530	27.7	56.6	140.4	396	7.5	3	19.4	0.9	26.3	51.7	137.9
KC07LB3	220	5880	39030	189600	1937	3866	200.7	9927	33310	2929	91	69.1	865	34380	43.3	59.2	135.5	391.6	7.8	3.7	24.7	1.2	28.1	51	138.7
KC07LB3	220	5490	38190	189100	1929	3903	201.8	9756	33230	2918	74.9	71.8	865	34060	32.1	57.2	127.7	390.2	7.4	4.2	22	1	27.7	51.6	138.3
KC07LB4	280	10120	45110	219900	1863	2481	141.7	12950	38340	2814	76.6	45.4	628	29710	26.8	33.6	68.9	182.4	10.6	2	9.4	0.6	10	46.8	214.3
KC07LB4	1210	10240	45390	222500	1866	2501	133.3	13250	38960	2846	72	41.9	637	29900	26.1	31.4	65.4	182.7	11.5	1.2	6.9	0.5	10.2	46.5	214.9
KC07LB4	290	8990	44970	220900	1882	2471	132.5	13050	38670	2850	51.4	40.1	614	29580	17.1	34	70.8	179.4	10.8	1.6	7.9	0.5	9.8	46.3	211
KC07LB5	230	4830	31920	181000	2696	3692	153.1	9323	35490	3028	53.5	93.9	635	27200	21.8	48.7	164.6	532.4	6.1	4.8	18.1	0.6	31.5	43.8	140
KC07LB5	260	4740	32470	185400	2796	3770	152.8	9635	36400	3144	57.6	86.3	654	27510	31.8	45.4	169.1	536.7	7.7	2.9	16.3	0.8	30.2	45	142.2
KC07LB5	230	4900	31620	183400	2771	3730	150.7	9476	36140	3136	68.9	90.3	629	27150	46.6	50.7	166.7	531.1	6.3	4.4	16.8	1.3	30.9	43.1	141.5
KC07LC1	260	3850	34900	250500	1564	2654	2	10170	12410	3356	53.7	88.8	335.4	17320	17.6	31.4	44.4	116.8	8.6	2	7.9	2.3	15.8	36.8	81.9
KC07LC1	280	3530	34700	252400	1611	2626	2	10210	12620	3495	51.7	98.7	350.3	17400	16.9	34.5	45.3	120.6	9.3	2.8	7.8	1.9	15.6	37.8	82.8
KC07LC1	270	3540	34490	252000	1551	2669	2	10220	12450	3413	60.6	111.4	343.6	17320	35.1	35.3	43	118.5	9.3	2.2	6.3	1.9	16.3	36.2	83.3
KC07LC2	290	3070	29520	250200	1682	2738	2	9946	10910	3378	51	90	298.9	15860	20.2	30.6	39.9	128.9	7.8	1.8	6.5	1.5	13.8	35.3	80
KC07LC2	280	2820	29700	251800	1666	2754	2	9910	10910	3553	71.4	104.9	307.1	15880	21.7	26.6	41.4	125.1	7.8	2.3	6.9	1.5	13.4	36.3	80.2
KC07LC2	200	4880	30010	253400	1673	2765	2	10030	10930	3443	56.3	93.5	305.5	15850	17.7	29.2	39.5	126.6	6.4	2.2	8	1.6	13.2	35.7	80.2
KC07LC3	3930	4490	34280	254300	1419	2456	0.2	9543	10080	3504	56.3	89.8	264.6	16470	16.3	31.2	38.5	102.3	10.1	2.5	6.6	1.8	15.7	36.7	78
KC07LC3	250	3570	33880	255500	1426	2442	2	9572	10030	3543	79.5	87.6	279.9	16380	24.5	28.7	37.9	108.1	7.2	2.5	7.2	2.1	15.4	36.7	79.4
KC07LC3	4270	4460	34740	256200	1406	2460	2	9675	10150	3769	76.3	75.6	274.9	16430	16.8	30.1	38.6	108	8.4	2.1	7	2.3	16.1	37.4	78.6
KC07LC4	280	3620	36650	269200	1145	1964	2	10740	9436	4004	70	139.3	241.3	15600	18.1	29.2	29.2	90.6	9.3	1.7	7.6	1.4	12	38	76.4
KC07LC4	270	0	37310	272100	1179	1998	2	10620	9461	4036	62.2	127.2	248.4	15550	29.9	27.4	29.8	90	9.3	2.2	6.5	1.6	12.4	38.7	76.3
KC07LC4	280	3550	36840	273200	1163	2010	2	11100	9513	4029	91.9	134.3	249.4	15630	17.7	29.9	30.2	90.5	9.2	2.6	5.2	1.5	12.6	38.2	76.1
KC07LC5	290	3120	37990	261500	1314	2330	2	9658	9734	3737	58.8	85.9	239.5	16380	9.2	32.6	34.1	102.9	8.6	2.3	8	2.2	16.7	38	77.9
KC07LC5	260	3690	37820	263700	1307	2367	0.7	9786	9954	3880	101.1	80.8	245.9	16350	14	31.4	37.5	106.8	10.1	3.2	7.1	2.2	15.8	37.4	77.8

KC07LC5	280	3430	37570	263900	1361	2299	2	9724	9937	3893	77.3	85.7	243.5	16390	11.3	31.9	33	105.8	7.4	2.3	5.9	2.1	15.2	37.8	77
KC07LAB	290	5020	30780	201900	2017	3211	186.8	11350	21010	2879	77	50.5	625	22910	13.7	29.6	60.7	147.2	9.1	2.4	8.9	0.8	13.6	46.9	129
KC07LAB	300	4740	30940	204900	2036	3168	186.4	11750	21230	2949	78.2	58.9	622	23130	16.3	30	62.8	153.3	8.8	2.4	10.3	0.7	13.8	46.5	128.9
KC07LAB	210	6330	30930	205200	2053	3273	175.6	11390	21450	2963	70.5	54.3	625	23060	34.2	27	61	148.5	9.3	2.2	10.5	0.9	13.7	47.1	128.8
KC07LAC	280	2930	26850	225800	1760	2989	111.5	10170	8854	3378	62.6	59.3	427.2	16000	6.7	24.1	34.8	91.5	8.2	2.7	9	1.2	14.9	40.9	67.5
KC07LAC	270	3200	27230	228200	1776	3048	111.6	10370	8910	3376	66.1	61.1	427.4	16050	18.1	25.5	33.2	95.5	8.3	3.4	9.6	1.5	15.6	41.8	67.1
KC07LAC	280	2860	26550	229400	1766	3036	102.8	10290	8947	3396	67.1	65.2	422.7	15990	23.3	24	32.8	92.8	7.4	1.7	9.6	1.5	14.7	42	68
KC07LBC	3840	7930	41350	232000	1908	2901	81.8	11540	26110	3074	71.6	75.6	520	24850	18	36.1	63.7	170.9	9.7	2.1	9.8	1	12.8	41.8	148.5
KC07LBC	250	6940	40890	232000	1991	2893	16.9	11370	26230	3130	57.4	69	521	24630	32.6	36	61.6	168	9.7	1.2	10.2	1.2	12.6	41.7	147.3
KC07LBC	280	6920	40940	231000	1969	2900	72.2	11560	26010	3018	45.9	68.1	500.9	24440	37.4	34.9	62.6	169.9	11.1	2.2	8.2	1	13.8	41.5	147.3
KC07LABC	270	4610	32670	215800	1928	3092	134.8	10890	17080	3161	72.3	64	491.2	20390	12.6	26	47.5	131.7	8.3	2.3	8.8	1	13.8	42	106.3
KC07LABC	290	4890	32780	215800	1974	3098	146.8	10960	17220	3155	70.5	52.9	510.4	20490	14.5	28.8	42.5	130.7	9.2	2.1	9.3	0.6	14.6	43.6	107.8
KC07LABC	280	4820	32920	218400	1977	3138	125.6	10980	17060	3217	81.2	78.6	505.1	20420	19.6	28.2	46.1	129.7	8.5	2.8	10.6	1	14.8	42.9	107.4
	Y	Zr	Nb	Mo	Ag	Cd	In	Sn	Sb	Te	I	Cs	Ba	La	Ce	Hf	Ta	W	Hg	Tl	Pb	Bi	Th	U	
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	
BR-S 2g/a	36.3	283.8	16.5	9.5	0.6	5	0.6	9.7	2.1	0.9	1.6	2.7	335.7	18.5	51.8	9.5	4.1	3.3	2	1.3	143	1.5	8.7	4.5	
BR-S 2g/a	37.1	283.5	15.6	3.5	0.6	4.3	0.6	8.3	0.7	0.9	1.6	3	331.9	27.3	32.6	7.2	4.4	3.3	0.7	1	144.8	0.5	10.1	5.1	
BR-S 2g/a	36.8	277.4	9.8	3.8	0.6	5	0.5	10	2.2	0.9	1.6	3	329	20.4	49.3	3.6	4.5	5.6	1.5	1.1	146.1	0.5	10	5.9	
KC10LA1	22.6	379.9	11.2	3.8	0.5	1.9	0.4	6.5	1.7	0.7	1.8	2.2	148.6	12	10.3	13.4	2.2	1.9	0.5	1.7	77.3	0.9	5.8	4.4	
KC10LA1	22.7	401.2	14	4.8	0.6	2.7	0.4	6	1.7	0.7	1.2	2.2	150.5	10.1	17	9.2	2.8	1	0.5	1.7	79	1	5.8	5.9	
KC10LA1	21.9	376.9	11.7	6.8	4.5	3.1	0.5	6.3	1.7	0.7	2.6	2.1	149.3	10.3	18.7	10.4	2.2	1.6	0.7	1.3	79.2	0.8	5.1	6.7	
KC10LA2	22.3	345.3	9.4	5	0.5	1.4	0.4	8.2	1.9	0.7	1.8	2.2	127.1	12.2	9.9	10.5	2.6	3.4	0.7	1.1	110.2	0.8	5.3	3.9	
KC10LA2	21.9	341.9	11.3	5	3.6	1.6	0.4	8.1	0.6	0.7	3.3	2.2	124.9	8.5	5.7	11.5	2.7	3.4	0.6	2.1	109.6	1.3	5.2	4	
KC10LA2	22.3	346.3	12.1	5.1	3.3	1.5	0.4	7.4	2.3	0.7	3.6	2.2	133.3	9.4	14.4	11.6	2.6	2	1.5	1.2	110.5	1.4	5.1	5.2	
KC10LA3	24.2	432.1	9.2	2.3	0.5	1.4	0.4	9	1.8	0.7	1.3	2.2	153.3	12	19.4	11.1	2.2	4.2	0.4	1.5	110.8	1.2	6	4.4	
KC10LA3	23.8	435.8	10.7	4.1	0.5	1.1	0.4	8.6	2.4	0.7	2	2.2	156.6	10	18.8	13	2.3	1.6	1.6	0.5	115	0.6	6	3.5	
KC10LA3	23.6	432.5	10.6	5.6	3	2.2	0.4	8.2	0.5	0.7	2.5	1.7	161.9	16.6	11.7	12.7	2.9	1	1	1.9	115	0.6	5.4	4	
KC10LA4	21.6	358.7	8.3	2.8	2.2	1.9	0.4	6.4	1.5	0.6	3	2.1	140.5	13.3	10.3	11	2.2	1.6	0.4	1.3	79.8	0.9	4.9	3.8	
KC10LA4	21.8	363.5	9.8	4.9	3.1	1.5	0.4	7	1.2	0.9	1.2	2.1	136.8	7.3	16	10.8	2.3	1.6	0.5	1.7	79.8	1.8	5.1	3.2	

KC10LA4	22.3	376.9	11.5	2.3	0.5	1.6	0.4	6.9	2.2	0.7	1.2	2.2	138.3	8.4	16.6	11	2.2	1.6	0.4	1.3	79.3	0.9	5.2	5.1	
KC10LA5	19.4	253.8	6.7	2.5	2.5	2.2	0.4	7.9	0.5	0.7	2	2.9	106.7	11	13.5	11.4	2.5	1.5	1	1.3	99.9	1.3	4.1	3.3	
KC10LA5	19.5	255	8.1	2.8	2.3	1.8	0.4	7	2.7	0.7	3.6	2.1	107	11.5	10.8	8.4	2.5	2	0.5	1.9	99.8	1.6	3.7	3.6	
KC10LA5	19.9	244.7	7.5	3.4	2.1	1.6	0.4	7.7	2.1	0.7	3	2.1	109.1	10	16.5	5	2.5	2	0.7	1.3	101.4	0.8	4.9	3.9	
KC10LB1	28.7	246.4	7.7	7.7	0.6	1.7	0.5	18.2	1.8	0.7	1.4	2.4	288.7	14.5	25.5	7.3	3.9	3.7	0.6	0.7	203.3	0.5	6.2	4.6	
KC10LB1	29.9	252.8	7.9	4.9	0.6	2.4	0.5	20.3	1.8	0.7	1.4	2.4	290.9	20.1	23.1	9.8	3.8	2.6	0.5	0.5	203.5	0.7	7.7	5.1	
KC10LB1	29.5	258	7.6	4	0.6	2.4	0.5	18.6	2.4	0.8	1.4	2.4	294.1	14.4	24.1	7.8	3.9	4.3	0.8	0.8	203.6	1	6.4	4.7	
KC10LB2	29.3	290.7	9.5	2.2	0.6	3	0.5	19.1	2.2	0.8	1.5	2.4	305.4	21.6	20.1	10.5	4	5.4	0.6	1.3	214.7	0.8	6.3	4.8	
KC10LB2	30.4	287.7	8.2	5	0.6	3	0.5	19.6	2.4	0.8	1.5	2.5	311.5	14.5	29.6	6.4	4	2.5	1	0.8	215.2	0.6	7.4	5.1	
KC10LB2	30.3	302.4	11.4	5.7	3.3	2.2	0.5	18.3	2.9	0.8	1.5	2.5	306.5	16	25.9	10.3	4	2.1	0.6	0.7	215.3	1.1	7	5	
KC10LB3	28.6	298.1	8.5	6.6	2.2	2.7	0.5	19.2	2.5	0.8	3	2.4	282.6	19.8	19.5	6.1	4	2.5	0.6	0.6	221.1	0.4	7.2	4.9	
KC10LB3	29	288	10.4	4.4	0.6	3.5	0.5	20.3	2.8	0.8	1.5	2.4	282.4	18.7	19.8	7.2	4	4.1	0.6	0.8	217.6	0.7	6.8	4.6	
KC10LB3	29.9	281.9	9.5	4.9	0.6	2.5	0.5	19.1	0.6	0.7	1.4	2.4	289.2	18.6	28.9	9.4	4	2.7	0.6	0.6	217.5	0.7	6.6	4.8	
KC10LB4	38.2	220.5	5.7	4.4	0.7	3.6	0.5	20.8	4.2	0.7	1.5	2.4	377.5	12.6	35.7	13	5.1	3	0.7	1.1	489.7	0.9	8.8	5.1	
KC10LB4	37	227.4	9.8	5.4	3.4	3.5	0.5	20.9	4.1	0.8	2.5	2.4	385.7	20	23.8	12.2	5.1	3.8	0.7	1.1	489.5	1	9.8	4.9	
KC10LB4	38.1	233	9	5	3.9	4.3	0.5	21.7	5.2	0.9	4.9	2.4	385.1	17	26	11.9	5.1	3.6	0.7	1.1	485.9	0.7	10.2	5.2	
KC10LB5	32	303.1	9	5.8	1.8	2.2	0.5	15.6	2.4	1.2	2.5	2.4	308.5	13.9	30.7	11.1	4.1	2.3	0.6	0.4	265	0.5	8.8	4.9	
KC10LB5	31.5	299.8	7.4	5	0.5	2.5	0.4	16	2.2	0.7	2.1	2.4	304.5	13.7	22.2	10.1	4	2.4	0.6	0.8	261.7	0.7	8.2	4	
KC10LB5	31.2	301.9	10.4	6.8	2.9	3.2	1.3	16.7	3	0.8	1.3	2.4	310.2	14.8	21.8	10.7	4.1	2.4	1.7	0.8	265.5	0.8	8	4.8	
KC10LC1	36.9	476.2	10.6	5.1	1.9	2.9	0.4	6.3	1.3	0.7	4.5	2.3	226.9	20.3	28.4	12.4	2.8	2.8	0.5	1.4	116.8	0.8	8.9	4.3	
KC10LC1	37.3	465.5	11.4	5.7	2	1.5	0.4	5.8	0.6	0.5	4.4	2.4	237.1	27.1	33.2	10.7	2.8	2.3	1.4	0.9	117.6	1.2	7.9	4.5	
KC10LC1	37.8	485.6	12.5	3.6	0.5	2.6	0.4	6.5	2	0.6	4.4	2.4	235.7	18.7	47.6	12.6	2.8	1.6	0.5	1.6	119.2	0.5	9.1	5	
KC10LC2	38.4	547.9	15	5.3	0.6	1.9	0.5	6.7	2	0.8	2.8	2.5	267.2	25.8	36.5	13.3	2.8	1.9	0.6	1.9	118.5	0.5	9.2	5.1	
KC10LC2	38.5	567.2	14.1	3.5	0.5	2.4	0.4	7	1.7	0.8	4.4	2.5	272.2	23.7	56.1	13.8	2.9	1.9	0.7	1.1	119.8	0.7	9.5	4.5	
KC10LC2	39.1	519.9	10.8	8.9	0.5	2.4	0.4	6.8	2	0.8	3.4	2.5	266.7	19.4	54.5	10	2.8	1.3	1.2	1.2	117.3	0.6	9.3	4.4	
KC10LC3	37.7	492.6	11.9	3.8	0.5	2.4	0.4	6.7	1	0.7	2.9	2.4	252.5	18.3	33.1	11.6	5.4	3.1	0.9	1.3	156.6	0.5	9.2	4.6	
KC10LC3	37.7	486.1	10	7.1	1.9	2.2	0.4	6.3	1.5	0.8	3.3	2.4	254.4	14.8	40.1	11.5	2.7	3.1	0.5	0.9	153.9	0.8	8.8	4.9	
KC10LC3	37.7	508.3	9.1	3.1	0.5	2.4	0.5	6.9	0.6	0.8	4.2	2.4	256.3	18.1	35.6	11.3	2.7	3.2	0.8	0.7	157.1	0.6	9.7	4.9	
KC10LC4	36.1	476.6	11.1	4.7	0.5	2	0.4	5.9	1.9	0.7	1.4	2.3	224.2	15.4	43.3	12	2.7	2	0.5	1.6	104.6	0.7	8.6	4.7	

KC10LC4	36.4	486.2	9.2	5.8	0.5	1.3	0.4	5.8	0.6	0.7	2.9	2.3	220.5	21.2	42.8	10.4	2.8	2	0.3	1	108.8	0.5	9.2	3.9	
KC10LC4	36.8	509.2	10.9	4.7	0.5	2.6	0.4	5.8	0.9	0.7	3.8	2.3	230.9	15	28.9	10.7	2.8	4	0.5	0.8	108.8	0.5	10.6	4.5	
KC10LC5	37.9	477	14.3	2.7	0.5	2.4	0.4	5.7	1.7	0.8	4.7	2.4	242.5	25.1	48.5	11.2	2.9	1.8	0.5	0.9	110.9	0.3	8.3	4.9	
KC10LC5	38.2	457	10.3	3.1	2.2	2	0.4	6	1.6	0.7	4.3	2.4	245.3	29.3	24.3	11.6	2.8	2	0.5	1.3	111.2	0.7	8.9	4.6	
KC10LC5	38.8	468.5	12.2	2.9	0.5	2.6	0.5	6	2.2	0.8	5.8	2.4	257	25.3	50.2	10.3	2.8	3	0.5	1.3	110.9	0.7	10.2	4.6	
KC10LAB	33	392.4	7.2	4.5	0.6	1.5	0.5	12.5	2.9	0.8	1.4	2.4	272.9	14.6	33.4	8.7	3.5	2.4	0.6	0.7	162.1	0.5	8.3	5.2	
KC10LAB	34	404.7	9.8	2.4	2.5	2.6	0.5	12	0.6	0.8	2.9	2.4	272.5	19.8	27	8.6	3.5	2.9	0.6	1.5	161.1	0.6	8.7	5.4	
KC10LAB	33.6	385.2	7.2	6.5	0.5	2.4	0.5	11.9	1.9	0.7	2.4	2.4	272.6	18.6	16.8	7.9	3.5	2.4	0.4	0.5	165.3	0.8	8.5	4.5	
KC10LAC	34.9	438.9	12.2	6.4	0.5	1.9	0.4	6.4	1.7	0.8	3.7	2.4	222.6	26.9	51	9.5	2.4	2	0.9	1.5	108.7	0.7	8.5	5	
KC10LAC	35.5	426.9	9.3	4.7	0.5	2.7	0.4	7	1.8	0.7	4.2	2.3	212.4	21.5	40.9	10.8	2.7	2.7	1	1.4	107.5	0.3	9.1	4	
KC10LAC	35.8	441.3	9.9	7.7	0.6	2.1	0.5	6.4	1.8	0.7	3.2	2.4	226.3	19.8	36.5	12.1	2.8	3.3	1	1.6	106.2	1.4	8.1	4.7	
KC10LBC	25.7	308.6	9.6	3.9	0.5	2.3	0.5	13.7	2.7	0.6	1.4	2.3	226.1	11.1	20.4	8.6	3.2	2.7	0.6	1.2	162.9	0.6	6.2	4.4	
KC10LBC	25.4	305.4	7.8	6.4	0.5	2	0.4	12.4	2.1	0.7	2.4	2.3	218.6	15.2	32.2	11.7	3.2	6.4	0.5	0.9	166	0.6	6.9	4.3	
KC10LBC	25.4	317.2	2.4	5.4	2.7	2.3	0.5	13	2	0.7	2	2.3	231	12.7	18.9	7.8	3.3	4.2	0.5	1.4	163.6	0.6	5.6	4.6	
KC10LABC	33.3	381.5	9.1	6.4	2.7	2.2	0.4	9.8	1.9	0.7	2.8	2.4	247.1	16	33.8	12.7	3.2	2.4	0.5	1.6	146.9	0.8	7.6	4.6	
KC10LABC	33.1	400.6	9.8	6.7	0.5	2.5	0.5	9.9	0.6	0.7	3.1	2.4	256.2	21.4	47	11.6	3.2	2.6	0.5	0.9	145.9	0.3	8.3	4.8	
KC10LABC	34.2	386.5	9.5	5.9	2.1	2	0.4	9.4	0.6	0.9	2.9	2.4	255.8	16.6	43.4	10.9	3.2	2.1	0.5	1.2	147.2	0.8	8.3	4.4	
BR-S 2g/a	35.5	314.3	16.1	7.3	0.7	5.2	0.6	12.8	4.4	0.4	1.8	3.4	488.1	31.7	49.5	8.6	4.5	3.2	0.7	0.5	152	0.7	10	5.6	
BR-S 2g/a	24	244.4	13.5	6.9	1.6	5.3	0.5	10.5	2.6	0.7	1.6	3.1	400.7	23.2	58.8	5.4	3.1	3	1.6	1.5	83.9	0.7	4.1	3.5	
BR-S 2g/a	36.4	336.6	16.2	6.6	0.7	6.4	0.7	11	3.7	1	1.9	3.5	498.4	32	74.2	3.6	4.5	2.9	1.7	1.5	153.1	0.3	10	5.7	
KC01LA1	20.9	350.7	12.4	7.9	0.7	6.8	0.5	10.2	3.5	0.7	3.5	2.2	147.9	9.1	17.1	9.8	1.9	1.3	0.9	1.6	111.7	1.7	4.6	13.8	
KC01LA1	20.3	338.7	10.3	7.1	4.7	2.9	0.4	7.8	2.6	0.6	2.8	2.2	146.6	13.5	14.6	9.5	2.3	2.4	1	1.6	111.7	1.3	4.9	4.6	
KC01LA1	20.2	340.2	9.7	4.1	3.6	2.3	0.4	8.5	2.6	0.6	2.7	2.2	151.1	11.6	18.7	12.5	2.5	3.6	2	1.8	111.8	1.3	4.2	12	
KC01LA2	24	492	14.6	10.5	0.6	3.5	0.5	8.8	2.3	0.7	1.3	2.3	200.8	11.7	16.9	11.7	2.2	1.6	1.8	1.1	97	0.5	5.3	4.2	
KC01LA2	24.2	493.8	13.7	3	2.9	1.6	0.4	7.8	2.9	0.7	1.3	2.3	196.7	14.2	19.8	11	2.2	1.2	0.6	1.1	94.4	0.7	6.4	3.8	
KC01LA2	24.3	474.6	11.6	6.2	0.6	1.5	0.4	8.1	2.1	0.7	1.9	2.3	207	14.2	24.6	9.4	2.2	3.5	0.5	1.1	98	1.2	5.5	4.1	
KC01LA3	25.2	548.4	15.2	11.4	3.9	2.7	0.5	9.6	3.6	0.7	3.9	1.8	239.2	14.4	23.3	11.5	2	2.7	1.1	0.9	104.3	0.8	7.5	4.6	
KC01LA3	26	538	17.4	8.5	0.5	1.9	0.5	8.5	2.2	0.7	3.5	2.4	236.5	16.7	27.8	12.3	2.3	2.5	0.9	0.8	100.2	1.3	7.4	4.2	
KC01LA3	26	539.2	13.1	6.9	3	1.5	0.5	9.6	3.3	0.8	2.3	2.5	246.7	21.6	24.7	14.1	2.4	1.6	0.6	0.9	103.2	1.1	7.4	4.4	

KC01LA4	20.7	359.5	8.2	5.3	3.5	1.9	0.4	8.3	2.4	0.9	4.3	2.2	153	14.6	16.4	9.8	2.4	1.3	0.5	0.6	140.9	0.5	5.7	3.4	
KC01LA4	20.4	367.8	9.8	3.8	2.4	1.4	0.4	8.4	3	0.7	3.4	2.2	161.3	13.9	15.3	8.8	2.4	2.4	0.6	0.8	136.2	0.3	5.4	3.4	
KC01LA4	20.1	353	10.7	5.2	0.5	1.4	0.4	7.9	3	0.6	3.7	2.2	157.3	12	18.8	7.1	2.4	1.1	0.7	0.6	140.7	1.3	4.2	2.9	
KC01LA5	22.6	440.5	12.6	4.4	0.5	1.6	0.4	9.5	2.9	0.7	3.9	2.3	191.9	14.7	20.6	11.2	2.4	2.7	0.8	0.8	162.2	1.4	5.8	3.9	
KC01LA5	22.7	435.8	11.4	5.8	3	1.5	0.4	8.3	3.2	0.7	5.5	2.3	193.6	18	22.2	9.5	2.4	3	0.6	0.6	160.5	1.1	6.2	4	
KC01LA5	22.9	444.1	12.7	6.3	0.5	1.2	1	9.9	3	1.2	4.6	2.4	197.3	15.2	25.8	10.1	2.4	2.8	0.8	0.8	160.8	1.4	6.5	4.4	
KC01LB1	30.3	189.4	8	3.9	1.9	2.6	0.9	20.8	3.3	0.7	1.9	2.2	284.2	18.8	38	8.8	4.5	3	0.5	0.9	298.4	0.5	7.2	4.4	
KC01LB1	29	186.3	7.9	4.4	2.8	2.5	0.5	21.5	3	0.7	1.4	2.2	273.4	13.2	35.1	9.1	4.5	6.1	0.6	0.9	292.7	0.3	6.5	4.5	
KC01LB1	29.8	187	6.8	3.4	0.5	2.6	0.4	21.9	3.3	0.7	4.2	2.3	287.2	13.7	26.5	6.2	4.6	3	0.6	0.9	298.1	0.8	7.7	4.3	
KC01LB2	29.8	323.7	7.9	5.6	0.6	2.5	0.5	26.4	2.7	0.8	1.5	2.5	380.7	22.3	42	7.3	4.1	2.2	1.5	0.8	237.9	0.7	7.4	4.9	
KC01LB2	30.1	338.3	7.1	6.5	1.9	3.1	0.5	24	4.2	0.8	1.5	2.6	394.3	23.5	30.6	7.6	4.1	2.6	1.3	0.8	232.6	0.7	7.7	5.2	
KC01LB2	31.3	339.6	13.4	6	3	3.2	0.5	26.7	3.1	0.8	1.6	2.6	394.4	14.4	32.9	6.9	4.2	5.8	0.6	0.4	237.9	0.7	8.1	5.2	
KC01LB3	32.1	282.9	9.4	6.7	0.6	2.9	0.5	22.6	4	0.8	2	2.5	481.2	22.5	26.9	10.8	5.1	4.8	0.7	0.9	370.4	0.6	8.7	4.7	
KC01LB3	32.3	285.8	10	6.4	0.6	3.3	0.5	19.2	4.4	0.8	1	2.5	494	25.9	34.1	7	4.7	5.4	0.6	0.9	358.6	0.8	9.3	4.9	
KC01LB3	32.1	299.7	10.5	3.9	2.9	3.5	0.5	25.8	3.8	0.8	1.6	2.6	497.4	21	30.9	10.4	4.8	3.3	0.7	1	373.5	0.8	9.4	4.8	
KC01LB4	30.5	338.9	7.7	5.3	0.5	2.3	0.5	23.5	3.8	0.7	3	2.4	347.4	15.2	40.1	7.9	4	2	0.6	0.6	237.2	1	8.9	5	
KC01LB4	29.6	318.3	14.8	7.2	2	2.8	0.5	22	3.4	0.8	1.5	2.5	346.7	16.2	49.1	9.1	3.9	2.5	0.6	0.8	231.1	0.7	5.5	4.6	
KC01LB4	29.8	354.5	11	5.2	0.6	3.1	0.5	23.3	3	0.8	1.5	2.5	365.6	21	31	12.8	4	4.1	0.5	0.8	244	1.3	7.6	4.6	
KC01LB5	36.3	304.9	9.7	6.2	2.9	3.1	0.5	24.5	5	0.8	4.7	2.5	431.2	18.5	55.4	9.8	4.9	5.1	1.1	1	416	0.9	11.8	5.2	
KC01LB5	36	272.2	8.2	5.5	2.7	2.9	0.5	25	4.8	0.8	2.7	2.5	430.3	13.4	53.8	8.6	4.7	6	0.6	1	403.1	0.9	10.2	4.9	
KC01LB5	37	298.4	12.5	7.6	0.6	4	0.5	24.9	4	0.8	4.1	2.6	444.2	19.2	48.9	9.6	4.8	3.1	0.7	1	414.6	0.5	10.3	5.1	
KC01LC1	39.7	604.1	13.2	4.8	0.5	2.9	0.5	8.8	2.3	1.8	6.8	2.7	353.2	32.1	60.9	10.3	3	3.1	0.5	1.4	132.1	0.4	9.6	4.7	
KC01LC1	38.8	589	18.5	8.1	0.6	2.2	0.5	8.8	0.6	0.8	3.9	2.7	351.7	30.2	74.3	12	2.9	2.1	0.9	1	130.1	0.5	8.8	5.3	
KC01LC1	39.5	600.7	15	5.9	0.6	3.2	1.5	9.2	2.9	0.8	7.7	2.7	362.5	31.8	69.1	9.6	3.1	2.7	0.6	1.3	132.2	1	8.7	5.3	
KC01LC2	37.9	634.8	16.2	4.4	0.6	1.8	0.5	5.8	0.6	0.4	4	2.5	307.5	28.9	60.4	15	2.7	1.8	0.8	1.1	113.3	0.5	8.8	4.7	
KC01LC2	36	614	16	6.1	0.5	2.6	0.5	7	1.1	0.8	5.7	2.5	299	24.3	56.8	13.1	2.6	2.8	0.6	0.6	105.7	1.4	8.5	4.8	
KC01LC2	37.5	639.2	14.4	5.8	0.5	2.1	0.5	6.7	0.6	0.8	4.4	2.6	313.9	29.7	45.8	15.8	2.6	4.1	0.5	1.2	112.9	0.4	8.9	5	
KC01LC3	38	549.9	14.5	6.9	0.5	2.1	0.4	6.5	1.6	0.8	4.9	2.5	301.9	27	59.2	10.9	2.2	2.5	0.5	0.9	115.1	1.1	8.7	4.7	
KC01LC3	36.9	541.4	13.9	6.6	0.5	1.8	0.4	7.7	0.6	0.7	4.2	2.4	289.6	27.1	62.6	13.6	3.5	2.4	0.5	1.8	110.4	0.3	8.7	4.3	

KC01LC3	37.5	551.8	13.7	4.6	2.1	1.9	0.5	8.2	1.8	0.8	4.3	2.5	300.1	28.3	62.6	12.2	2.8	2.1	1.5	1.3	115.2	0.5	9.6	4.7	
KC01LC4	39.7	627.2	15	4.8	2.2	1.7	1.4	6.2	0.6	0.8	4.3	2.6	333	26.9	61.6	11.8	2.6	2.3	1	1.7	103.6	0.4	9.8	5	
KC01LC4	38.6	627.3	13.6	6.3	0.5	2.1	0.5	7.1	1.9	0.8	4.8	2.6	329.9	24.1	65.2	14.5	2.5	4.2	1.3	2.7	102.8	0.5	10.7	4.8	
KC01LC4	40.1	643.4	14.1	6.4	0.5	2.9	1.4	7.9	0.6	0.8	4.2	2.7	347.6	32.2	68.3	11.7	2.2	4.6	0.8	0.9	106.6	0.6	9.5	5	
KC01LC5	38.9	614.3	15.3	8.1	1.8	2.3	0.4	6.9	2.5	1.2	4.7	2.6	312.7	23.6	41.9	11	4.1	3.4	2	2.1	116.1	0.5	9.4	4.5	
KC01LC5	37.7	606.9	13.9	2.9	0.6	2.8	0.5	7.6	1.3	0.8	4	2.6	311.8	20.5	65.4	13.5	2.6	1.7	1.1	1.5	111.7	1.5	9	4.6	
KC01LC5	38.6	606.6	15.5	8.1	0.5	2.4	0.5	7.5	2.1	0.8	5.5	2.6	320	24.3	59.7	12.1	2.8	3.9	0.5	1.1	115.5	1.6	9.3	4.1	
KC01LAB	25	257	10.4	2.9	0.5	2.5	0.4	16.3	3.1	0.7	3.8	2.3	221.5	9.8	26	7.9	3.7	3.7	1.3	0.6	223.2	1	6.5	4.3	
KC01LAB	24.5	241.1	5.4	5.5	2.2	2.5	0.4	15.9	2.5	0.7	3.8	2.2	231.5	15.8	19.4	5.9	3.7	2.5	0.4	0.7	216.2	0.8	5.4	4.3	
KC01LAB	25.6	267.4	8.8	3.9	2.7	2.4	0.4	16.8	3.4	0.7	3.6	2.3	236.8	8.2	23	10.6	3.7	2.5	0.7	0.8	221.6	0.6	6.2	4.2	
KC01LAC	34.8	535.2	11.6	6.5	0.6	2.1	0.4	9.6	3.2	0.8	5.1	2.6	317.6	24.9	48.9	11.4	2.8	3.3	0.6	1.5	127.3	1	7.7	4.8	
KC01LAC	34.4	540.2	15.5	5.3	2.7	2.3	0.5	10	2.4	0.8	4.2	2.6	315.2	22.9	56	12.1	2.8	2.1	1.2	0.7	125.6	1.5	8.5	4.6	
KC01LAC	34.1	532.7	17.1	5.4	0.5	2.6	0.5	10.1	2.6	1.2	5.8	2.6	318.5	26.4	55.6	14	2.8	5.2	0.5	1.4	125.9	0.5	7.8	4.6	
KC01LBC	36	546.6	11.6	4.4	0.6	3.1	1.2	12.4	1.8	0.8	6.5	2.6	343.9	26.2	58.7	16.8	3.2	5	0.6	1.7	166.5	0.6	8.8	4.8	
KC01LBC	34.8	542.6	12.5	7.4	0.6	3	0.5	12.8	2.3	0.8	5.5	2.6	328.9	26.3	35.7	13.6	3.3	2.2	1	1.5	162	0.6	9.3	4.8	
KC01LBC	36.6	558.2	16.8	5.7	0.6	2.3	0.5	12.3	3.6	0.9	4.6	2.6	350.2	30.2	60.7	11.6	3.3	5.2	0.5	1.2	163.6	0.8	9.2	4.9	
KC01LABC	34.7	490.1	13.1	4.1	1.9	2.3	1.3	13.2	3.4	0.8	3.7	2.5	311	24.6	59.6	11.3	3.2	2.2	0.7	1.3	157.5	0.6	7.3	4.7	
KC01LABC	34.1	472.9	9.8	6	2.3	2.7	0.5	11.6	2.9	0.7	4.2	2.5	302.6	22.4	37.7	11.6	3.1	2.1	1.4	1.7	152	1.3	7.6	4.6	
KC01LABC	34	509.8	11.4	8.1	0.5	2.7	0.5	12.3	2.8	1.1	4.3	2.6	319.2	23.5	60.7	11.2	3.1	2.2	1.1	0.5	158.2	0.6	8.8	4.9	
BR-S 2g/a2	36.7	307.2	13.5	5.3	2.9	5.6	0.7	11.2	2.5	0.9	1.7	3.1	346.2	18.9	31.4	3.4	4.9	3.4	0.5	1.1	152.5	0.9	7.9	5.8	
BR-S 2g/a2	36.9	304.2	11.9	6.7	0.7	4.8	0.6	11.7	2.3	0.9	1.7	3	349.8	30.5	36.1	6.5	4.5	3.3	1.2	1.1	147.5	1	9.4	5.3	
BR-S 2g/a2	36.1	312.6	12.6	9.1	0.7	4.8	0.6	11.9	2.1	0.9	1.7	3.1	349.1	22.7	59.8	5.4	4.6	3.3	0.6	1.2	146.8	0.7	11.2	6.2	
KC04LA1	24.8	499.7	14.5	4.9	0.6	1.7	0.4	7.2	1.6	0.7	1.7	2.4	184	13.1	25.7	11.4	2.2	3	1.1	1.2	86.3	1.7	6.2	6.8	
KC04LA1	24.9	512	17	10.9	0.7	2.5	0.5	7.5	2	0.8	1.5	2.4	184.2	16.3	20.9	12.1	2.2	1.6	0.5	1	88.6	0.5	7.2	4.5	
KC04LA1	24.4	514.7	15.8	5.7	0.7	3.2	0.5	8.6	1.2	0.7	1.4	2.4	196.5	21.3	21.9	12.4	2.1	2	0.8	1.1	87.8	0.7	7.5	10.3	
KC04LA2	24.8	438	13.3	5.2	0.6	1.7	0.4	7.7	2.5	0.7	1.5	2.3	160.2	11.3	14.5	10.4	1.9	3	0.5	2	107.8	0.5	7.5	3.6	
KC04LA2	25.1	426.6	15	6.5	0.5	2.1	0.4	7.6	1.6	0.7	2.6	2.2	164.2	14	16.2	10.1	2.2	1.3	0.6	1.2	110.1	1	7.4	3.3	
KC04LA2	23.5	438.7	12.3	5.4	0.6	2.1	0.4	8	2	0.7	1.3	1.8	162.7	15	19.8	12.5	2.2	2.4	0.4	1.2	107.3	0.3	7.4	4.7	
KC04LA3	28.7	593.7	15.8	4	0.6	1.8	0.5	5.2	1.9	0.8	1.4	2.5	228.9	18.9	26.7	12.6	2.2	3.5	0.8	0.9	67.4	1.5	7.1	4.6	

KC04LA3	28.2	600.6	12.9	4.1	3.4	1.6	0.5	4.7	1.4	0.8	2.6	2.5	226.9	17.2	19.8	12.8	2.2	1.6	0.5	1.3	68	1.3	7.1	4.7	
KC04LA3	28.6	583.6	14.8	9	0.6	2	0.5	5.4	1.1	0.8	2	2.5	225	21.2	24.3	15.4	1.9	1.5	0.6	1.4	67.5	0.4	8	5.2	
KC04LA4	24	521.1	9.4	4.2	0.5	1.2	0.4	6.3	1.4	0.7	2.2	2.4	184.4	7.8	31.7	12.1	2.2	1.9	0.4	0.9	68.8	0.5	5.4	4.4	
KC04LA4	24	527	10.4	4.2	0.6	1.6	0.4	6.3	0.5	0.7	1.2	2.3	189.2	12.7	20.3	9.7	2.2	2.9	1.3	0.8	67.6	0.8	5.7	4.1	
KC04LA4	23.9	523.5	10.6	2.5	0.5	1.7	0.5	5.5	0.6	0.8	1.4	2.4	192.5	15	14.1	9.8	2.2	2.3	1.5	0.9	68.9	0.5	6.4	4.4	
KC04LA5	26.3	510.7	15.5	6.5	1.8	1.6	0.5	15.3	1.5	0.8	1.4	2.1	200.9	13.2	23.2	12.4	2.1	1.6	0.8	0.6	69.9	0.5	6.4	4.6	
KC04LA5	27.4	545	13.8	4	0.6	1.2	0.4	17.2	2.5	1.1	1.4	2.4	201.3	12.4	19.4	13.6	5.3	1.6	0.8	1.4	68	0.4	6.7	4.6	
KC04LA5	27.4	537.2	12.1	6.3	2.6	1.6	0.5	16.5	1.7	0.8	1.9	2.4	202.9	17.1	38.7	13.9	2.2	1.8	0.5	1.1	68.3	0.5	7.7	4.7	
KC04LB1	29.8	249.4	10.5	4.2	0.6	2.7	0.5	17.4	2.3	0.8	1.5	2.6	366.9	18.4	27.1	5.9	4	3.3	0.6	0.8	171.8	0.6	6.4	5.3	
KC04LB1	30.3	252.6	8.8	5.3	0.6	3	1	19.3	2.8	0.8	1.5	2.6	377.5	18.7	31.4	5.3	4.1	2.6	0.6	1.8	172.9	0.5	8	4.7	
KC04LB1	29.6	263.4	11.4	6.8	3.9	2.9	0.5	18.8	0.7	0.8	1.6	2.7	380.6	21.6	36.8	5	4.1	2.5	0.6	1.4	173.8	0.6	7.9	5.5	
KC04LB2	29.1	313	11.6	5.7	0.7	2.6	0.5	18.5	3.5	0.8	1.6	2.6	327	18.5	23.9	10.3	3.8	2.5	1.7	0.8	173.3	1.4	5.9	5.6	
KC04LB2	28.3	306.4	8	5.5	0.6	2.8	0.6	19.3	3.7	0.8	1.2	2.6	335	22.8	53.3	3	3.8	2.7	0.6	0.7	175.6	0.6	7.8	5.6	
KC04LB2	28.6	298.4	8.6	4.8	2.2	3.2	0.6	19.4	4	0.8	1.8	2.6	330.6	16.1	26.7	9.3	3.7	2.7	0.6	0.6	175.9	0.8	6.2	5.8	
KC04LB3	33.6	233.7	8.5	4.1	0.5	3.3	1.3	15.3	3.1	0.7	1.4	2.3	345.1	18.2	35.7	10.7	4.7	3.3	0.7	0.9	363.9	0.8	7.9	4.5	
KC04LB3	33.9	234.5	7.3	4.6	0.5	3.1	0.5	15.4	4	0.8	2.5	2.3	355.5	16.9	21.7	7.3	4.7	3.3	0.6	0.9	357.7	0.6	8	4.7	
KC04LB3	34.3	228.1	8.4	4.8	2.7	2.6	0.5	14.6	3.3	0.7	1.4	2.3	355.8	18.8	26.1	13.5	4.7	3.2	0.7	0.9	357.6	0.8	7.8	4.6	
KC04LB4	29.4	260.8	9.1	5.9	0.6	2.7	0.5	17.5	0.7	0.8	1.5	2.6	329.6	16.4	31.1	9.5	3.8	2.4	0.5	0.6	179.3	0.6	7.2	5.4	
KC04LB4	29.6	269.2	10.1	5.1	0.6	2.2	0.5	18	2	0.8	2.4	2.6	331.3	13.9	40.5	4.8	3.9	2.4	0.5	0.8	181.1	0.5	7.6	5.3	
KC04LB4	29.8	258.3	7.9	5.5	0.6	1.8	0.5	16.6	2.2	0.8	3.1	2.6	334	7.7	35.2	8.5	3.8	2.4	0.8	0.8	180.7	0.6	7.9	5.1	
KC04LB5	38.1	260.6	6.8	5.4	3.5	1.7	0.5	21	4.2	0.8	3.8	2.4	349.6	17.5	47.2	7.3	5	3.2	0.7	1.1	477.3	0.4	9.8	4.9	
KC04LB5	38.6	261.8	9.1	3.7	3.3	2.4	0.5	21.7	3.5	0.8	1.7	2.4	345.3	18	49.5	10.4	5	5.4	1	1.1	475.8	0.9	9.7	4.4	
KC04LB5	38.8	264.7	9.6	4.4	3.2	3.4	0.5	22.1	3.6	0.8	1.5	2.4	345.2	15.2	25.6	10	5	3.2	0.7	1.1	480.1	0.7	9.2	5.4	
KC04LC1	41.9	558.9	18.5	3.4	0.6	2.3	0.5	6.2	1.9	0.8	2.7	2.6	289.1	23.6	44.6	11.3	2.9	4.4	0.5	0.7	99.2	0.4	9.5	4.9	
KC04LC1	42.3	559.5	13.3	8.2	0.5	2.4	0.5	4.6	1	0.8	5.1	2.5	278.6	22.7	61.5	10.5	2.7	1.9	0.6	1.7	96.4	0.6	9.5	5.2	
KC04LC1	42.4	587.5	12.9	3.2	0.6	3.2	1.1	6.6	1.5	0.8	6.5	2.5	289.7	32.8	70	11.4	2.8	4.6	0.5	0.8	99.3	0.7	9.8	4.4	
KC04LC2	39.4	582.6	15.1	3.6	0.6	2	0.5	5.7	2	0.8	3.2	2.6	275.2	20	53	14	2.2	1.8	0.6	1.4	94.2	0.6	9.9	5.3	
KC04LC2	40.1	582.1	14.5	5.7	0.6	1.6	0.4	4.9	2.2	0.8	4.4	2.5	277.2	27.4	30.1	11.2	2.6	1.8	0.5	1.3	93	0.8	9.9	5.2	
KC04LC2	40	595.7	16	8	0.6	2	0.5	6.8	1.5	0.8	3	2.6	276.6	22.8	28.7	14.6	2.7	1.5	0.5	1.3	93.6	0.8	8.5	5.2	

KC04LC3	38.9	531	11.8	6.4	0.5	2.1	0.4	5.9	1.1	0.8	1.5	2.5	260.4	24.3	47.9	9.8	2.7	1.9	0.4	1.3	103.7	1.9	8.9	5	
KC04LC3	39.5	536.8	12.6	5.8	0.5	2.2	0.4	6	0.8	0.8	4.4	2.5	264	28.4	54	14	2.7	3.4	0.6	1	104.8	0.8	9.2	4.4	
KC04LC3	40.1	546.6	13.1	3.4	0.6	2.4	0.5	6.6	1.5	0.8	3.1	2.5	260.7	24.9	50.2	11.7	2.7	1.9	0.7	1.8	103.3	0.5	9.9	5.2	
KC04LC4	40.3	555.2	10.8	6.8	0.5	2.4	0.5	6.3	1.5	0.8	4.5	2.5	297.7	27.3	64.4	14.8	3	2.7	1.3	1.6	108.1	0.5	9.1	5	
KC04LC4	40.9	550.5	16.3	6.5	0.6	2.3	0.5	6.4	1.9	0.6	5.8	2.6	298.8	26.2	49	10	3.1	1.9	0.5	1	108.1	1.3	8.4	5.6	
KC04LC4	40.3	558.4	13.7	11.1	0.6	2.9	0.5	6.9	1.5	0.8	6	2.6	296.8	27.7	41.3	12	3.1	1.9	0.5	1.5	109.3	0.5	10.2	5	
KC04LC5	42.2	524.5	13.8	5.2	2	1.6	0.5	5.7	1.7	0.8	4.1	2.6	288.7	27.3	53.1	14.1	2.7	1.4	0.9	1.1	99	1.3	8.4	5.1	
KC04LC5	41.7	527.8	14.4	4.3	0.6	2	0.5	5.8	1.8	0.8	5.9	2.5	280.9	24.6	61.6	11.8	2.6	2.2	0.7	1.6	97.1	0.5	10	4.9	
KC04LC5	41.7	538.6	12.3	2.1	3.2	2.5	1.4	5	0.6	0.8	4.9	2.5	284.8	23	37.4	12	3.7	1.8	0.5	1.2	97.7	0.5	9.9	5	
KC04LAB	27.9	356.6	9.5	6.5	0.6	2.2	0.5	13.6	1.9	0.8	1	2.5	286.5	21.1	22.6	6.6	3.2	2	1	0.5	129.1	1.3	6.6	5.2	
KC04LAB	28.7	354.5	12.8	2.5	2.8	2.4	0.5	13.3	2.5	0.8	2.1	2.5	271.8	15.1	21	7.8	3.2	1.5	0.5	1.4	128.3	0.6	8	4.8	
KC04LAB	28.8	366	12.8	4.8	0.6	2.9	0.5	12.9	0.6	0.8	2.3	2.5	287.1	18	23.8	9.6	3.2	3.1	0.9	0.8	129.7	0.6	8.4	5.4	
KC04LAC	35	494.4	10.6	4.5	0.6	1.7	0.5	7.8	1.9	0.8	3.3	2.5	238.9	20.5	39.5	12.7	2.4	2	0.8	0.5	97.5	0.9	9.2	5	
KC04LAC	35.1	506.7	14.1	2.5	0.6	2.1	0.5	6.8	1.1	0.8	4.6	2.5	241.1	19.9	41.2	11.8	2.5	1.7	1.7	1.6	94.5	0.5	9.8	4.5	
KC04LAC	34.7	495.9	16.7	8.6	0.6	2.2	0.9	7.5	1.7	0.8	3.2	2.5	238.1	20.2	33.3	9.7	2.4	3.7	0.5	1	96.3	0.6	8.4	4.9	
KC04LBC	36.6	402.3	10.1	3.2	0.6	2.3	0.5	11	0.6	0.8	3.3	2.5	317.7	25.1	54.4	8.3	3.4	2.2	0.6	1.6	132.2	0.6	9.4	4.9	
KC04LBC	36.3	388.4	10.3	6.6	0.6	2.4	0.5	10.8	1.8	0.8	3.1	2.5	319.6	23.3	29.3	8.7	3.4	2.2	0.5	0.7	134	0.5	10	4.8	
KC04LBC	36	394.7	11	10.5	0.6	3.2	0.5	12.1	1.2	0.8	1.6	2.6	320.7	20.9	34.6	8.8	3.4	2.2	0.6	0.5	135.1	0.9	8.6	5.4	
KC04LABC	34.8	432.7	10.7	5.3	0.6	1.8	0.5	9.6	1.4	0.8	3.7	2.5	270.9	23.4	28.9	9.5	3.1	3.5	0.5	1.1	118	0.5	7.8	5.1	
KC04LABC	34.8	434.9	10.8	4.1	0.6	3	0.5	10.7	0.6	0.8	3.8	2.5	277.9	22.1	23.9	10.6	3.1	4.4	0.6	1.6	115.5	0.8	7.6	5.3	
KC04LABC	35	429.1	12.6	2.1	2.6	2.2	0.5	9.1	1.6	0.8	2.4	2.5	274.3	17.4	31.5	8.5	3.1	2.7	0.4	0.6	120.5	0.6	8.2	5.4	
BR-S 2g/a2	36	289.9	11.5	8.1	0.7	4.1	0.6	10.6	2.4	0.9	1.7	3	359.8	26.7	58.9	6.3	4.6	3.3	0.4	0.9	154.9	0.6	10.8	5.5	
BR-S 2g/a2	36.8	282.8	11.5	7.1	0.7	5.7	0.6	10.8	1.7	0.9	1.6	3	363.7	25.1	38.3	5.4	4.5	3.3	0.7	0.7	152.3	1	9.3	4.7	
BR-S 2g/a2	34.7	288.2	16.5	6.5	0.7	4.8	0.6	11	1.7	0.9	1.6	3	360.2	29.2	39.6	8.1	4.4	5.1	0.7	1.2	154.7	1.6	7.8	5.1	
KC07LA1	22	418.4	12.5	8.2	6	4.5	0.5	11.5	1.7	0.7	2.3	2.2	159.8	13.7	32.6	12.4	2.2	1.6	0.5	1.8	99.1	0.7	5.8	14.4	
KC07LA1	22.3	393.9	13.8	4.8	0.6	3.5	1.9	11	1.9	0.7	1.7	2.2	157.5	10.3	16.5	8.8	2.3	2.7	1.3	1.4	100.7	0.6	4.9	9.9	
KC07LA1	22.8	391.1	15.6	4.5	0.6	2.5	1.6	11.6	2.5	0.7	2.5	2.2	156.8	11.3	17.8	10.2	2.3	2.2	1.7	1.4	99	1.6	5.1	13.3	
KC07LA2	19.3	252.5	8.4	4.9	0.6	2.4	0.4	5.9	1.9	0.6	3.5	2.1	113.7	13.1	5.4	10.1	2.5	4.2	0.4	0.9	111.5	1.6	3.9	3.5	
KC07LA2	20.4	257.4	8.6	4.9	3.6	1.7	0.4	5.5	1.4	0.7	2.8	2.2	120	12	11.7	7.8	2.5	2.3	1.8	1.2	110.2	1.4	3.9	4	

KC07LA2	19.3	250.5	7	5.4	3.3	1.7	0.4	5.9	2	0.6	3.2	2.1	112.7	12.3	13.5	9.6	3	1.7	1	1	108.5	1.1	4.5	3.5	
KC07LA3	20.9	305.3	7.1	6.4	3.6	2.3	0.4	9.1	2.3	0.4	4.1	2.3	130.4	10.1	12.7	11.6	3.7	1.4	0.5	1.9	117.2	1.1	4.7	3.8	
KC07LA3	21.3	308.8	9.7	5	2.9	1.8	0.4	10.9	1.8	0.7	2.9	2.2	131.3	16	25.6	9.6	2.8	3.2	0.5	1.3	117.2	1.1	4.3	3.7	
KC07LA3	21.4	302.9	8.4	5.2	3.3	2.1	0.4	9.5	2.1	0.7	4.9	1.7	134.3	13.4	11.7	11.8	2.7	1.5	0.7	1.6	113.8	1.3	5.4	3.5	
KC07LA4	23.1	403.7	11.7	4.6	0.5	1.8	0.4	5.8	2.3	0.7	1.3	2.2	178.1	17.2	15.9	10.3	2.2	1.6	1.3	1.2	83	0.7	5.4	3.7	
KC07LA4	22	388.3	11.8	6	3	2.4	0.4	4.8	1.4	0.7	3.6	2.3	174.2	18.4	24.5	10.3	2.2	1.1	0.5	1.3	84	0.4	5.1	4.5	
KC07LA4	22.1	387.6	11.1	3.6	0.5	2.1	0.4	6	2.4	0.7	2.6	2.2	173.5	14	17.7	11.8	2.5	2.3	0.3	1.1	82.7	1	5.2	3.8	
KC07LA5	22.8	397	11.9	6.4	0.5	1.9	0.4	6.4	2.1	0.7	1.3	2.2	160.5	14.4	20	9.6	2.2	3	0.5	1.4	84.6	1.1	5.2	4.2	
KC07LA5	22.6	402.5	9.8	5.6	2.9	1.8	0.4	6.9	1.8	0.7	1.5	2.2	155.2	15.1	15	11	2.1	1.9	1.5	1.3	84	1.6	4.5	3.5	
KC07LA5	23	406.4	11.5	3.8	0.5	1.6	0.4	7.3	1.8	1.2	1.3	2.3	160.2	14.3	23.4	11.9	2.2	2.7	0.5	0.9	84.7	1.7	4.8	4.1	
KC07LB1	29.7	269.6	7.7	5.3	0.6	1.9	0.5	15.8	2.5	0.8	1.5	2.5	334.5	24.3	28.2	6.3	4	2.5	0.6	1.1	185.4	0.9	7.6	5.4	
KC07LB1	28.9	277.5	8.5	3.6	0.6	2.9	0.5	14.7	2.6	0.7	1.5	2.6	332.8	9.5	22.3	8.9	4.1	2.5	1.5	0.9	186.1	0.5	5.2	5.4	
KC07LB1	28.7	277.4	9.3	6	0.7	2.6	0.5	14.9	1.9	0.8	1.2	2.6	332.3	19	27.1	6.7	4	2.4	0.6	1.3	186.2	0.6	5.5	5.6	
KC07LB2	29.7	311.7	7.1	3.9	2.9	3	0.5	18.9	1.6	0.8	1.5	2.5	342.3	17.1	25.4	6	3.9	2.4	0.6	0.7	172.9	0.3	6.2	5.6	
KC07LB2	29.4	308.4	10.7	3.3	0.6	2.1	0.6	17.5	2	0.8	1.1	2.6	348.6	19.5	29.9	8	4	2.5	0.8	1.1	172.6	0.9	6.1	4.2	
KC07LB2	29.2	309.3	10.8	3.9	0.6	3.1	0.5	18.8	0.7	0.8	1.5	2.6	347.3	18.7	27.5	7.1	3.5	2.5	0.6	0.5	174.5	0.6	6.8	5.3	
KC07LB3	37.9	268.9	11	6.8	3.4	3.1	1	21.5	4	0.7	3.3	2.4	370.8	21.7	46.7	10.1	5.1	3.1	2	1.1	474.3	1	11.4	4.8	
KC07LB3	38	266.6	10.4	8	3	3.5	0.5	22.4	3.7	0.7	1.4	2.4	370.1	18.7	35.1	12	5	2.7	0.7	1.1	469.9	1.4	10.1	4.9	
KC07LB3	38.6	269.4	9.6	4.3	0.6	3.5	0.5	21.9	3.6	0.7	2.9	2.4	367.8	18.6	52.3	10.1	4.9	3.8	0.7	1.1	467.3	0.9	10.4	4.6	
KC07LB4	30.8	305.5	11.2	3.3	0.6	2.8	0.5	18.3	2.8	0.8	1.7	2.6	337.5	10.6	32.7	7.7	3.8	2.3	0.6	0.8	155.3	0.6	7.5	5.6	
KC07LB4	30.5	294.9	7.6	5.9	0.7	2.7	0.5	18.7	2.1	0.8	1.5	2.6	340.6	21.6	29.6	9.9	3.7	2.8	0.7	0.3	156.1	0.4	8	5.1	
KC07LB4	29.6	295.2	2.9	4.1	0.6	2.6	0.6	19.1	0.6	0.8	1	2.6	352.8	16.1	26.1	7.8	3.8	2.3	0.6	1.2	159.6	0.6	7.2	7.7	
KC07LB5	33.6	260.7	10.4	5.3	2	3.7	0.4	14.8	3.7	0.7	1.4	2.4	423.6	11.8	29.7	8.8	5.3	3.6	0.7	0.9	361.4	0.9	8.7	4.5	
KC07LB5	33.2	276.3	9.8	8.8	0.6	3.9	0.5	16	5	0.8	1.5	2.5	435.8	13.6	30.8	9	5.4	7.9	0.6	0.9	369.8	0.7	9.5	5.5	
KC07LB5	32.5	273.5	6.3	5.8	3.3	3.7	0.5	14.3	3.7	0.7	1.3	2.4	434.8	14.4	44.4	7.9	5.3	3.5	0.7	0.9	363.2	1.1	8	4.4	
KC07LC1	36.6	476.8	13.8	7.6	0.6	2.7	0.5	6.3	1.5	0.8	4.4	2.5	288	20	55	11.5	2.8	4.2	0.9	0.9	113.4	1.3	9.5	5.2	
KC07LC1	35.9	487.2	9.7	6.5	0.6	2	0.4	5	1	0.7	3.9	2.4	293.6	21.3	50.8	8.9	2.9	2	0.7	0.8	115.1	0.7	8.7	4.8	
KC07LC1	37.4	503.3	15.4	6.1	0.6	2.8	0.5	6.1	1.2	0.8	3.7	2.5	300.5	26	38.2	12.5	2.8	1.4	1.1	1	115.9	0.5	9.2	5.1	
KC07LC2	35.4	546.8	15.1	6.8	0.6	1.9	1.4	6.4	1.4	0.8	2.9	2.5	276.3	28.2	26.4	11.8	2.7	2	1.2	1.1	105.9	1.1	9	5.3	

KC07LC2	35.9	545.6	12.9	6.3	0.6	2.1	1	7.2	2.4	0.8	4.3	2.5	272.8	18.7	47.4	12.4	2.7	2.5	0.5	1	107.5	0.6	8.6	4.3	
KC07LC2	36.4	537.8	15.3	4.2	0.6	3.6	0.5	7.3	1.2	0.8	4.7	2.5	277.5	22.8	56.7	14.3	2.8	1.9	0.9	1.3	107.2	0.5	9.1	5.3	
KC07LC3	37.2	535.9	12.3	5.7	0.6	3	0.5	5.6	0.6	0.8	4	2.6	290	23.7	54.6	9.4	2.7	3.6	0.5	1.4	105.4	0.8	8.7	4.8	
KC07LC3	38.6	529.6	16.1	9	2	2.5	0.8	5.7	1.1	0.8	5	2.6	289.5	20.1	52.1	12.3	5.3	1.9	1.3	2	106.7	0.4	9.1	5	
KC07LC3	37.6	524.2	16.8	9.6	0.6	2.4	0.5	6.1	1.6	0.7	3.8	2.5	286.1	26.6	61.7	12.9	2.7	1.2	0.4	1.1	105.9	0.4	9.4	4.6	
KC07LC4	39.2	559.4	13.9	4.7	0.6	2.4	0.4	5.8	1.7	1.3	3.8	2.6	278.2	23.5	59.1	11.3	2.5	3.2	0.5	1.3	84.3	0.5	10	4	
KC07LC4	38.3	559.3	15.7	6.3	0.6	2.6	0.5	5.7	1.9	0.8	1.5	2.6	280.9	20.7	47	11.6	2.5	2.7	0.5	1.4	86	1.4	8.8	5.3	
KC07LC4	38.7	577.1	13.7	6.5	2.9	2.7	0.5	5.1	0.6	0.8	3.4	2.6	286.1	28.1	63.9	15.7	2.5	1.2	0.4	0.7	89	0.4	9.7	4.7	
KC07LC5	38.4	523.3	13.3	7.9	0.6	2.1	0.5	4.9	1.3	0.8	6.7	2.5	276.2	25	35	13.2	2.2	1.4	0.5	1.3	100.9	0.8	8.8	5.2	
KC07LC5	38.7	540.7	12.2	6.1	0.6	2.5	0.5	5.3	2.1	0.8	3.3	2.5	271.9	21.4	60.4	12.2	2.7	1.8	0.5	1.3	103.8	0.5	9.4	5	
KC07LC5	39.4	521.5	14.3	6.8	0.5	2.1	0.5	5.1	1.1	1.4	2.7	2.5	271.5	23.9	60.8	13.7	6.2	1.9	1.7	1.3	103.2	0.8	8.9	3.8	
KC07LAB	25.6	320.5	8.8	3.8	0.6	1.9	0.5	13.4	2.4	0.7	1.4	2.4	244.4	17.2	24.2	7.6	3.2	2.1	0.9	1.1	145.3	0.8	6.1	4.5	
KC07LAB	24.9	316.1	9.6	5.4	0.6	2.5	0.5	13	3	0.8	2.6	2.4	246.2	14.8	24.4	8.1	3.4	3.9	0.9	1.1	146.7	0.8	5.8	4.7	
KC07LAB	24.9	328.5	11.8	3.6	0.6	2.6	1.4	13.2	2.6	0.8	3.4	2.4	246.1	15.1	25.7	8.5	3.2	4.1	0.5	1.3	146.7	1.6	6.1	4.7	
KC07LAC	29.9	419.9	8.9	6.8	0.5	1.8	0.8	8.4	2.2	0.7	3.3	2.3	198	17	38.5	10.7	2.5	1.1	0.6	1.8	104.9	1.3	6.8	4	
KC07LAC	29	448.4	10.6	6.7	3	2.5	1.1	8.3	1.1	0.7	3.5	2.4	211.1	18.5	26.6	14.6	2.5	1.7	0.5	1.3	103.7	0.8	7	4.4	
KC07LAC	30.3	422.2	9.1	4.9	0.5	2.4	0.4	7.7	2.2	0.7	4.1	2.3	207.7	21.9	18.2	11.2	2	4.5	0.7	1.2	102.1	0.5	8	3.3	
KC07LBC	33	401.7	10.3	3	0.6	2.7	0.5	12	2.1	0.6	5	2.5	308.8	12.7	35.7	6	3.5	2.2	0.5	1	156.7	1.1	8.2	5.1	
KC07LBC	32.4	399.1	11.7	5.8	0.6	2.2	0.5	12.2	0.6	0.8	1.5	2.5	305.9	19.6	42.2	11.7	3.5	2.2	2.2	1.4	154	1.6	7.3	5.1	
KC07LBC	33.1	412.2	12.2	4.9	0.6	2.8	0.5	12.8	2.2	0.8	3.6	2.5	313.4	19.7	23.3	7.6	3.5	2.2	0.5	1.6	154.2	1.3	6.9	5.3	
KC07LABC	29.1	383.6	9.4	5.2	0.5	2.1	0.5	12.8	2.1	0.8	1.1	2.4	256.5	21.5	29	10.3	3	2.3	1.4	1.3	129.2	1.4	6	4.5	
KC07LABC	29.1	388.8	12.8	9.1	2.5	2	0.5	12.9	1.8	0.8	2.9	2.5	259.5	20.6	27.9	10.4	2.9	3.2	0.6	0.6	129.2	0.5	6.5	4.9	
KC07LABC	29.1	372.3	11.9	6.6	0.6	2.4	0.5	13.7	2.9	0.8	3.9	2.5	251	18.2	27.8	10.1	2.9	1.5	0.5	0.7	127.5	0.5	7.7	5.2	

Appendix 5.6: ICP-MS Raw Data for Nottingham Samples (Intensities)

	V	Cr	Co	Cu	Sr	Y	Zr	Nb	Mo	Cd	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	W	Tl	Pb	U
1KC0NA1	26876	3045.2	4832.6	6877	6927.5	16385	48001	7180.6	731.16	53.2298	27933	64867	8985.4	6418.8	1578.8	1385.2	1623.2	1554.2	1938.8	1613.2	1634.8	1034.2	1281.6	1029.4	1146.8	1074.8	38206	5831.6
1KC0NA2	24812	2918.2	4598.2	6260.4	7051.6	15824	46163	7423	764.85	228.9496	29110	67509	9432.2	6803.6	1659.8	1437.4	1751.8	1591.4	2064.8	1743.2	1717.6	1073.8	1367.2	1084.2	1202.8	1118.2	34784	3983.6
1KC0NA3	25757	2551.6	4211.8	6083.2	6451.9	15943	48199	6878.2	422.56	-8.3489	26922	62314	8450.6	5987.4	1200.4	1003.8	1274.4	1179.2	1594.2	1357.8	1324.2	738.8	951.8	716.2	875.2	660.2	35967	3634.4
1KC0NA4	26362	2930.8	5156.4	6437	7138.1	17232	50339	7518	671.63	-75.3361	30196	71330	9751.6	6901.6	1561.6	1363.4	1681.2	1550.6	2047.8	1729.2	1650.2	1011.8	1300.8	986.8	1112.2	995.2	48350	4156.8
1KC0NA5	24993	3073.2	4667.2	6159.8	6811.4	16339	49833	7444.4	837.9	227.4224	26562	62070	8780.6	6283.8	1624.4	1437.8	1717.8	1632.2	2002.8	1723.2	1704.8	1149.2	1405.4	1102.2	1212.6	1137.2	45391	4041.2
1KC0NB1	26815	2381.8	3917.8	5987.8	5730.5	15036	63948	6424.4	460.29	39.2982	25275	57731	7703.6	5537.4	1055.2	896	1157.4	1069.8	1452.2	1173.6	1161.2	566.8	836.2	544.4	1269.8	739.4	57693	3284.8
1KC0NB2	26666	2412.2	3949.6	5815.8	5114.9	14498	53343	6498.4	388.53	380.2536	24322	55930	7466.8	5303.4	1008.4	856.6	1105.2	1037.2	1394.2	1149.2	1143.2	550.8	830.2	570.2	1029.8	751.6	54512	3188.2
1KC0NB3	27060	2772.2	4112.8	5949.4	6084.1	15073	47828	7035.2	446.83	47.9431	25679	59376	8060.4	5813.2	1188.2	1038.6	1287.2	1200.2	1549.6	1316.2	1301.8	703.4	944.2	690	983.8	875.4	50004	3459
1KC0NB4	27496	2887.4	4192.8	7621.4	6037.4	15201	44493	6990.2	3083.8	735.1647	25648	58337	7955.6	5788.8	1329.8	1134.2	1428	1283.8	1707.2	1409	1432.2	829.8	1094.6	805.2	6219.6	1233.8	83988	3550.6
1KC0NB5	27324	2793.4	4218.2	6101.8	6342.9	15441	49672	7318.4	515.69	67.0251	27346	62185	8638.8	6204	1326.8	1150.2	1425.4	1297	1750.8	1449.2	1471.8	823.8	1075.6	820.8	1219.8	894	47249	3581.2
1KC0NC1	29663	3272.6	4570.8	6303.4	6138.5	16936	52204	7855.8	489.69	842.7346	30453	68377	9551	6832.4	1426.6	1223.8	1535.8	1393.4	1799.4	1521.8	1536.2	844.2	1157.2	867.2	1041.6	937.6	38947	3943.8
1KC0NC2	29126	2926.8	4283.2	5943.2	5816.3	16584	65155	7800.6	450.22	34.1437	28909	65394	9089.8	6485.6	1307.8	1123.2	1367.8	1312.8	1738.2	1383.8	1456.8	753.6	990.2	745.8	1125.6	767.2	34250	3686
1KC0NC3	30244	2783.8	4282.8	5986.6	5980.3	16604	49718	7651.2	372.25	58.1531	30390	68571	9415.2	6621.2	1263.2	1076.8	1376.4	1205.8	1635.4	1343.8	1303.8	704.4	909.6	678.6	918.2	690.8	32915	3647.6
1KC0NC4	29844	2766.4	4128.2	5921.2	6210.7	15992	50100	7473.4	336.36	-54.1525	28927	65776	9083.8	6465	1208.2	1010.2	1333.8	1158.8	1587.6	1266.2	1316.4	674.8	914.8	670.2	891.6	688.8	31647	3642.4
1KC0NC5	28112	2573.2	3861.4	5710.4	5287.6	15329	48850	7141.2	322.82	7.2618	28707	64679	8994.6	6292	1165.6	997.6	1299.8	1120.4	1520.6	1241.8	1211.2	625.2	854.2	626.2	818.8	685.8	32538	3568.4
1KC0NAB	24791	2344.2	3706	5944.4	5608.3	14669	45396	6303.4	400.36	119.8962	24500	56812	7568.4	5477.2	1059.8	913	1132.8	1051.4	1403.2	1219.4	1184.4	599.6	799.8	587.8	804.4	704.4	50053	3293.6
1KC0NAC	27172	2686.8	4087.2	5814.8	5877.8	15353	50907	7051.2	357.27	96.5264	27674	62897	8588	6071	1211.8	1026.8	1297.6	1156.2	1559.2	1290.4	1287.4	658.4	952.8	674.6	841.8	708.6	32605	3580.8
1KC0NBC	25546	2727.8	4028.8	5870.4	5811.1	15166	60991	7117.4	583.18	-25.0839	25849	58702	8205.4	5873.2	1330	1140.2	1409.2	1308	1730.4	1429.6	1430.4	853.6	1091.4	825.8	1154.8	934.8	38765	3504.2
1KC0NABC	25598	2622.2	4141.2	5934.2	5840.6	15286	45261	6745.2	552.94	51.7511	26009	59532	8175.4	5801.4	1343.4	1139.8	1392.8	1293.6	1735.8	1420.6	1436.8	864.2	1085.4	839.2	1010.8	917.2	42456	3481.2
KC01NA1	26558	2961.2	4720.8	6532.4	6721.2	17783	58581	7803.4	700.38	84.9373	28602	65928	9165	6566.4	1501.2	1358.8	1659.8	1579.8	2015.8	1709.4	1725.6	1012.2	1310.4	1049.2	1075.8	1044.2	42123	4299.4
KC01NA2	27513	3058.8	5196.4	6877.2	6980.3	17871	53189	8265.8	617.92	6.0993	30829	70997	9799	7188.4	1641.8	1437.2	1700.2	1629.2	2043.8	1730.6	1756.2	1012.2	1299.8	1017.6	1200.4	1091.8	58917	4151.2
KC01NA3	23916	2654.8	4262.6	5989.2	5798.5	15725	48629	7163.4	620.78	78.0767	26394	60473	8355	5915.8	1352	1206.8	1495.8	1400.2	1780.6	1606.2	1557.2	906.6	1207.2	914.8	994.2	909.2	47146	3617
KC01NA4	24907	2402.6	3974.4	5560.8	6469.6	15760	48079	6957.4	376.49	124.2549	26537	61350	8379.2	5781.8	1171.2	950.6	1195.2	1145.8	1525.2	1301.8	1314.8	631.2	858.8	653.4	714.8	684.6	42694	3409.6
KC01NA5	24547	2590	4057.2	5589.8	6066.1	15504	48599	6883.6	486.67	-31.9496	26435	61184	8319.4	5934.8	1316	1087.8	1387.4	1273.2	1663.4	1372.8	1459.2	802.2	1035.2	824.2	890.4	824.4	43620	3572.2
KC01NB1	27701	2575.8	3955.8	6200.6	6222.2	16198	50014	6996.2	342.4	117.0762	26538	60383	8083.8	5778.8	1098.8	955.2	1204	1086	1551.4	1270.8	1254.8	649.8	923.8	618.4	808.8	785.2	67602	3417
KC01NB2	26675	2487.2	3846.6	5627.4	5960.6	15076	49143	6887.8	316.14	75.6505	25263	58816	7822.4	5577	1101.2	928.4	1182.8	1063.6	1515.2	1212.6	1231.2	665.8	863.8	637.8	900.8	762	51921	3331.6

KC01NB3	25594	2401.2	3643.4	6045.2	5857.5	14362	45081	6224.8	316.36	59.5001	24043	55215	7348.6	5318.4	978.2	860.8	1104.2	995.6	1421.8	1120.6	1153.2	583.6	812.2	573.2	827.8	737.4	60011	3141.8
KC01NB4	28374	2596.2	4063.8	6676	5779.9	16046	51144	7014	337.27	92.7799	26774	59900	8217.8	5890.4	1106.8	991.8	1196.8	1127.6	1577.2	1336.2	1324.4	681.6	909	655.2	970.2	829	91352	3326.4
KC01NB5	27206	2658.2	3863.2	6100.8	5946.5	16172	52079	7807.4	321.51	121.8537	27456	61868	8405.8	6027.6	1098.6	983.2	1256.2	1133.6	1607.8	1310.8	1289.4	643.8	910.4	684.6	904.8	721.4	49170	3456.2
KC01NC1	28940	2853.2	4013.2	6002.6	6447.1	16240	66849	7560.4	379.89	26.9502	28924	64052	8810.2	6369.8	1190.8	1016.4	1294.2	1136.8	1602.6	1293.2	1323.4	645.8	914.4	655.8	957.8	681.8	31502	3623.4
KC01NC2	30148	2902.8	4160.2	5857.2	5997	13193	58711	7983.8	311.53	26.2934	24550	54824	7892.8	5654.2	1098.2	942.6	1179.8	1035.8	1413.2	1172.8	1123.2	611.8	845.6	557.8	861.8	753.2	35969	3796.2
KC01NC3	28971	2703.4	4002.2	5924.2	6383.8	16567	50295	7329.2	310.47	34.9957	29535	65675	9006	6254.8	1158.8	1000.2	1341.8	1175.2	1644.8	1310.2	1338.2	673.2	929.2	644.8	794.8	713.8	31437	3603.4
KC01NC4	28259	2709.8	4402.2	5983.8	6427.4	16418	51990	7458.6	315.11	57.0046	29434	66124	9217.2	6455.2	1238.6	1019.6	1351.2	1170.6	1633.2	1339.2	1290.8	686	911.6	661.8	808.8	745.6	32826	3607.2
KC01NC5	29737	2862.8	4088.2	5845.2	6752.6	16868	52682	7538.4	338.34	14.7041	30599	67053	9309.6	6558.4	1269.2	1068.2	1391.8	1272.8	1678.8	1392.4	1338.6	760.8	958.2	719.8	785.8	764.8	35345	3733
KC01NAB	26684	2661.8	4053.8	6358.8	12762	16467	52761	7131.4	349	5.1876	26419	54754	8440	6022.8	1085.2	967.6	1242	1127.2	1600.8	1265	1255	662.4	913.8	658.2	734.4	723.6	50522	3594.2
KC01NAC	26552	2410	3909.8	5689.4	6282.4	16428	64948	7201.2	266.05	82.9356	27527	62138	8378.8	5976.8	1076.8	901.8	1185.6	1100.2	1560.6	1196.4	1182.8	574.6	836.2	617	806.8	628.4	35415	3393.6
KC01NBC	120230	10810	17436	25372	29904	75445	238920	33761	971.27	19.4818	127330	262820	38894	27722	4839.4	4042.4	5258.6	4971.2	7009.8	5653.2	5609.6	2515.2	3776.2	2522.2	3096.2	2964.4	217050	16265
KC01NABC	24165	2375.8	3536.6	5179.4	5976.8	14651	44050	6407.8	296.16	90.1694	24851	57563	7737.2	5510.2	1047.6	898.6	1078.6	1085.6	1421.2	1171.2	1159.8	576.8	799.8	551.4	709.6	609.8	37148	3252.2
KC04NA1	26632	2453.2	4675.4	5765.4	6361.2	16238	49903	6940.6	326.89	286.3387	28076	66609	8748.2	6227.6	1176.8	928.8	1260.2	1135.4	1562.2	1267.2	1289.6	623	852.6	597.6	727.8	645	56817	3487.2
KC04NA2	29349	2691.4	5154.6	6474.4	6936.8	17744	57312	7873.4	479.96	81.4649	30836	72580	9634.8	6914.8	1294.4	1054.2	1392.8	1269.2	1721.4	1416.2	1421.2	726.4	1013.2	707.8	1202.4	687.2	39191	3803.4
KC04NA3	29921	2561.2	5594.6	6346	6951.4	17163	52253	7619.6	361.89	52.7302	29778	71864	9196	6538	1233.2	1068.4	1303.2	1197.2	1616.2	1328.2	1362.2	659.8	903.8	622.2	964.4	690.2	55574	3672.4
KC04NA4	25643	2466.2	4277.8	5945.6	6884.3	16163	51596	7402.6	1011.5	176.5768	27404	63329	8501	6057.6	1174.8	982.8	1237.6	1162.8	1585.8	1312.8	1295.8	616	905.8	639.6	2951.4	701.2	39439	3594.6
KC04NA5	25305	2441.6	4473.6	5889.2	6232.3	15756	48351	7051.2	3697.8	977.5153	26909	63218	8434.6	6054	1127.2	973.8	1256.8	1111.8	1511.2	1269.8	1258.8	625.2	893.4	630.2	8727.2	1052.2	44585	3337.4
KC04NB1	25189	2251.2	3854.2	5836.8	5892.7	14154	42240	6225.8	317.98	169.5977	23875	55553	7360.2	5160.4	967.6	801.2	1021.6	930	1315.4	1087.8	1075.6	513.2	788.6	526.2	830.2	699.2	81927	2853.2
KC04NB2	28007	2374.8	4041.8	6729.8	6272.3	14764	41904	6361.4	305.91	162.179	25283	58304	7652.2	5391.6	980.2	809.8	1102.8	1017.2	1399.8	1144.2	1130.6	532.2	759.8	541	798.8	774.2	105070	3113.2
KC04NB3	26445	2365.2	3859.6	6076.8	6123.8	14350	46539	6493	300.58	127.821	24629	56781	7477.4	5370.2	967	811.8	1079.6	972.8	1358.2	1096.2	1125.2	524.8	738.8	512.6	782.4	617	60916	3191.8
KC04NB4	24557	2249.2	3718.6	5553.6	6531.4	13933	43135	6163.2	274	48.3046	23462	55170	7210.2	5187.8	974.2	809.2	1058.6	994.6	1366.2	1052.2	1099.2	534.8	744.2	519.2	768.2	636.4	52675	3057
KC04NB5	26807	2153.2	4040.6	6085.2	5759.9	14500	42943	6020.2	284.38	90.5629	24523	56820	7467.6	5287.4	969.8	850.8	1044.8	968.8	1351.8	1078.8	1101.4	551.2	766.2	493.4	762.8	726.8	69499	2979.8
KC04NC1	27183	2314.8	3857.8	5605.4	5598.4	16121	53355	7346.4	223.29	-25.5342	28320	63366	8544.6	6097.2	1055.4	900.2	1173.4	1079.6	1451.4	1196.6	1233.8	549.2	826.2	521.4	756	589.2	36400	3215.4
KC04NC2	28642	2500.8	3981.8	6012.8	6512.3	16828	56142	7771	255.82	526.8364	29700	66598	8989.4	6501.6	1135	968.8	1239.4	1114.2	1592	1255.6	1253.6	588.2	861.6	600.4	825.4	613.8	74475	3451.6
KC04NC3	28511	2519.8	4045.2	5916.6	6104.1	16448	52859	7718.2	293.87	207.3772	29359	66597	8979.2	6358.6	1118.2	929.2	1243.2	1138.8	1573.4	1257.8	1330.8	585.2	858.2	575.2	852.2	662.8	44056	3510.2
KC04NC4	28099	2451.2	4013.2	5745.8	5998.3	15971	51533	7473.6	315.73	26.1383	28708	64846	8846.8	6228.8	1144.8	951.4	1190.8	1106.2	1517.8	1247.8	1264.8	618.8	835.6	594.8	912.2	640.8	31958	3433.4
KC04NC5	30227	2939.2	4428.4	6235.8	6563.9	16651	52781	7741.4	372.98	845.3682	30874	69793	9549.4	6748.6	1293.6	1036.6	1382.8	1207.8	1670.2	1344.8	1331.8	677.2	963.6	649.2	986.6	760.8	107920	3690.2
KC04NAB	25112	2427.2	4350.2	5907.2	5889.1	14985	60920	6888.4	1532.8	379.8423	25044	58671	7741.2	5642.8	1089.6	984.8	1213.6	1125.2	1464.2	1230.6	1238.8	675.8	901.2	653.6	3764.6	834	58505	3136.4
KC04NAC	26150	2667.8	4574.8	5993.6	6073	16696	55778	7728	444.67	-19.4332	28116	65168	9001.4	6345.4	1321.2	1109.6	1357.4	1246.2	1707.6	1421.4	1464.2	752.8	1048.2	765.8	1110.4	749.6	49676	3547.2

KC04NBC	15387	1568.4	2340.6	3620.2	3415.8	8889.8	26671	4034.4	358.34	71.1362	14786	37171	4597	3302.4	736	704.2	820	775.2	997.6	823.4	826.6	508.8	651.2	484	717.2	521.4	37856	1864.6
KC04NABC	27793	2493.8	4367.4	6230.6	12204	16481	53027	7476.4	371.56	60.3658	28152	57474	8769	6228.8	1161.8	1025.6	1233.4	1158.8	1617.4	1324.8	1286.8	647.2	943.8	640.4	855.8	740.8	48197	3354.8
KC07NA1	24633	2711.8	4326.4	5868.8	6698.2	17524	114900	7886.2	564.85	-24.8407	30460	69015	9694.6	6940.8	1531.2	1327.8	1651.8	1468.8	1983.6	1594.2	1640.8	937.6	1201.8	943.8	1256.6	911.8	39795	4155.4
KC07NA2	24605	2622.4	4541.2	5781.8	7404.3	16454	54628	7746	601.14	21.8979	29911	68781	9533.2	6966.2	1477.8	1350.2	1580.8	1481.8	1888.8	1562.8	1588.4	953.8	1239.8	966.6	1090.4	964.6	36033	3949.2
KC07NA3	23744	2335.8	4283.8	5832.6	6727.2	16004	49625	7303	410.82	16.0445	28909	67848	9143.6	6655.8	1340.4	1171.8	1428.4	1293.2	1733.2	1416.2	1385.8	762.8	1019.6	745.8	872.2	799	54166	3788.4
KC07NA4	23753	2363.2	3768.8	5484	6400.1	16282	54455	7339.2	392.16	59.6226	28942	67114	9203.4	6556.2	1267	1091.4	1362.4	1220.8	1692.2	1345.6	1326.8	705.6	1020.2	706.2	812.8	721.4	40172	3790
KC07NA5	24646	2351.6	4676.8	5658.6	6743.6	17168	57072	7506	397.76	-13.7962	29355	69925	9405.6	6709.6	1298.6	1108.8	1454.2	1289.2	1774.4	1421.8	1460.4	700.2	985.2	714.2	781.2	754.2	47295	3885.6
KC07NB1	24472	2440.8	4214	5952.8	6035.7	15400	43412	6755	530.71	81.4993	27114	62302	8467.6	6254	1351.6	1187.8	1412.4	1348.2	1694	1416.6	1506.8	805.4	1057.6	815	989.8	1007.2	68381	3555.4
KC07NB2	23194	2471.4	3775.4	5798.2	6581.6	14473	77577	6735	559.49	143.0637	24751	57162	7860.6	5651.6	1315.2	1148.2	1450.8	1318.4	1654.8	1444.6	1391.6	878	1089.2	863.8	1298.8	968.4	45639	3424.2
KC07NB3	23847	2466.8	3822	5827	6415.6	14232	46950	6382.6	521.96	150.5029	24842	58225	7750.4	5623.6	1235.6	1069.6	1314.2	1264.4	1566.2	1328.2	1327.8	767.8	992.2	728	1062.2	873.2	66906	3400.4
KC07NB4	23978	2252.8	3622.6	6219.8	6205.5	14308	42630	6422.4	496.69	152.4295	24281	55187	7613.6	5440	1222.2	1064.6	1283.6	1228.6	1565.6	1348.8	1353.2	717.2	947.6	743.2	1087.4	849.4	79210	3163.2
KC07NB5	24051	3077.4	3943.6	6481.4	12385	14505	43886	6581	761.14	105.2866	24627	49718	7845.8	5739.6	1252.2	1144.6	1325.8	1267.8	1661.6	1377.8	1362.4	817.8	994.2	801.4	1178	978	65941	3425.2
KC07NC1	24522	2249.2	3512.6	5186	5695.8	14704	45891	6952.6	218.65	50.261	26916	61683	8321	6026.6	1048	942.6	1212.8	1053.8	1448.8	1152.2	1162.2	538.2	798.6	575.8	714.2	568.8	30039	3221.8
KC07NC2	25191	2336.4	3745	5343.6	6070.1	15215	50756	7202.6	265.25	71.41	28181	63904	8769.8	6183.8	1123.4	965.4	1292.8	1111.2	1489.8	1255.4	1234.2	558.8	823.8	562.8	725.8	619.6	27365	3451.6
KC07NC3	25352	2522.2	3999.2	5494.2	5832.8	15973	81817	7475	419.87	141.2208	28726	64296	8849.6	6315.6	1268	1099.8	1343.6	1281.2	1708.8	1421.6	1407.8	778.6	1071.4	789.8	1045.4	786.4	39417	3566.2
KC07NC4	26326	2577	3853.6	5710.4	6013.4	15940	53815	7573.2	376.62	147.7933	29312	66284	9164.8	6481	1225.2	1045.2	1345.2	1239.2	1704.8	1393.2	1335.6	683	983.8	716.8	883.2	742.4	32571	3677.2
KC07NC5	25294	2446.8	3665.4	5261.2	5672.7	15150	50988	7157.6	363.6	-0.0115	28090	63469	8780	6176.4	1238.8	1033.4	1316.4	1183.2	1574.8	1250.4	1267.4	670.2	956.2	662.8	914.4	700.2	30501	3436.6
KC07NAB	24421	2725.2	4494.2	6004.8	6115	15915	51629	7335.6	707.3	114.1455	26779	61685	8632.4	6228.4	1500.8	1380	1623.4	1541.8	1932.2	1646.6	1657.2	1031.6	1280.6	1000.8	1279	1141.2	53541	3705.6
KC07NAC	23852	2710	3968.6	5673	6062.3	15671	50938	7384.2	537.67	31.2444	27496	61975	8592.2	6176.8	1393.8	1245.8	1491	1373.2	1742.4	1494.8	1426.2	859.4	1100.8	868.2	1056.8	940.2	40858	3508.6
KC07NBC	24993	2464.4	4075	5905.4	6267.4	16319	52049	7320	536.05	0.9271	27911	62423	8732.8	6165.2	1330.4	1286.2	1491.8	1357.8	1754.2	1525.4	1449.8	886.6	1121.4	876.8	1053.2	971.4	46126	3417.2
KC07NABC	26639	2766.2	4452	6160.8	6525.7	17162	80490	7935	537.74	217.9282	28986	65879	9079.8	6474	1388.8	1250.2	1525.8	1429	1836.6	1564.4	1528	843.4	1148.2	877.8	1269.6	946.6	55824	3691.8

Appendix 5.7: ICP-MS Raw Data for London Samples (Intensities)

	V	Cr	Co	Cu	Sr	Y	Zr	Nb	Mo	Cd	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	W	Tl	Pb	U
10LA1	14752	2289.4	2067.4	5055.4	4260.5	9302.4	148710	6389.2	793.78	-154.543	18769	44147	5674.4	4033.2	1057.2	912.8	1107.8	1034.2	1278.8	1182.2	1113.4	816.4	1002.6	878.8	1362.2	844.8	61300	3042.2
10LA2	13630	1860.2	2118.6	6231.8	3401.7	7514.6	48522	4823.2	902.89	524.8571	15894	38174	4771.8	3477.2	968.2	823.4	1016.8	942.4	1124.2	1012.2	995.4	744.2	916.2	737	1225.8	797.2	95818	2476.2
10LA3	14545	2085.8	2390.4	5440.6	3904.2	8816.4	63337	5761.2	889.41	-68.749	18501	43204	5576.8	4049	1073.4	937.4	1120.8	1089.2	1243.6	1138.2	1164.8	834.8	1032.4	856.2	1106.8	924.8	75374	2942.2
10LA4	13064	2059.6	2376.6	5407.6	3913.7	8327	59477	5665.2	995.83	72.1568	16459	39642	5198.6	3889.2	1196.8	1103.8	1235.8	1176.8	1404.4	1243.8	1312.8	975.4	1200.8	1007.4	1301.8	1085.6	54713	2937.6
10LA5	10300	2159.6	2111.8	6243.8	3591	6549.8	42543	4476.2	1039.8	151.685	13370	32585	4348.2	3195.6	1109.8	1081.8	1127.8	1092.4	1330.2	1157.8	1174.2	931.6	1056.6	929.8	1257	983.8	57901	2384.8
10LB1	22633	2089.8	5071.2	16615	8391.1	14648	38234	4628	800.81	122.9568	22935	53241	7301.8	5397.2	1316	1252.6	1521.8	1388.2	1707.4	1494	1436	886.8	1183.6	915.8	1206.8	852.2	129270	2806.2
10LB2	26287	2170.2	5249.4	13828	9383.1	16734	83649	5180.4	723.32	135.0794	24181	56384	7815.2	5706.2	1395.2	1210.6	1516.4	1404.6	1795.4	1522.4	1541.8	904.6	1109.2	884.2	1254.8	787.6	157040	2928.6
10LB3	24642	2282.6	5565	13584	8849	15733	44951	5001	840.18	313.0031	24395	56021	7477	5633.2	1369.6	1347.8	1514.8	1422.6	1846.2	1589.4	1517.2	917.8	1139.8	926.2	1152.6	892.8	143420	2763.2
10LB4	31764	3050.8	7076.2	22589	8257	22067	47292	5266	1012.8	468.3432	32213	74447	10609	7887	1769.4	1624	1925.4	1844.8	2366	1945.2	1892.6	1046.6	1338.2	1023.4	1272.4	1089.4	320940	3182
10LB5	22670	2108.4	5496.6	14227	6938.4	15722	52470	4852.8	674.98	59.1411	23001	55362	7512.8	5530	1279.6	1183	1408.6	1293.2	1715.2	1461.2	1431.8	798.8	1009.2	767.4	988.8	734	169350	2842.6
10LC1	20742	2222.8	4063.4	6998.2	4845.3	17625	69290	6273.4	456.18	96.0088	26946	62292	8253.4	5975.2	1236.2	1066.6	1371.6	1305.2	1723.6	1489.2	1398.4	755.8	1052.4	773.2	751.4	708.2	73823	3285.2
10LC2	20534	2462.2	3814.2	6468.2	4387.3	17263	72876	6187.4	450.2	18.1874	27734	62372	8483	6130.8	1223.8	999.8	1347.6	1299.2	1683.4	1408.6	1416.4	727.4	989.2	729.8	730.8	690.6	70530	3271.2
10LC3	22539	2297.8	4202.4	7028.2	4765.9	18060	105090	6265	448.53	129.1987	27379	62443	8247.4	5987.6	1161.8	996.2	1355.2	1231.6	1640.4	1354.2	1341.4	685.8	880.2	700.2	781.6	592.8	72224	3159.8
10LC4	23571	2488.8	4389.8	7414	5120.5	19450	82267	7056.2	534.74	139.3073	29397	66863	8868.4	6491.2	1366.6	1099.2	1471.2	1409.2	1867.6	1553.8	1505.8	826.2	1110.2	780.8	835.2	761.6	75952	3748
10LC5	22675	3002.2	4690.8	8365.8	5255.5	19074	72101	6619.8	8628.6	2523.001	29078	66245	9026.4	6614.2	1361.8	1218.4	1585.2	1493.8	1916.6	1607.8	1584.2	843.8	1155.6	916.8	11965	1817.4	72784	3555
10LAB	22972	2202.6	4466.8	10256	7151.7	16757	51335	5359.4	672.69	231.1343	25845	61859	7709	5686.2	1161.6	1089.2	1337.2	1244.8	1650.8	1356.8	1384.2	728.8	990.6	731.2	1045.8	720.6	105950	3210.4
10LAC	20686	2206.8	3717.8	6754.4	4572.8	16841	67305	6076.8	522.82	197.5582	26229	59788	7854.6	5761.6	1168.4	977.8	1328.8	1229.6	1649	1358.2	1356.6	722.4	993.8	710.6	924.2	666	73835	3138.4
10LBC	21871	1847.2	3827.6	10149	7199.9	12985	54795	5215.4	553.2	153.7498	20370	48244	6168.2	4481.8	943.8	836.6	1002.8	928.6	1282.2	1114.4	1058.2	548.2	816.6	568.8	859.2	558.8	112260	2486.2
10LABC	24037	2429.2	4660.2	9945.2	6864.7	17435	100860	6061.2	603.49	18.4726	25326	58192	7802.6	5739.8	1256.8	1104.8	1354.8	1334.8	1761.8	1512.4	1508.4	834.8	1086.2	818.6	1192.4	750.2	96579	3015.2
01LA1	13606	1514.2	1843.8	5299.4	3277.9	6934.8	45912	4534.2	625.56	-16.5767	13418	32998	3907.6	2756.2	622.8	559.8	699.2	672.8	815.2	686.4	696.6	456.8	581.8	461.8	761.6	493.8	61498	1974.4
01LA2	15206	1593.8	1924.2	4377.2	3377	8811.8	57619	5345.6	600.56	-123.726	18589	44243	5516	3870.6	824.2	630.2	891.8	805.2	1011.2	838.8	857.8	533.6	698.8	567.8	812.8	583	55519	2566.8
01LA3	20299	2184.8	2228	5276.4	4129.9	11446	83003	7250.8	640.29	23.1938	22777	53495	6580.6	4658.6	933.8	776.4	1006	961.4	1264.4	1030.4	1072.8	647.2	859.4	659.8	868.4	661.8	71730	3248.8
01LA4	14458	1590.8	1924.8	5873	3455.8	7450.2	49563	4979.4	664.74	24.6024	14560	35370	4325.8	3057.8	755.2	649	787.2	760.2	929.8	826.6	805	574.4	674.8	553.8	853.2	612.2	66737	2175.8
01LA5	17414	1966.2	2234.8	5349	3702.6	9695.4	60651	5876.6	668.07	39.0626	18673	44043	5486.4	3812.4	885.6	687.8	930.8	840.8	1143.2	945.8	994.6	577.6	790.2	632.2	852.2	654.2	97671	2732.8
01LB1	22432	2281.8	5390	13569	8361.5	15896	78970	4876	770.09	267.7514	25970	59366	7954	5799.2	1433.8	1270.8	1533.6	1502.4	1888.2	1537.8	1564.8	949.4	1095.4	953.2	1276.8	868.6	134030	2634.6
01LB2	24005	2318.6	5693.4	14273	9066.1	16623	46243	5163.4	781.23	271.6767	27525	62687	8570.2	6090.6	1490.2	1366.2	1615.8	1556.8	1959.8	1644.2	1672.8	996.6	1223.6	971.2	1116.8	930.6	142590	2773.6

01LB3	26174	2467.8	6495	22279	8052.8	17635	40121	4936	923.81	474.6581	25177	58421	8234.4	6307.2	1549.2	1449.4	1672.2	1590.8	1975.4	1703.4	1632.6	960.2	1208.8	978.4	1071.2	980	219200	2766.4
01LB4	25521	3236	5787.6	15112	8499.2	16419	44632	5080.4	813.76	220.3136	23337	54596	7492.8	5663.6	1429.8	1275.2	1572.8	1444.8	1934	1546.6	1587.2	972.8	1179.2	945.2	1139.6	902.8	163520	2779.2
01LB5	30589	2853.8	7255	20362	7663.5	20727	43272	5202.8	935.45	421.2294	29722	69446	9834.8	7189.4	1766.8	1558.4	1937.4	1750.2	2300.2	1932.6	1809	1063.8	1396.2	1046	1153.2	1052.8	254770	3071.6
01LC1	22301	2970.2	4903.2	8824.4	5087.1	19725	72143	6838.6	795.34	227.9311	28475	63868	8856.4	6436	1546.6	1386.2	1707.8	1605.8	2147.2	1783.2	1846.4	1046.4	1268	1047.2	1031.8	1028.6	84181	3666.8
01LC2	22237	2657.8	4382.6	6947.8	4869.5	19039	113150	7204.4	627.45	10.4743	28019	63629	8651.8	6299.4	1411.8	1244.4	1574	1434.8	1929.8	1698.2	1639.6	969.4	1260.2	955.8	1137.2	888.6	68730	3439.8
01LC3	23449	2905.8	4613.2	7493	5039.2	19132	69579	6713.6	662.72	305.0599	29531	66654	9247	6666.6	1497.6	1294.2	1686.8	1552.8	1951.8	1660.2	1674.2	971.2	1217.6	936.8	1023.2	917.8	89303	3523.8
01LC4	26612	3106.4	4798.2	7255.8	5673.1	22694	89056	8270.4	561.47	190.0661	34484	76484	10537	7623.6	1615.8	1404.6	1803.2	1703.6	2281.4	1896.8	1793.8	1012.4	1360.6	1039.2	1017.2	908.8	78514	4078.8
01LC5	22792	2569.8	4237.8	7109.6	4939.4	18786	73306	6843.2	577.76	98.6641	28131	64279	8621.2	6247.6	1378.4	1198.4	1548.2	1436.4	1916	1567.2	1554.2	889.2	1159.8	898.2	861	741.6	70003	3496.2
01LAB	19979	2754.6	4723.6	13109	5897	12222	40072	5028.2	2885.5	640.4392	18759	44337	6068.2	4389.2	1302.4	1177.2	1396.8	1345.8	1612.8	1459.8	1403.4	1003.8	1167.8	982.8	4571.6	1221.6	130690	2456.4
01LAC	20184	2463.6	4204.2	7526.2	4589.6	16199	65075	6118.8	891.23	79.6679	24180	55932	7520.2	5491.6	1410.8	1271.4	1577.4	1510.2	1866.8	1580.2	1619.2	1048.4	1240.4	1036.8	1211.2	1005.4	78143	3368.8
01LBC	24139	2646.8	5111.4	10562	5670.7	18675	102130	6607.2	774.41	143.7327	26670	61032	8295.4	6011.8	1500.4	1322.8	1612.8	1553.8	1997.2	1670.2	1717.6	1020.6	1302.4	972.2	1237.2	969.8	99353	3453.2
01LABC	22339	2869	4854.4	10283	5648.2	17476	69853	6351	889.3	149.661	25637	58246	7883.6	5894.2	1518.8	1357.2	1612.2	1528.6	1897.2	1631.8	1708.6	1053.4	1318.6	1048.2	1140.2	1041.8	100690	3349.6
04LA1	16088	2386.6	2419.6	4558.6	4065	10858	76246	7022.8	786.63	273.551	21937	51033	6729.8	4660.4	1248.2	1102.2	1346.2	1290.8	1457.2	1324.2	1367.2	940.2	1146.6	933.4	1098.6	950.4	80524	3201.2
04LA2	16315	2267.4	2414.8	4994.8	3786.4	9595.8	62453	6442	877.81	324.7287	18887	44741	5713.2	4089.8	1075.4	944.2	1206.2	1139.6	1295.8	1213.2	1250.2	838.8	1061.8	878.2	1087.8	928.4	93968	2939.4
04LA3	15090	2333.2	2110.8	4099.6	4584.9	11745	85289	7390.6	652.47	137.4215	24170	55459	7104.4	5115.4	1204.8	1021.2	1273.8	1199.8	1471.2	1330.2	1349.2	838.4	1109.6	948.2	986.6	862.4	60514	3431.2
04LA4	11342	2261.6	2518.8	5043.2	4666.8	10337	72439	6259	776.74	523.8672	19389	45756	6126.8	4376	1256	1111.4	1317.4	1245.6	1432.4	1331.8	1386	992.4	1160.8	1020.8	1126.8	942.8	85928	3117.2
04LA5	13956	2265.2	2391.2	3931.2	4201.6	10220	77654	6690	732.94	352.6192	20204	47697	6206.6	4396.4	1184.2	1047.6	1277.2	1198.6	1496.2	1227.2	1315.8	916.2	1119.4	985.8	1055.8	914.2	74385	3203.4
04LB1	27801	2039.4	5740.6	13031	13384	16428	46438	4773	723.83	443.8916	25892	59201	8149.8	6004.8	1416.2	1382.8	1592.8	1443.8	1858.6	1601.4	1574.8	932.2	1165.8	940.6	986.4	795.2	129910	2416
04LB2	25416	2062.4	5500.2	13255	10799	15330	48637	5031.2	564.29	432.9332	24683	57510	7757.6	5607.8	1258.4	1124.2	1361.2	1228.2	1646.4	1400.4	1370.2	759.4	972.8	770.8	874.8	690.6	128850	2439.6
04LB3	26484	2854.2	6914.4	22037	8648.1	19216	43068	5185	983.72	670.8446	26616	62203	8855.6	6626.6	1687.8	1681.2	1923.8	1815.2	2204.6	1916.8	1876.6	1124.8	1377.6	1095.2	1162.8	1122.2	240310	3050.2
04LB4	24095	2496.2	5740.2	12688	10282	15732	44653	5318.4	1018.8	475.8554	23029	53852	7696.4	5706.8	1611.6	1543.8	1791.8	1741.2	2075.8	1826	1803.8	1191.4	1414.8	1208.2	1244.8	1115.8	163610	3102.6
04LB5	39623	3836.6	9298.6	27887	10598	27105	56235	7002.6	1360.7	655.0825	38563	88605	12722	9557.6	2289.2	2149.2	2571.2	2420.2	3104.4	2593.4	2500.8	1489.8	1815.8	1426.8	1739	1436.8	379170	4033
04LC1	23244	3305.6	4816.2	6993.2	4992.6	20854	110600	7592.6	808.45	555.0786	29923	67910	9394.6	6863.8	1688	1504.2	1937.8	1829.8	2248.8	1927.2	1966.6	1217	1516.4	1249.2	1337	1093.8	97022	3596
04LC2	21113	3058.4	4599.2	6822	5259.4	19558	85599	7502.6	888.34	444.9739	29106	66551	9192.4	6751.4	1716.8	1533	1830.2	1807.4	2244.8	1928.6	1907.2	1206.6	1507.8	1231.2	1228.2	1144.4	92275	3777.2
04LC3	23357	3081.2	4832.8	7280	5453.5	20766	85915	7623	760.76	487.136	29535	67376	9254.6	6796.2	1625.6	1475.4	1847.8	1780.6	2281.8	1938	1945.4	1174.2	1502.6	1264.2	1172.6	1072.8	99210	4026
04LC4	23853	3248.4	5103.8	9161	5169.4	20556	75948	7225.4	852.34	373.2825	29541	66951	9253.4	6826.2	1739.4	1519.8	1924.2	1800.8	2316	1898.2	1991.8	1222.8	1579.6	1173.2	1137.2	1143.8	92775	3666.8
04LC5	24092	2978.8	4771.2	7257.2	5226.9	21167	79773	7509	706.78	364.1432	31996	71839	10005	7173.4	1711.8	1448.8	1876.2	1760.6	2165.2	1929.2	1873.6	1117.8	1422.8	1134.8	1081.6	1017.2	84835	3554.8
04LAB	20127	3600.4	5297.4	11459	9159.5	13440	57008	5676.2	27433	7793.291	20465	48513	6536.2	4889.8	1404.2	1312.4	1490.4	1457.2	1859.8	1578.2	1539.6	1003.2	1277.2	1090.6	68720	5059.4	110280	2792.8
04LAC	20540	2716.4	3487.4	5992.2	4534.1	16387	108970	7077.6	1891.4	634.642	26086	60482	7879.2	5706	1202.6	1005.8	1357.4	1221.2	1653.2	1410.8	1373.8	793.8	1005.2	788.2	4824.6	843.4	79683	3265.8

04LBC	25384	2393	5078.4	10504	8974.3	18826	63461	6221.4	752.69	383.3651	26903	61634	8464.2	6127	1369.8	1265.6	1493.4	1462.2	1952.2	1635.8	1584.8	918.8	1189.2	880.2	1691.2	754.8	106270	2775.2
04LABC	23073	2603.6	4655.6	8739.8	8154.3	17099	63541	6541.6	917.5	324.3748	25200	58444	7980.8	5886.2	1524.2	1394.8	1677.2	1620.4	2021.8	1765.8	1727.6	1086.8	1350.2	1079	1586	995.2	100180	3051.4
07LA1	15953	1827.4	2002.6	5432.2	4224.6	9312	93816	5910.4	651.29	171.4196	19503	46207	5726.2	4006.8	882.2	717.2	896.6	840.8	1107.8	940.4	967.8	582.8	786.8	612.8	1134.2	682	103830	2950.8
07LA2	11758	1474.2	1634.6	5131.4	3154.2	6392.4	44339	4014.2	624.98	305.726	12584	32361	3706.8	2566.8	637.4	539.2	674.8	617.8	799.8	703	718.8	490.2	609.6	464.8	814.8	560	88478	1999
07LA3	13250	1599.8	1778.2	6399.6	3206.3	7336	46835	4477.6	631.4	338.8277	13414	34570	4006.4	2768.2	663.8	599.8	728.8	693.6	907.8	781.8	800.8	510.2	655.4	537.8	887.2	545.8	92763	2174.8
07LA4	12944	1768.8	2161	4599.2	3765.6	8480.6	57818	5571.6	630.29	295.6876	16342	40754	4956.8	3421.4	935.4	775.4	915.8	911.8	1111.8	1020.6	965.2	692.8	883.6	716.8	947.8	724.8	80211	2593.4
07LA5	13859	1976	2081.2	4766.4	4012.4	8986	62971	6041.2	850.58	360.2156	17187	41414	5264.6	3721.4	1001.2	842.2	1023.8	970	1193.8	1096.6	1123	778.8	965.6	806.2	1162.6	839.8	86654	2857.8
07LB1	27604	2223	5707.8	13953	12784	17223	42567	5003.8	769.83	510.8299	24906	59015	8295.2	6138	1472.2	1329.2	1590.2	1543.4	1978.2	1594.8	1619.4	974.4	1249.6	991.8	1114.2	830.2	160130	2702.2
07LB2	26275	2071.4	5781.2	12915	12291	16531	62618	5187.2	809.52	436.6065	23383	55360	7590.6	5573.8	1385.8	1291.6	1514.4	1432.4	1862.8	1651.6	1576.4	956.8	1234.8	961.8	1169.8	799.8	145080	2673.4
07LB3	31772	2695.8	7138.8	21286	8516.5	21422	46097	5370.6	880.56	693.9077	31226	72669	10105	7354.6	1660.2	1551.2	1895.4	1697.2	2324.8	1881.8	1807.8	1012.2	1334.2	1017.8	1193.4	976.2	330550	3199.8
07LB4	26298	2036.2	5159.4	11564	12510	16700	47291	4753.6	734.49	505.2172	25276	59030	7937.8	5759.8	1385.8	1260.2	1509.2	1441.4	1874.2	1587.6	1573.8	954.4	1171.8	921.6	960.8	732.4	130500	2580.6
07LB5	21589	2532.8	6051.2	22950	7780.4	16443	38776	4735.6	914.69	729.9412	22812	54384	7733	5567.8	1429.4	1363.2	1610.8	1482.6	1939.8	1665	1637.2	1013	1286.2	952.8	1118.8	922	232600	2744.2
07LC1	18757	2682.2	4388.2	7650	5109.2	16726	59061	5973.6	4119.4	1411.818	24155	56317	7466	5482.2	1390.8	1275	1495.6	1443.8	1829	1639.2	1671.2	1000.2	1305.8	1011.8	9530.6	1445.8	98046	3190.6
07LC2	19273	2430	3942.2	7538.6	5148.9	16961	74007	6252.6	796.85	491.8011	24613	57627	7633.6	5485.2	1222.4	1148.8	1434.6	1330.6	1724.2	1449.2	1455.8	879.8	1130.8	891.2	1310.6	807.8	98169	3256.4
07LC3	22323	2838.6	4337.4	7592.8	5368.2	19170	91396	7079.8	785.83	311.131	27980	64160	8665.6	6380.2	1437.4	1308.2	1710	1544.8	2085.2	1759.4	1696.6	1035.6	1325.2	1057.8	1293.6	968.4	99213	3535.6
07LC4	22221	2771.8	4296.2	5858.8	5221.4	21161	81721	7256	515.8	390.4868	31601	72528	9707.2	7076.6	1439.6	1184.2	1619.8	1493.4	2017.2	1691.8	1717.6	925.2	1194.4	869.6	1009	713	87552	3807.2
07LC5	22341	2719.2	4140.6	7100.8	5230.2	19292	78470	6879.2	581.63	509.6417	29054	66474	8885.4	6380.6	1386.4	1156.2	1553	1470.4	1939.8	1629.6	1578.4	908	1204.6	925.2	1027.2	848.8	95210	3514.2
07LAB	22211	2208.4	4121.8	9670.2	9096.1	13382	54816	5357.6	790.03	457.0483	20001	48213	6285	4659.8	1114	1062.4	1282.4	1220	1576.6	1300.8	1321.4	847.6	1056.2	871.2	1062.4	815.8	127390	2777.4
07LAC	19506	2201.4	3323.6	6939	4897.7	14436	71640	6413.4	645.43	334.8437	22541	53036	6744.8	4828.6	1094.6	963.2	1216	1085.2	1427.6	1268.8	1361.2	733.8	997.8	754.2	976.8	749.8	101500	3028.4
07LBC	27217	2475.8	5536.2	11947	10023	19190	60002	6396.2	682.18	468.2697	27300	63300	8483.8	6198	1424.2	1311.8	1593.8	1518.6	1969.2	1648.2	1661.8	974.2	1264.6	920.2	1067.6	852.8	134930	3144.8
07LABC	21239	2500.8	4188.4	9105.4	7190.3	14493	74578	6192.8	979.81	317.746	21116	49401	6661.8	4872.6	1421.8	1284.2	1521.8	1432.4	1836.2	1539.8	1612.8	1049.2	1294.8	1084.8	1440.6	1055.4	112050	3029.8

Appendix 5.8: ICP-AES Raw Data for Nottingham Samples (Intensities)

	K	Al	Be	Ca	Fe	Mg	Mn	Na	Ni	P	Ti	Zn
KC10NA1	459220	209079	1214.35	163750	163449	1339280	11269.1	149.696	166.267	1140.82	3636.77	4166.29
KC10NA2	433700	196694	1083.24	153997	150640	1223470	10877.5	157.849	145.437	1060.53	3550.88	4212.25
KC10NA3	464880	208567	1167.35	171890	160384	1313430	11790.7	172.388	165.968	1087.84	3720.75	4470.7
KC10NA4	478360	210274	1157.22	226703	162481	1311180	15332.2	166.249	166.258	944.742	3792.23	4069.04
KC10NA5	449960	198024	1030.33	264643	148883	1285610	11953	179.734	154.756	949.464	3558.81	7100.83
KC10NB1	422490	194283	1116.43	159036	149153	1116530	9939.49	153.173	148.939	1448.36	3434.85	5682.38
KC10NB2	417940	192641	1079.56	136280	147731	1071320	10875.8	148.163	152.509	1258.87	3395.09	11620.6
KC10NB3	433760	195118	1057.57	140741	150352	1117080	11570.7	153.309	147.066	1353.5	3517.81	4241.25
KC10NB4	405950	193045	1145.79	225943	147790	1120070	10378.4	154.029	128.069	2309.49	3509.92	4930.4
KC10NB5	434410	205374	1129.81	113853	152240	1117160	10375.9	168.409	137.726	1219.56	3827.64	5155.26
KC10NC1	465960	225106	1231.73	100543	176591	1323550	12581.6	192.538	158.053	745.739	4035.25	25471.1
KC10NC2	447390	217933	1177.55	84018.1	170042	1231160	11348.9	163.715	155.148	770.743	3906.1	3755.66
KC10NC3	458790	221027	1160.68	83747.8	172156	1258220	12039.3	160.381	157.982	792.336	3972.82	5098.31
KC10NC4	474590	228590	1216.2	91762.1	178603	1319100	11479.5	169	154.415	786.818	4042.32	3797.07
KC10NC5	444400	214765	1162.61	79437.6	169605	1217530	11350.1	156.955	146.383	761.204	3911.12	3488.42
KC10NAB	396410	191702	1054.79	152245	146926	1123310	9471.54	161.45	139.592	1316.01	3598.81	5809.56
KC10NAC	442070	214175	1164.48	116227	165336	1280900	11172.1	168.924	151.011	892.19	3894.3	4706.91
KC10NBC	422990	204030	1110.6	122028	156490	1170730	11210.7	169.308	141.572	1173.64	3776.58	5527.19
KC10NABC	409820	194979	1082.96	146991	153033	1175080	11502.1	155.944	129.179	1325.4	3630.07	5779.73
KC01NA1	451200	212785	1109.25	159913	159558	1243410	11992.3	174.122	145.804	1076.9	4030.63	4162.62
KC01NA2	486990	225984	1195.55	197818	169018	1345000	14312.7	180.063	158.359	918.259	4318.37	4804.49
KC01NA3	453310	208784	1088.2	178534	155210	1254230	10309	177.594	139.805	1042.53	3994.48	4510.52
KC01NA4	444890	206903	1044.03	250288	154664	1278310	11596.7	166.538	137.204	943.178	3948.24	6352.51
KC01NA5	428120	205862	1049.07	124956	155811	1174830	10639.6	168.856	148.202	1065.19	3850.48	4371.7
KC01NB1	406610	194537	1060.53	163895	148958	1125000	9954.62	161.395	134.326	1504.51	3674.11	5203.52
KC01NB2	440060	207719	1105.49	110630	155286	1127620	9774.77	178.197	138.961	1322.68	3989.14	4691.34

KC01NB3	404870	192681	1106.14	173339	148702	1105010	10493.2	151.14	135.937	1766.53	3634.99	4917.45
KC01NB4	412100	195914	1135.06	193363	152130	1128980	10760.6	164.717	142.257	1587.56	3673.54	4540.36
KC01NB5	433770	205781	1075.06	116769	152686	1126960	9077.78	185.218	136.144	1131.04	3945.7	4661.63
KC01NC1	473810	230895	1202.55	134837	186632	1498470	10133.8	152.091	169.66	950.644	4001.48	3901.61
KC01NC2	545350	211525	1406.02	120053	197257	1468410	11040.8	169.063	188.571	920.801	4602.3	4015.82
KC01NC3	486890	231398	1282.42	155009	184295	1563570	10187.7	146.105	165.636	853.482	3951.23	3990.65
KC01NC4	485530	231979	1278.6	149687	187038	1563430	10422.5	154.163	168.057	885.609	4011.34	4028.1
KC01NC5	485670	232401	1287.15	141799	186392	1533460	10491.1	152.126	165.389	934.147	3989.35	3976.6
KC01NAB	431700	202960	1125.4	162914	153194	1185550	11082.6	168.27	139.589	1300.94	3822.82	4729.99
KC01NAC	462740	221704	1178.15	147519	171395	1363060	11092.7	168.749	151.362	1004.95	3972.19	3990.8
KC01NBC	451240	217871	1209.22	153659	171091	1349980	10608.3	157.046	162.131	1246.3	3922.72	4669.1
KC01NABC	444800	211996	1154.17	150463	164134	1288330	10635.8	173.061	146.95	1136.65	3876.83	5658.97
KC04NA1	464420	213997	1207.12	148171	164088	1290520	15401.7	170.156	148.044	1012.92	3980.16	3552.02
KC04NA2	505280	234463	1327.47	158833	176136	1366230	17640.5	211.253	156.107	971.345	4311.01	4077.56
KC04NA3	498660	228620	1394.82	249348	173323	1360370	21697.7	194.792	166.584	912.004	4261.02	3703.05
KC04NA4	461810	215776	1206.27	176387	159946	1358710	12354.6	181.605	151.677	1063.94	4087.9	3697.05
KC04NA5	469130	218296	1189.76	260719	161568	1361560	14259.6	180.429	153.555	969.648	4038.57	4813.21
KC04NB1	404050	195917	1153.58	227883	151621	1163350	13274.8	171.16	145.727	1649.41	3594.25	4199.89
KC04NB2	421510	204248	1247.72	264555	159845	1204680	14378.3	164.419	147.778	2192.72	3651.38	4740.81
KC04NB3	415310	196563	1127.26	163665	152235	1111630	11397	163.464	150.22	1705.03	3705.56	4178.05
KC04NB4	398490	189012	1047.64	175254	145290	1103610	11042.9	160.029	134.626	2349.01	3611.9	4249.73
KC04NB5	394480	195803	1155.21	181088	155028	1123300	12377.7	155.431	148.395	1575.44	3533.99	4033.64
KC04NC1	472320	233878	1256.06	100979	180321	1367340	11311.4	175.649	155.764	894.32	4295.32	4175.41
KC04NC2	469290	234345	1242.96	121773	180915	1464850	11010.1	183.252	158.002	838.428	4161.46	3344.83
KC04NC3	475060	229218	1242.98	107435	181813	1383940	11814.2	183.211	172.758	876.376	4273.98	3302.18
KC04NC4	474510	230793	1228.64	114536	182980	1406290	12274	184.756	159.647	835.621	4184.45	3371.63
KC04NC5	482730	235437	1256.16	118510	187062	1436470	12814.8	174.218	162.34	817.784	4210.6	3429.08
KC04NAB	417750	203114	1117.35	183227	154863	1212920	14229.3	163.821	148.98	1304.53	3781.9	4371.55
KC04NAC	435040	214064	1140.83	125573	162017	1271310	12865.9	183.85	150.752	930.631	4027.78	3855.39

KC04NBC	430030	210602	1165.9	164349	162163	1240110	11887.7	172.26	146.698	1280.56	3908.32	3753.57
KC04NABC	437230	215975	1152.28	146497	165498	1266570	12482.6	178.835	155.902	1098	3986.27	3913.66
KC07NA1	477100	223596	1166.09	149325	167559	1294840	12411.1	179.665	153.726	1047.78	4272.44	3818.8
KC07NA2	486590	224895	1195.31	179767	170212	1401250	14282.8	186.371	155.406	937.138	4212.04	3569.72
KC07NA3	481870	223705	1192.41	206913	163716	1312450	14392	188.48	158.756	887.241	4269.63	3838.07
KC07NA4	464260	218155	1127.4	147468	159451	1275540	11217.3	186.827	143.942	949.253	4120.29	3453.6
KC07NA5	491170	225616	1163.64	294879	170639	1377070	18120.9	201.651	157.688	826.318	4364.56	3424.96
KC07NB1	419960	204238	1180.97	169417	156932	1130480	11677.8	166.751	142.511	1319.59	3781.78	4019
KC07NB2	419400	200612	1055.28	170708	150333	1125300	10753.8	161.584	144.479	2083.03	3777.69	4517.27
KC07NB3	379050	183416	1021.09	183168	141111	1070800	11567.6	159.727	127.403	1568.41	3464.95	4342.12
KC07NB4	356910	175732	1016.98	230783	135947	1058300	10605.8	142.564	117.319	1647.77	3329.76	4276.16
KC07NB5	379800	184304	1077.83	210044	142419	1095700	11727	163.48	127.242	1667.67	3479.6	4449.14
KC07NC1	432560	213689	1151.28	95757.9	165495	1244730	10330	178.593	157.482	767.739	4028.38	3144.16
KC07NC2	447920	220686	1198.87	96273	171921	1291490	11692.3	168.179	154.48	775.004	4153.67	3201.96
KC07NC3	436490	220702	1180.62	85831.1	168359	1232270	10707	182.724	150.092	782.386	4101.28	3167.93
KC07NC4	467710	226143	1229.21	88086.9	178901	1293620	11559.8	182.491	156.419	778.465	4261.39	3609.94
KC07NC5	446810	220539	1197.26	91003.8	169741	1265110	10014.7	186.333	149.996	728.978	4135.29	3058.84
KC07NAB	419520	203541	1088.47	153940	152963	1155240	11583.5	179.517	142.047	1131.55	3854.73	3895.43
KC07NAC	423990	209751	1130.95	113706	158650	1222170	10850.6	180.59	144.4	840.571	4000.75	3327.6
KC07NBC	409060	204222	1131.23	129557	154992	1168240	10797.7	170.594	145.065	1056.74	3834.17	4299.77
KC07NABC	419390	206522	1136.59	139586	156195	1191220	11725.8	180.004	141.088	1061.11	3899.77	3838.7

Appendix 5.9: ICP-AES Raw Data for London Samples (Intensities)

	K	Al	Be	Ca	Fe	Mg	Mn	Na	Ni	P	Ti	Zn
KC10LA1	20.54	52.3886	-0.001163	9.82643	30.9926	3.63561	0.985547	0.798249	0.054637	2.92473	11.7154	0.018752
KC10LA2	19.65	51.1838	-0.000941	11.197	33.5437	3.52441	1.02978	0.703203	0.074716	3.56008	11.7484	0.038985
KC10LA3	19.24	49.9923	-0.001007	10.4402	32.0847	3.36061	1.05901	0.747352	0.065483	3.33155	11.6507	0.028668
KC10LA4	18.85	49.5701	-0.001178	12.2165	30.3753	3.6082	1.76725	0.729812	0.071629	2.84054	11.0273	0.025777
KC10LA5	13.03	35.285	-0.00137	16.7603	23.502	2.88982	1.98444	0.457942	0.050329	3.18957	8.08914	0.031675
KC10LB1	23.8	81.4155	0.001508	85.7733	56.3569	10.7154	1.17888	1.42149	0.145151	4.54994	9.21628	0.051839
KC10LB2	23.51	80.8555	0.001713	---	55.7577	10.4471	1.03441	1.44283	0.148688	4.06006	9.52018	0.059121
KC10LB3	23.63	82.3973	0.001483	79.6901	57.7762	10.2834	1.32045	1.34976	0.161293	4.81115	9.68093	0.064622
KC10LB4	19.07	87.7492	0.006709	70.2923	71.8345	8.88849	1.94107	0.660752	0.238201	4.30061	9.86478	0.10605
KC10LB5	21.08	75.5579	0.004615	78.4401	58.0123	7.49443	1.29869	0.737377	0.176642	4.11933	9.64992	0.049717
KC10LC1	20.13	82.3467	0.003534	22.8858	36.3557	5.73513	0.762768	0.867722	0.111445	3.21167	13.3361	0.033291
KC10LC2	20.5	84.4927	0.003575	19.9192	35.5929	5.59306	0.628083	0.959964	0.109606	2.6191	14.0165	0.031234
KC10LC3	21.99	89.0261	0.003814	21.9297	38.3355	6.11186	0.803335	0.983148	0.136903	3.24169	14.3496	0.035683
KC10LC4	21.8	87.7496	0.003686	21.5439	37.6378	6.03423	0.763348	0.980584	0.126758	3.13871	14.4029	0.041273
KC10LC5	20.61	85.2094	0.003631	21.5602	36.713	5.80756	0.644648	0.929331	0.119466	3.03792	13.398	0.045265
KC10LAB	22.79	86.5004	0.003768	55.08	47.8097	9.07497	0.9918	1.30508	0.15126	3.85488	11.5642	0.044428
KC10LAC	19.41	76.6837	0.003189	18.952	33.916	5.13091	0.76732	0.840011	0.131199	2.85784	13.0795	0.030929
KC10LBC	22.85	70.6439	0.002701	51.392	46.5027	8.05939	1.12525	1.19916	0.129107	4.05548	10.4912	0.041171
KC10LABC	22.19	82.8964	0.003592	39.9969	44.3206	7.80365	0.912014	1.17649	0.137246	3.61701	11.9254	0.040782
KC01LA1	15.75	41.1504	0.000974	11.8775	27.102	3.00649	1.17721	0.546877	0.081987	3.08582	9.41095	0.024101
KC01LA2	19.67	50.6001	0.001153	8.93254	30.6676	3.32583	0.921432	0.741724	0.084844	2.74007	11.7635	0.020092
KC01LA3	23.62	63.3104	0.001318	5.59477	39.3025	3.67007	0.538342	0.838065	0.099379	2.44138	14.9264	0.021611
KC01LA4	21.6	56.854	0.001304	7.33927	36.1332	3.53588	0.509826	0.806851	0.099552	2.81841	13.3382	0.023387
KC01LA5	19.46	51.5008	0.001231	8.76246	32.8342	3.37082	0.475023	0.668023	0.109506	3.07309	11.6431	0.024514
KC01LB1	20.51	81.8147	0.005062	81.6331	60.8796	8.87703	1.4986	1.06306	0.193028	4.57226	10.0374	0.073739
KC01LB2	21.71	82.0834	0.004136	85.2412	55.9726	9.79206	1.30223	1.39196	0.159987	4.26886	9.82121	0.055101

KC01LB3	18.01	74.1996	0.00569	81.2424	55.8875	6.83082	1.44373	0.597238	0.195375	4.94464	10.0535	0.094718
KC01LB4	23.22	82.4827	0.003952	81.8473	59.5076	10.1256	1.36595	1.36286	0.168283	4.70798	10.3004	0.058154
KC01LB5	19.65	87.2309	0.005977	78.1296	71.341	8.91876	1.80369	0.716513	0.233986	4.43234	9.85223	0.083197
KC01LC1	19.45	83.4864	0.004129	19.5103	35.9903	5.46201	0.675464	0.910547	0.115494	2.95089	13.6444	0.041701
KC01LC2	20.23	81.4107	0.00345	19.357	33.8276	5.44444	0.639348	0.904109	0.108104	3.33518	14.3061	0.031702
KC01LC3	21.39	89.057	0.003764	21.6176	37.5788	5.89029	0.698563	0.902664	0.112699	3.3029	14.2071	0.029755
KC01LC4	25.29	102.155	0.003958	23.5568	39.4386	7.12497	0.639336	1.21979	0.133877	3.31513	17.755	0.065703
KC01LC5	19.87	81.9758	0.00345	19.3718	33.9185	5.39451	0.601759	0.840944	0.106527	2.81129	13.9859	0.033157
KC01LAB	18.37	63.6605	0.00263	42.0732	47.476	7.25824	1.4491	0.744581	0.139629	4.91189	9.14402	0.054844
KC01LAC	18.71	74.1616	0.003414	17.8404	34.6426	4.88838	0.827943	0.754278	0.107582	3.05188	12.7156	0.037323
KC01LBC	20.24	83.6147	0.004102	28.5996	42.1329	6.5673	0.840551	0.899359	0.135889	3.63111	12.9673	0.04666
KC01LABC	19.2	75.4322	0.003535	25.6358	39.7868	5.90284	0.916537	0.790287	0.129782	3.5549	12.253	0.049299
KC04LA1	22.75	58.6334	0.001313	6.57074	38.222	3.85125	0.663538	0.842491	0.088166	2.91567	13.8081	0.01611
KC04LA2	20.71	54.705	0.001309	8.22168	34.6314	3.59255	0.658471	0.774896	0.083086	3.02684	12.5839	0.017402
KC04LA3	26.16	64.1997	0.00117	6.79045	32.6973	4.28017	0.521758	1.03218	0.069926	2.43626	15.3216	0.014447
KC04LA4	21.37	48.9194	0.001098	15.369	26.3205	3.79427	1.69113	0.865809	0.062863	2.96537	11.7336	0.025528
KC04LA5	24.11	59.4083	0.001166	7.38866	31.7117	3.82393	0.921862	0.969972	0.065407	2.46127	13.522	0.014716
KC04LB1	30.56	125.61	0.00368	---	67.2786	19.1011	1.49224	3.18984	0.163982	3.7654	11.5648	0.043984
KC04LB2	25.77	96.9068	0.003632	85.4576	57.3954	12.2082	1.29918	2.16616	0.157847	3.86875	10.5979	0.042128
KC04LB3	17.44	75.3424	0.00594	67.5262	55.8408	6.88889	1.4031	0.54857	0.191029	4.83187	10.0106	0.088006
KC04LB4	26.61	99.2395	0.003748	82.1965	59.8846	13.1283	1.38792	2.0823	0.157487	4.00563	11.0046	0.044555
KC04LB5	19.8	89.3838	0.006739	79.2634	71.0579	8.74656	1.88002	0.657759	0.228536	4.05194	10.4264	0.084705
KC04LC1	22.48	93.6585	0.003656	19.0844	37.7168	6.00833	0.588522	1.02068	0.111731	2.49556	15.3791	0.023861
KC04LC2	21.92	81.5397	0.003344	16.8826	32.7988	5.33675	0.572247	1.00315	0.099804	2.79338	14.4722	0.024451
KC04LC3	21.74	87.4462	0.003992	20.4756	36.7858	5.69976	0.654231	1.00048	0.118693	2.8014	14.8292	0.026159
KC04LC4	21.29	86.9535	0.003969	18.4799	37.0743	5.53045	0.575504	0.926394	0.110835	2.40197	14.288	0.024005
KC04LC5	21.56	83.557	0.003637	17.548	34.9648	5.42689	0.569288	0.979249	0.126224	2.57166	14.3839	0.024324
KC04LAB	26.24	89.8855	0.002442	39.8962	51.9494	11.1787	1.03845	1.99631	0.134698	3.27888	12.359	0.029501
KC04LAC	21.74	75.6703	0.002555	13.0374	36.8722	4.93567	0.591919	0.897441	0.099222	2.70888	14.3101	0.021024

KC04LBC	25.33	105.726	0.003596	47.1276	50.7809	11.8538	0.965888	2.00083	0.140427	3.08704	13.1937	0.033734
KC04LABC	24.2	91.973	0.002933	34.9675	46.7978	9.92349	0.88862	1.75524	0.131384	3.02823	12.9234	0.029303
KC07LA1	18.93	48.4505	0.001076	9.19292	29.9702	3.17699	0.997576	0.718791	0.08028	2.83114	11.0187	0.016373
KC07LA2	13.84	37.6942	0.000857	11.5672	24.1384	2.69035	1.20441	0.548566	0.070672	2.90068	8.3143	0.021672
KC07LA3	15.18	41.0148	0.001002	9.9612	26.1166	2.74423	0.755248	0.581137	0.063266	2.9474	9.11664	0.018801
KC07LA4	19.14	51.1693	0.001048	12.6468	29.8753	3.71659	2.11773	0.777235	0.075517	2.45713	11.4027	0.021438
KC07LA5	19.07	50.0375	0.001022	7.16712	29.4941	3.25093	0.555667	0.796309	0.074691	2.71374	11.6844	0.019191
KC07LB1	27.31	106.105	0.00369	---	63.4998	15.7547	1.39707	2.45945	0.163418	4.27716	10.706	0.047582
KC07LB2	26.46	103.149	0.003471	80.5924	59.964	14.9833	1.37049	2.50098	0.148581	3.87968	10.4672	0.04215
KC07LB3	19.8	87.9753	0.006575	76.411	69.2025	8.67105	1.76272	0.677532	0.224501	3.86454	10.2528	0.078262
KC07LB4	29.33	113.005	0.003441	---	62.9839	16.9804	1.34419	2.82867	0.159385	3.66017	11.4255	0.044081
KC07LB5	18.38	74.684	0.005469	82.5376	54.7811	7.16947	1.26696	0.705338	0.254863	5.42115	10.5626	0.107415
KC07LC1	19.84	80.0807	0.003863	21.5327	35.5839	5.32823	0.691433	0.889255	0.113318	2.99452	13.1596	0.02687
KC07LC2	19.15	71.6637	0.003386	18.4725	32.3629	4.84008	0.619256	0.89948	0.108654	2.97765	12.5487	0.026561
KC07LC3	18.8	79.7294	0.003508	17.0639	33.7841	4.9906	0.565282	0.87626	0.11939	2.59541	13.1996	0.023088
KC07LC4	22.05	84.7682	0.003214	16.5509	33.4014	5.7092	0.526057	1.00388	0.126047	2.08864	14.8031	0.019748
KC07LC5	19.15	81.7579	0.003349	16.27	32.9138	5.03662	0.488832	0.873394	0.103311	2.31304	13.5119	0.024044
KC07LAB	23.43	78.7666	0.002438	43.9084	46.6808	9.70192	1.17804	1.65751	0.132767	3.50265	10.9238	0.031357
KC07LAC	19.41	65.5123	0.002396	15.4573	32.34	4.23832	0.84643	0.751933	0.097163	2.88915	12.1352	0.021863
KC07LBC	24.22	96.5194	0.003858	56.4466	52.2279	11.1582	1.12144	1.75687	0.149316	3.70116	12.4621	0.037931
KC07LABC	21.5	75.8381	0.002674	32.3133	41.7955	7.59893	0.993351	1.34981	0.125152	3.17075	11.7409	0.028493

Chapter 6 Appendix

Appendix 6.1: Raw Isotope Data for Nottingham Sample Sites

Identifier 1	Row	$\delta^{13}C$ (permil)	$\delta^{15}N$ (permil)	%C	%N
OEA Labs Alanine	*7*	*-19.29*	*-4.01*	*38.99*	*15.28*
N10A1	26	**-28.23**	**3.76**	9.03	0.71
N10A2	27	**-28.74**	**3.11**	6.65	0.54
N10A3	28	**-28.18**	**3.79**	5.63	0.45
N10A4	29	**-26.78**	**3.99**	6.76	0.57
N10A5	30	**-27.02**	**3.87**	9.62	0.97
N10B1	35	**-29.16**	**4.97**	9.20	0.93
N10B2	36	**-29.04**	**4.98**	7.44	0.72
N10B3	37	**-28.96**	**5.29**	9.46	0.94
N10B4	38	**-28.52**	**5.48**	7.44	0.74
N10B5	39	**-28.72**	**5.32**	5.77	0.54
N10C1	40	**-28.50**	**4.56**	6.71	0.64
N10C2	41	**-28.96**	**4.12**	68.36	6.27
N10C3	42	**-29.32**	**4.30**	6.70	0.63
N10C4	43	**-29.08**	**4.05**	42.03	15.84
OEA Labs Alanine	*7*	*-19.67*	*-4.01*	*41.12*	*15.76*
N10C5	8	**-29.02**	**4.20**	6.85	0.68
N10AB	9	**-28.80**	**4.67**	8.77	0.85
N10AC	10	**-28.68**	**4.03**	6.82	0.63
N10BC	11	**-29.27**	**4.52**	8.75	0.83
N10ABC	12	**-29.12**	**4.64**	9.48	0.95
N01A1	13	**-28.45**	**4.16**	6.62	0.58
N01B1	14	**-27.94**	**5.18**	8.44	0.87
N01C1	15	**-28.85**	**4.09**	7.46	0.73
NO1AB	21	**-28.56**	**4.44**	7.44	0.69

N01AC	22	**-28.76**	**3.94**	7.12	0.65
N01BC	23	**-28.62**	**4.67**	8.10	0.81
N01ABC	24	**-28.72**	**4.29**	7.38	0.70
OEA Labs Alanine	*16*	***-19.42***	***-3.70***	*39.94*	*15.45*
N04A1	25	**-28.17**	**4.01**	5.94	0.54
N04B1	26	**-28.82**	**4.91**	10.37	1.03
N04C1	27	**-28.99**	**4.48**	6.87	0.70
N04AB	28	**-28.52**	**4.62**	8.05	0.75
N04AC	29	**-28.54**	**4.28**	6.21	0.58
N04BC	30	**-28.80**	**4.80**	8.62	0.86
N04ABC	35	**-28.72**	**4.51**	7.55	0.75
N07A1	36	**-28.21**	**3.91**	5.75	0.51
N07B1	37	**-28.34**	**4.88**	8.04	0.82
N07C1	38	**-29.05**	**4.51**	6.38	0.62
N07AB	39	**-28.40**	**4.60**	7.08	0.68
N07AC	40	**-33.81**	**4.33**	6.25	0.58
N07BC	41	**-28.60**	**4.83**	7.42	0.73
N07ABC	42	**-28.58**	**4.72**	6.91	0.67
OEA Labs Alanine	*44*	***-19.22***	***-3.43***	*40.28*	*15.96*
Error		***0.20***	***0.28***		

Appendix 6.2: Raw Isotope Data for London Sample Sites

Identifier 1	Row	$\delta^{13}C$ (permil)	$\delta^{15}N$ (permil)	%C	%N
OEA Labs Alanine	*7*	*-19.16*	*-3.80*	*39.74*	*14.71*
L10A1	8	**-28.48**	**1.20**	17.18	1.21
L10A2	9	**-28.59**	**1.41**	24.29	1.60
L10A3	10	**-28.38**	**1.74**	18.33	1.33
L10A4	11	**-28.56**	**1.32**	19.12	1.27
L10A5	12	**-28.68**	**1.36**	26.38	1.77
L10B1	13	**-26.70**	**4.52**	13.11	0.89
L10B2	14	**-26.26**	**4.70**	11.16	0.85
L10B3	15	**-26.52**	**4.57**	12.35	0.79
L10B4	21	**-27.28**	**4.38**	16.46	1.15
L10B5	22	**-27.53**	**5.09**	14.33	1.06
L10C1	23	**-28.30**	**6.20**	11.06	0.97
L10C2	24	**-27.94**	**6.21**	9.80	0.83
L10C3	25	**-28.29**	**5.74**	10.62	1.00
L10C4	26	**-27.99**	**6.15**	9.74	0.88
OEA Labs Alanine	*16*	*-19.42*	*-3.93*	*40.94*	*15.58*
L10C5	27	**-28.08**	**6.09**	10.63	0.91
L10AB	28	**-27.11**	**5.28**	12.00	0.89
L10AC	29	**-28.31**	**4.84**	13.33	1.07
L10BC	30	**-27.61**	**2.67**	14.95	1.04
L10ABC	35	**-27.69**	**5.12**	12.54	0.96
L01A1	36	**-28.64**	**1.33**	25.74	1.77
L01B1	37	**-27.64**	**4.26**	19.57	1.50
L01C1	38	**-27.73**	**6.63**	10.38	0.89
L01AB	39	**-28.09**	**2.67**	19.55	1.36
L01AC	40	**-28.10**	**4.76**	13.49	1.01

L01BC	41	**-27.63**	**5.82**	11.28	0.97
L01ABC	42	**-27.97**	**4.38**	13.82	1.04
L04A1	43	**-28.27**	**1.59**	10.06	0.77
OEA Labs Alanine	*44*	***-19.16***	***-3.87***	*39.86*	*14.87*
L04B1	8	**-25.98**	**4.96**	7.95	0.52
L04C1	9	**-27.72**	**6.38**	7.28	0.67
L04AB	10	**-27.17**	**2.53**	9.28	0.67
L04AC	11	**-27.74**	**4.11**	8.63	0.69
L04BC	12	**-26.81**	**5.75**	7.82	0.63
L04ABC	13	**-27.11**	**4.65**	8.41	0.63
L07A1	14	**-29.62**	**1.46**	18.28	1.24
L07B1	15	**-29.48**	**4.41**	10.32	0.72
L07C1	21	**-27.83**	**6.64**	14.14	0.94
L07AB	22	**-27.67**	**2.73**	15.04	1.14
L07AC	23	**-30.59**	**3.51**	9.93	0.74
L07BC	24	**-26.97**	**5.58**	13.33	0.95
L07ABC	25	**-27.86**	**3.42**	7.60	0.66
OEA Labs Alanine	*44*	***-19.29***	***-3.97***	*39.86*	*14.87*
Error		***0.12***	***0.07***		

Chapter 7 Appendix

Appendix 7.1: Raw mineral data for Nottingham sample sites

Mineral	Nottingham Samples						
	R0K-01	R0K-02	R0K-03	R0K-04	R0K-05	R0K-06	R0K-07
Quartz/Silica	32.97	27.47	23.78	31.12	28.12	24.10	27.28
Plagioclase	2.19	2.03	2.05	2.08	2.13	1.82	1.99
K-Feldspar	5.76	4.96	4.85	5.87	5.11	4.25	3.64
Muscovite	1.47	1.30	1.44	1.44	1.50	1.15	0.80
Biotite	1.62	1.80	1.45	1.65	1.42	1.55	1.65
Chlorite	0.49	0.48	0.53	0.49	0.44	0.44	0.25
Kaolinite/Dickite	0.43	0.35	0.34	0.54	0.41	0.29	0.29
Other Clays	43.47	49.52	53.91	45.19	50.00	49.98	52.88
Epidote	0.01	0.02	0.01	0.01	0.00	0.01	0.01
Zircon	0.02	0.01	0.02	0.02	0.01	0.02	0.01
Tourmaline	0.21	0.22	0.27	0.22	0.27	0.21	0.15
Other Silicates	8.29	9.02	9.43	8.53	8.26	9.80	8.11
Calcite	0.22	0.11	0.03	0.12	0.07	0.05	0.08
Dolomite	0.35	0.17	0.21	0.39	0.44	0.13	0.27
Ti(-Fe) Oxides	0.37	0.42	0.41	0.41	0.41	0.35	0.37
Fe Oxide/Carbonate	0.08	0.02	0.04	0.05	0.09	4.61	0.11
Apatite	0.11	0.06	0.04	0.07	0.05	0.04	0.07
Sulphides	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Phases	0.00	0.01	0.00	0.00	0.00	0.01	0.01
Unclassified	0.32	0.24	0.17	0.30	0.14	0.13	0.26
Organic Matter	1.61	1.78	1.03	1.49	1.11	1.06	1.77

Appendix 7.2: Raw mineral data for London sample sites

Mineral	London Samples						
	R0K-08	R0K-09	R0K-10	R0K-11	R0K-12	R0K-13	R0K-14
Quartz/Silica	78.29	53.11	74.87	57.57	67.32	55.56	58.35
Plagioclase	3.83	20.27	3.09	16.85	6.04	11.99	15.32
K-Feldspar	5.22	5.84	2.72	5.91	4.23	3.80	5.28
Muscovite	0.28	1.10	0.68	0.64	0.84	0.89	0.72
Biotite	0.08	0.11	0.04	0.10	0.08	0.06	0.12
Chlorite	0.13	1.62	0.10	1.66	0.15	3.97	2.46
Kaolinite/Dickite	0.55	1.23	1.80	1.03	1.61	1.55	1.09
Other Clays	4.86	6.49	7.66	6.52	9.87	7.70	6.26
Epidote	0.06	0.20	0.63	0.22	0.08	1.98	0.79
Zircon	0.05	0.02	0.03	0.03	0.09	0.03	0.02
Tourmaline	0.03	0.06	0.07	0.05	0.10	0.12	0.08
Other Silicates	1.55	2.59	3.24	2.48	2.73	3.54	3.27
Calcite	0.01	2.47	0.01	2.28	0.04	0.91	0.76
Dolomite	0.00	0.66	0.00	0.19	0.00	0.07	1.48
Ti(-Fe) Oxides	0.31	0.22	0.18	0.36	0.28	0.35	0.30
Fe Oxide/Carbonate	0.31	0.23	0.31	0.36	0.18	0.14	0.15
Apatite	0.01	0.09	0.02	0.08	0.03	0.10	0.07
Sulphides	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Other Phases	0.01	0.00	0.00	0.00	0.02	0.01	0.00
Unclassified	0.56	1.35	0.43	1.23	0.85	4.21	0.90
Organic Matter	3.85	2.32	4.11	2.45	5.45	3.04	2.57

Chapter 8 Appendix

Appendix 88.1: ANOVA Output for Reduced Element Set - Nottingham, October, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	19062937.763	2	9531468.881	33.370	.000
	Within Groups	3427555.552	12	285629.629		
	Total	22490493.315	14			
Al	Between Groups	227630739.224	2	113815369.612	33.620	.000
	Within Groups	40624435.536	12	3385369.628		
	Total	268255174.761	14			
Si	Between Groups	576147111.972	2	288073555.986	5.107	.025
	Within Groups	676901333.831	12	56408444.486		
	Total	1253048445.802	14			
P	Between Groups	1502296.948	2	751148.474	11.507	.002
	Within Groups	783299.245	12	65274.937		
	Total	2285596.192	14			
S	Between Groups	919715.972	2	459857.986	20.097	.000
	Within Groups	274577.111	12	22881.426		
	Total	1194293.082	14			
Cl	Between Groups	6210.727	2	3105.364	4.174	.042
	Within Groups	8927.152	12	743.929		
	Total	15137.879	14			
K	Between Groups	34027157.014	2	17013578.507	16.836	.000
	Within Groups	12126853.294	12	1010571.108		
	Total	46154010.309	14			
Ca	Between Groups	183241538.108	2	91620769.054	12.911	.001
	Within Groups	85156901.177	12	7096408.431		
	Total	268398439.285	14			
Ti	Between Groups	415410.548	2	207705.274	9.915	.003
	Within Groups	251382.444	12	20948.537		
	Total	666792.992	14			
Fe	Between Groups	53374019.304	2	26687009.652	72.368	.000
	Within Groups	4425240.015	12	368770.001		
	Total	57799259.319	14			
Zn	Between Groups	2271.443	2	1135.722	11.663	.002
	Within Groups	1168.575	12	97.381		
	Total	3440.018	14			
Ga	Between Groups	6.710	2	3.355	7.636	.007
	Within Groups	5.272	12	.439		
	Total	11.982	14			
Rb	Between Groups	393.160	2	196.580	22.831	.000
	Within Groups	103.324	12	8.610		
	Total	496.485	14			
Sr	Between Groups	754.016	2	377.008	32.716	.000
	Within Groups	138.285	12	11.524		
	Total	892.301	14			
Y	Between Groups	15.640	2	7.820	6.603	.012
	Within Groups	14.212	12	1.184		
	Total	29.853	14			
Sn	Between Groups	21.187	2	10.594	10.504	.002
	Within Groups	12.102	12	1.008		
	Total	33.289	14			
Ba	Between Groups	3097.883	2	1548.941	4.609	.033
	Within Groups	4032.678	12	336.057		
	Total	7130.561	14			
Pb	Between Groups	3166.870	2	1583.435	9.249	.004
	Within Groups	2054.436	12	171.203		
	Total	5221.306	14			
U	Between Groups	15.389	2	7.695	1.133	.354
	Within Groups	81.479	12	6.790		
	Total	96.868	14			

Appendix 8.8.2: ANOVA Output for Reduced Element Set - Nottingham, January, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	27295094.803	2	13647547.401	15.414	.000
	Within Groups	10624475.554	12	885372.963		
	Total	37919570.357	14			
Al	Between Groups	330547183.486	2	165273591.743	25.216	.000
	Within Groups	78651879.971	12	6554323.331		
	Total	409199063.457	14			
Si	Between Groups	7813288539.541	2	3906644269.771	78.623	.000
	Within Groups	596259031.286	12	49688252.607		
	Total	8409547570.828	14			
P	Between Groups	740761.969	2	370380.985	21.685	.000
	Within Groups	204957.517	12	17079.793		
	Total	945719.486	14			
S	Between Groups	633958.192	2	316979.096	12.841	.001
	Within Groups	296227.616	12	24685.635		
	Total	930185.808	14			
Cl	Between Groups	9798.121	2	4899.061	10.461	.002
	Within Groups	5619.796	12	468.316		
	Total	15417.917	14			
K	Between Groups	124870862.936	2	62435431.468	34.454	.000
	Within Groups	21745362.965	12	1812113.580		
	Total	146616225.901	14			
Ca	Between Groups	82833747.385	2	41416873.692	6.787	.011
	Within Groups	73224080.608	12	6102006.717		
	Total	156057827.993	14			
Ti	Between Groups	2890646.029	2	1445323.014	53.023	.000
	Within Groups	327098.532	12	27258.211		
	Total	3217744.561	14			
Fe	Between Groups	81582748.257	2	40791374.128	17.941	.000
	Within Groups	27284354.278	12	2273696.190		
	Total	108867102.535	14			
Zn	Between Groups	3784.203	2	1892.102	13.090	.001
	Within Groups	1734.495	12	144.541		
	Total	5518.698	14			
Ga	Between Groups	25.560	2	12.780	26.996	.000
	Within Groups	5.681	12	.473		
	Total	31.241	14			
Rb	Between Groups	939.205	2	469.602	20.638	.000
	Within Groups	273.052	12	22.754		
	Total	1212.257	14			
Sr	Between Groups	1524.216	2	762.108	27.546	.000
	Within Groups	331.996	12	27.666		
	Total	1856.212	14			
Y	Between Groups	136.404	2	68.202	36.959	.000
	Within Groups	22.144	12	1.845		
	Total	158.548	14			
Sn	Between Groups	43.502	2	21.751	9.184	.004
	Within Groups	28.419	12	2.368		
	Total	71.920	14			
Ba	Between Groups	29524.930	2	14762.465	70.833	.000
	Within Groups	2500.931	12	208.411		
	Total	32025.860	14			
Pb	Between Groups	3931.094	2	1965.547	14.036	.001
	Within Groups	1680.404	12	140.034		
	Total	5611.498	14			
U	Between Groups	323.373	2	161.687	4.405	.037
	Within Groups	440.503	12	36.709		
	Total	763.877	14			

Appendix 8.8.3: ANOVA Output for Reduced Element Set - Nottingham, April, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	49528534.910	2	24764267.455	63.381	.000
	Within Groups	4688683.125	12	390723.594		
	Total	54217218.034	14			
Al	Between Groups	438979302.849	2	219489651.424	82.200	.000
	Within Groups	32042190.271	12	2670182.523		
	Total	471021493.120	14			
Si	Between Groups	2534091408.030	2	1267045704.015	77.574	.000
	Within Groups	196001428.667	12	16333452.389		
	Total	2730092836.696	14			
P	Between Groups	2890525.574	2	1445262.787	31.937	.000
	Within Groups	543049.186	12	45254.099		
	Total	3433574.760	14			
S	Between Groups	2428669.926	2	1214334.963	116.203	.000
	Within Groups	125401.210	12	10450.101		
	Total	2554071.136	14			
Cl	Between Groups	1060.145	2	530.073	8.568	.005
	Within Groups	742.401	12	61.867		
	Total	1802.546	14			
K	Between Groups	72009802.767	2	36004901.384	73.275	.000
	Within Groups	5896437.845	12	491369.820		
	Total	77906240.612	14			
Ca	Between Groups	125397337.747	2	62698668.873	10.308	.002
	Within Groups	72989573.170	12	6082464.431		
	Total	198386910.917	14			
Ti	Between Groups	1298835.210	2	649417.605	99.881	.000
	Within Groups	78023.073	12	6501.923		
	Total	1376858.283	14			
Fe	Between Groups	77833854.074	2	38916927.037	34.330	.000
	Within Groups	13603234.907	12	1133602.909		
	Total	91437088.981	14			
Zn	Between Groups	2505.780	2	1252.890	37.103	.000
	Within Groups	405.210	12	33.767		
	Total	2910.989	14			
Ga	Between Groups	14.152	2	7.076	26.672	.000
	Within Groups	3.184	12	.265		
	Total	17.336	14			
Rb	Between Groups	565.348	2	282.674	31.991	.000
	Within Groups	106.032	12	8.836		
	Total	671.380	14			
Sr	Between Groups	302.233	2	151.116	4.339	.038
	Within Groups	417.919	12	34.827		
	Total	720.152	14			
Y	Between Groups	53.771	2	26.886	48.973	.000
	Within Groups	6.588	12	.549		
	Total	60.359	14			
Sn	Between Groups	23.541	2	11.770	8.672	.005
	Within Groups	16.288	12	1.357		
	Total	39.828	14			
Ba	Between Groups	19543.525	2	9771.762	16.350	.000
	Within Groups	7171.878	12	597.656		
	Total	26715.402	14			
Pb	Between Groups	8023.574	2	4011.787	22.304	.000
	Within Groups	2158.411	12	179.868		
	Total	10181.985	14			
U	Between Groups	55.361	2	27.680	3.619	.059
	Within Groups	91.786	12	7.649		
	Total	147.147	14			

Appendix 88.4: ANOVA Output for Reduced Element Set - Nottingham, July, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	21476226.492	2	10738113.246	15.272	.001
	Within Groups	8437215.760	12	703101.313		
	Total	29913442.252	14			
Al	Between Groups	274195973.834	2	137097986.917	17.022	.000
	Within Groups	96651425.707	12	8054285.476		
	Total	370847399.541	14			
Si	Between Groups	1395040725.985	2	697520362.993	11.264	.002
	Within Groups	743089111.067	12	61924092.589		
	Total	2138129837.052	14			
P	Between Groups	1703267.159	2	851633.580	19.298	.000
	Within Groups	529576.713	12	44131.393		
	Total	2232843.872	14			
S	Between Groups	1864456.114	2	932228.057	36.768	.000
	Within Groups	304250.689	12	25354.224		
	Total	2168706.803	14			
Cl	Between Groups	328.605	2	164.302	1.272	.315
	Within Groups	1549.922	12	129.160		
	Total	1878.527	14			
K	Between Groups	48629016.132	2	24314508.066	17.181	.000
	Within Groups	16982224.120	12	1415185.343		
	Total	65611240.252	14			
Ca	Between Groups	181457622.439	2	90728811.219	9.914	.003
	Within Groups	109823765.251	12	9151980.438		
	Total	291281387.690	14			
Ti	Between Groups	1002629.323	2	501314.661	18.270	.000
	Within Groups	329272.285	12	27439.357		
	Total	1331901.608	14			
Fe	Between Groups	42777296.142	2	21388648.071	18.603	.000
	Within Groups	13797067.080	12	1149755.590		
	Total	56574363.222	14			
Zn	Between Groups	2561.232	2	1280.616	25.328	.000
	Within Groups	606.737	12	50.561		
	Total	3167.969	14			
Ga	Between Groups	9.921	2	4.961	9.346	.004
	Within Groups	6.369	12	.531		
	Total	16.290	14			
Rb	Between Groups	312.561	2	156.280	15.211	.001
	Within Groups	123.294	12	10.274		
	Total	435.854	14			
Sr	Between Groups	477.730	2	238.865	6.686	.011
	Within Groups	428.688	12	35.724		
	Total	906.418	14			
Y	Between Groups	30.821	2	15.410	18.565	.000
	Within Groups	9.961	12	.830		
	Total	40.782	14			
Sn	Between Groups	32.209	2	16.105	6.570	.012
	Within Groups	29.413	12	2.451		
	Total	61.622	14			
Ba	Between Groups	12872.122	2	6436.061	35.453	.000
	Within Groups	2178.467	12	181.539		
	Total	15050.590	14			
Pb	Between Groups	4309.437	2	2154.718	19.438	.000
	Within Groups	1330.222	12	110.852		
	Total	5639.659	14			
U	Between Groups	44.250	2	22.125	2.982	.089
	Within Groups	89.019	12	7.418		
	Total	133.269	14			

Appendix 8.8.5: ANOVA Output for Reduced Element Set - Nottingham, October, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	315506.501	2	157753.251	7.081	.009
	Within Groups	267341.216	12	22278.435		
	Total	582847.717	14			
Eu	Between Groups	264390.400	2	132195.200	6.611	.012
	Within Groups	239937.424	12	19994.785		
	Total	504327.824	14			
Gd	Between Groups	283664.149	2	141832.075	6.275	.014
	Within Groups	271244.288	12	22603.691		
	Total	554908.437	14			
Tb	Between Groups	296529.557	2	148264.779	7.337	.008
	Within Groups	242491.600	12	20207.633		
	Total	539021.157	14			
Dy	Between Groups	351440.469	2	175720.235	7.084	.009
	Within Groups	297650.400	12	24804.200		
	Total	649090.869	14			
Ho	Between Groups	322696.336	2	161348.168	8.485	.005
	Within Groups	228196.048	12	19016.337		
	Total	550892.384	14			
Er	Between Groups	258047.429	2	129023.715	5.893	.016
	Within Groups	262734.448	12	21894.537		
	Total	520781.877	14			
Tm	Between Groups	289513.024	2	144756.512	8.812	.004
	Within Groups	197116.192	12	16426.349		
	Total	486629.216	14			
Yb	Between Groups	301565.845	2	150782.923	7.266	.009
	Within Groups	249014.624	12	20751.219		
	Total	550580.469	14			
Lu	Between Groups	267369.509	2	133684.755	8.063	.006
	Within Groups	198949.760	12	16579.147		
	Total	466319.269	14			
Pb	Between Groups	1630046700.400	2	815023350.200	9.385	.004
	Within Groups	1042170237.200	12	86847519.767		
	Total	2672216937.600	14			
U	Between Groups	2201463.077	2	1100731.539	4.165	.042
	Within Groups	3171357.072	12	264279.756		
	Total	5372820.149	14			

Appendix 88.6: ANOVA Output for Reduced Element Set - Nottingham, January, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	262440.901	2	131220.451	9.807	.003
	Within Groups	160560.928	12	13380.077		
	Total	423001.829	14			
Eu	Between Groups	189527.376	2	94763.688	6.489	.012
	Within Groups	175247.040	12	14603.920		
	Total	364774.416	14			
Gd	Between Groups	225660.437	2	112830.219	6.476	.012
	Within Groups	209073.680	12	17422.807		
	Total	434734.117	14			
Tb	Between Groups	287231.685	2	143615.843	8.327	.005
	Within Groups	206972.032	12	17247.669		
	Total	494203.717	14			
Dy	Between Groups	202812.549	2	101406.275	4.592	.033
	Within Groups	265018.128	12	22084.844		
	Total	467830.677	14			
Ho	Between Groups	246508.485	2	123254.243	7.039	.009
	Within Groups	210110.704	12	17509.225		
	Total	456619.189	14			
Er	Between Groups	294415.125	2	147207.563	9.478	.003
	Within Groups	186375.472	12	15531.289		
	Total	480790.597	14			
Tm	Between Groups	153088.485	2	76544.243	7.575	.007
	Within Groups	121260.064	12	10105.005		
	Total	274348.549	14			
Yb	Between Groups	201156.709	2	100578.355	7.340	.008
	Within Groups	164432.640	12	13702.720		
	Total	365589.349	14			
Lu	Between Groups	210370.752	2	105185.376	10.258	.003
	Within Groups	123050.624	12	10254.219		
	Total	333421.376	14			
Pb	Between Groups	2351158860.400	2	1175579430.200	10.398	.002
	Within Groups	1356753099.600	12	113062758.300		
	Total	3707911960.000	14			
U	Between Groups	598328.229	2	299164.115	5.134	.024
	Within Groups	699283.680	12	58273.640		
	Total	1297611.909	14			

Appendix 8.8.7: ANOVA Output for Reduced Element Set - Nottingham, April, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	144878.224	2	72439.112	18.327	.000
	Within Groups	47431.120	12	3952.593		
	Total	192309.344	14			
Eu	Between Groups	93330.789	2	46665.395	21.796	.000
	Within Groups	25691.504	12	2140.959		
	Total	119022.293	14			
Gd	Between Groups	147080.005	2	73540.003	18.989	.000
	Within Groups	46474.064	12	3872.839		
	Total	193554.069	14			
Tb	Between Groups	108088.752	2	54044.376	22.534	.000
	Within Groups	28780.704	12	2398.392		
	Total	136869.456	14			
Dy	Between Groups	167788.848	2	83894.424	18.271	.000
	Within Groups	55099.392	12	4591.616		
	Total	222888.240	14			
Ho	Between Groups	138971.941	2	69485.971	27.271	.000
	Within Groups	30575.232	12	2547.936		
	Total	169547.173	14			
Er	Between Groups	134997.269	2	67498.635	29.591	.000
	Within Groups	27372.240	12	2281.020		
	Total	162369.509	14			
Tm	Between Groups	35875.909	2	17937.955	11.702	.002
	Within Groups	18394.928	12	1532.911		
	Total	54270.837	14			
Yb	Between Groups	62974.144	2	31487.072	13.578	.001
	Within Groups	27828.272	12	2319.023		
	Total	90802.416	14			
Lu	Between Groups	36885.861	2	18442.931	13.347	.001
	Within Groups	16581.776	12	1381.815		
	Total	53467.637	14			
Pb	Between Groups	1817127456.933	2	908563728.467	1.797	.208
	Within Groups	6066168970.800	12	505514080.900		
	Total	7883296427.733	14			
U	Between Groups	805164.485	2	402582.243	15.612	.000
	Within Groups	309443.072	12	25786.923		
	Total	1114607.557	14			

Appendix 8.8.8: ANOVA Output for Reduced Element Set - Nottingham, July, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	102473.424	2	51236.712	6.176	.014
	Within Groups	99557.120	12	8296.427		
	Total	202030.544	14			
Eu	Between Groups	93142.037	2	46571.019	6.425	.013
	Within Groups	86979.840	12	7248.320		
	Total	180121.877	14			
Gd	Between Groups	99205.525	2	49602.763	6.800	.011
	Within Groups	87534.592	12	7294.549		
	Total	186740.117	14			
Tb	Between Groups	80158.229	2	40079.115	4.891	.028
	Within Groups	98326.128	12	8193.844		
	Total	178484.357	14			
Dy	Between Groups	148179.605	2	74089.803	6.913	.010
	Within Groups	128600.704	12	10716.725		
	Total	276780.309	14			
Ho	Between Groups	75319.216	2	37659.608	4.368	.038
	Within Groups	103454.880	12	8621.240		
	Total	178774.096	14			
Er	Between Groups	99186.021	2	49593.011	4.742	.030
	Within Groups	125497.536	12	10458.128		
	Total	224683.557	14			
Tm	Between Groups	84666.309	2	42333.155	4.411	.037
	Within Groups	115169.824	12	9597.485		
	Total	199836.133	14			
Yb	Between Groups	69480.432	2	34740.216	3.458	.065
	Within Groups	120571.072	12	10047.589		
	Total	190051.504	14			
Lu	Between Groups	68025.637	2	34012.819	3.543	.062
	Within Groups	115200.256	12	9600.021		
	Total	183225.893	14			
Pb	Between Groups	2848575462.400	2	1424287731.200	19.331	.000
	Within Groups	884125275.200	12	73677106.267		
	Total	3732700737.600	14			
U	Between Groups	787758.405	2	393879.203	16.414	.000
	Within Groups	287956.384	12	23996.365		
	Total	1075714.789	14			

Appendix 8.8.9: ANOVA Output for Reduced Element Set - Nottingham, October, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	1672393201.200	2	836196600.600	24.663	.000
	Within Groups	406863030.800	12	33905252.567		
	Total	2079256232.000	14			
Be	Between Groups	18604.312	2	9302.156	3.616	.059
	Within Groups	30865.990	12	2572.166		
	Total	49470.302	14			
Fe	Between Groups	1494012000.133	2	747006000.067	33.429	.000
	Within Groups	268153429.200	12	22346119.100		
	Total	1762165429.333	14			
K	Between Groups	4042790760.000	2	2021395380.000	10.481	.002
	Within Groups	2314455040.000	12	192871253.333		
	Total	6357245800.000	14			
Mn	Between Groups	6881270.539	2	3440635.270	2.687	.109
	Within Groups	15363617.291	12	1280301.441		
	Total	22244887.830	14			
Ni	Between Groups	743.913	2	371.956	5.332	.022
	Within Groups	837.177	12	69.765		
	Total	1581.090	14			
P	Between Groups	1432351.721	2	716175.861	10.157	.003
	Within Groups	846110.617	12	70509.218		
	Total	2278462.339	14			
Ti	Between Groups	511884.620	2	255942.310	17.385	.000
	Within Groups	176662.519	12	14721.877		
	Total	688547.139	14			

Appendix 8.8.10: ANOVA Output for Reduced Element Set - Nottingham, January, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	2010808890.133	2	1005404445.067	15.332	15.332
	Within Groups	786891983.600	12	65574331.967		
	Total	2797700873.733	14			
Be	Between Groups	126115.260	2	63057.630	19.036	19.036
	Within Groups	39751.193	12	3312.599		
	Total	165866.453	14			
Fe	Between Groups	3789776100.933	2	1894888050.467	81.620	81.620
	Within Groups	278591918.800	12	23215993.233		
	Total	4068368019.733	14			
K	Between Groups	14497276213.333	2	7248638106.667	14.189	14.189
	Within Groups	6130316560.000	12	510859713.333		
	Total	20627592773.333	14			
Mn	Between Groups	8358731.474	2	4179365.737	4.110	4.110
	Within Groups	12201531.038	12	1016794.253		
	Total	20560262.512	14			
Ni	Between Groups	3127.026	2	1563.513	27.160	27.160
	Within Groups	690.801	12	57.567		
	Total	3817.826	14			
P	Between Groups	869809.229	2	434904.615	19.557	19.557
	Within Groups	266847.895	12	22237.325		
	Total	1136657.125	14			
Ti	Between Groups	290312.406	2	145156.203	3.216	3.216
	Within Groups	541656.041	12	45138.003		
	Total	831968.447	14			

Appendix 8.8.11: ANOVA Output for Reduced Element Set - Nottingham, April, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3515156441.733	2	1757578220.867	45.902	.000
	Within Groups	459479297.200	12	38289941.433		
	Total	3974635738.933	14			
Be	Between Groups	40534.183	2	20267.091	4.483	.035
	Within Groups	54252.891	12	4521.074		
	Total	94787.074	14			
Fe	Between Groups	2223873856.533	2	1111936928.267	37.842	.000
	Within Groups	352601290.400	12	29383440.867		
	Total	2576475146.933	14			
K	Between Groups	16656884573.333	2	8328442286.667	43.534	.000
	Within Groups	2295690960.000	12	191307580.000		
	Total	18952575533.333	14			
Mn	Between Groups	57122653.744	2	28561326.872	5.614	.019
	Within Groups	61054353.920	12	5087862.827		
	Total	118177007.664	14			
Ni	Between Groups	677.822	2	338.911	7.723	.007
	Within Groups	526.589	12	43.882		
	Total	1204.412	14	1606912.395		
P	Between Groups	3213824.789	2		37.806	.000
	Within Groups	510045.612	12	42503.801		
	Total	3723870.401	14	534590.128		
Ti	Between Groups	1069180.255	2		57.271	.000
	Within Groups	112013.173	12	9334.431		
	Total	1181193.428	14			

Appendix 8.8.12: ANOVA Output for Reduced Element Set - Nottingham, July, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3457498022.533	2	1728749011.267	29.346	.000
	Within Groups	706901847.200	12	58908487.267		
	Total	4164399869.733	14			
Be	Between Groups	41434.581	2	20717.290	10.338	.002
	Within Groups	24048.257	12	2004.021		
	Total	65482.838	14			
Fe	Between Groups	1854196563.333	2	927098281.667	23.909	.000
	Within Groups	465320759.600	12	38776729.967		
	Total	2319517322.933	14			
K	Between Groups	20260712253.333	2	10130356126.667	28.606	.000
	Within Groups	4249561080.000	12	354130090.000		
	Total	24510273333.333	14			
Mn	Between Groups	30837663.316	2	15418831.658	6.003	.016
	Within Groups	30820063.400	12	2568338.617		
	Total	61657726.716	14			
Ni	Between Groups	1614.602	2	807.301	13.573	.001
	Within Groups	713.722	12	59.477		
	Total	2328.324	14			
P	Between Groups	2249474.583	2	1124737.292	40.636	.000
	Within Groups	332142.162	12	27678.513		
	Total	2581616.745	14			
Ti	Between Groups	1333913.410	2	666956.705	35.424	.000
	Within Groups	225933.288	12	18827.774		
	Total	1559846.698	14			

Appendix 8.8.13: ANOVA Output for Reduced Element Set - London, October, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	33372991.109	2	16686495.554	41.399	.000
	Within Groups	4836808.891	12	403067.408		
	Total	38209799.999	14			
Al	Between Groups	1370733013.156	2	685366506.578	200.633	.000
	Within Groups	40992315.611	12	3416026.301		
	Total	1411725328.767	14			
Si	Between Groups	6067673035.989	2	3033836517.995	11.188	.002
	Within Groups	3254112442.746	12	271176036.896		
	Total	9321785478.735	14			
P	Between Groups	1663871.512	2	831935.756	26.469	.000
	Within Groups	377164.267	12	31430.356		
	Total	2041035.779	14			
Ca	Between Groups	2081803460.121	2	1040901730.060	178.992	.000
	Within Groups	69784423.090	12	5815368.591		
	Total	2151587883.211	14			
Fe	Between Groups	574358001.678	2	287179000.839	108.261	.000
	Within Groups	31831924.476	12	2652660.373		
	Total	606189926.155	14			
Co	Between Groups	195.283	2	97.641	6.860	.010
	Within Groups	170.797	12	14.233		
	Total	366.080	14			
Ni	Between Groups	1625.816	2	812.908	24.889	.000
	Within Groups	391.929	12	32.661		
	Total	2017.745	14			
Cu	Between Groups	11893.933	2	5946.967	24.413	.000
	Within Groups	2923.224	12	243.602		
	Total	14817.157	14			
Zn	Between Groups	76389.997	2	38194.998	3.749	.054
	Within Groups	122244.614	12	10187.051		
	Total	198634.611	14			
Ga	Between Groups	13.553	2	6.777	14.415	.001
	Within Groups	5.641	12	.470		
	Total	19.194	14			
Se	Between Groups	5.969	2	2.985	60.497	.000
	Within Groups	.592	12	.049		
	Total	6.561	14			
Rb	Between Groups	290.354	2	145.177	16.504	.000
	Within Groups	105.558	12	8.796		
	Total	395.912	14			
Sr	Between Groups	17433.136	2	8716.568	179.533	.000
	Within Groups	582.617	12	48.551		
	Total	18015.753	14			
Y	Between Groups	626.278	2	313.139	58.743	.000
	Within Groups	63.968	12	5.331		
	Total	690.246	14			
Zr	Between Groups	125895.457	2	62947.729	29.246	.000
	Within Groups	25828.025	12	2152.335		
	Total	151723.482	14			
Cr	Between Groups	.167	2	.084	12.011	.001
	Within Groups	.084	12	.007		
	Total	.251	14			
Ta	Between Groups	8.176	2	4.088	30.491	.000
	Within Groups	1.609	12	.134		
	Total	9.785	14			
Pb	Between Groups	96463.525	2	48231.762	9.632	.003
	Within Groups	60087.526	12	5007.294		
	Total	156551.051	14			
Th	Between Groups	40.658	2	20.329	30.240	.000
	Within Groups	8.067	12	.672		
	Total	48.725	14			

Appendix 88.14: ANOVA Output for Reduced Element Set - London, January, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	12827364.444	2	6413682.222	45.162	.000
	Within Groups	1704191.111	12	142015.926		
	Total	14531555.555	14			
Al	Between Groups	808756076.969	2	404378038.485	60.543	.000
	Within Groups	80150386.619	12	6679198.885		
	Total	888906463.588	14			
Si	Between Groups	7750856442.973	2	3875428221.486	10.391	.002
	Within Groups	4475687993.456	12	372973999.455		
	Total	12226544436.429	14			
P	Between Groups	2473397.884	2	1236698.942	37.182	.000
	Within Groups	399125.644	12	33260.470		
	Total	2872523.528	14			
Ca	Between Groups	1833958966.895	2	916979483.448	412.887	.000
	Within Groups	26650741.325	12	2220895.110		
	Total	1860609708.220	14			
Fe	Between Groups	585045085.980	2	292522542.990	71.068	.000
	Within Groups	49392968.861	12	4116080.738		
	Total	634438054.840	14			
Co	Between Groups	738.013	2	369.007	18.058	.000
	Within Groups	245.216	12	20.435		
	Total	983.229	14			
Ni	Between Groups	2027.464	2	1013.732	64.761	.000
	Within Groups	187.842	12	15.654		
	Total	2215.306	14			
Cu	Between Groups	19669.886	2	9834.943	59.138	.000
	Within Groups	1995.656	12	166.305		
	Total	21665.542	14			
Zn	Between Groups	178745.986	2	89372.993	26.283	.000
	Within Groups	40804.469	12	3400.372		
	Total	219550.455	14			
Ga	Between Groups	14.409	2	7.205	8.014	.006
	Within Groups	10.788	12	.899		
	Total	25.197	14			
Se	Between Groups	3.980	2	1.990	34.336	.000
	Within Groups	.696	12	.058		
	Total	4.676	14			
Rb	Between Groups	368.404	2	184.202	8.494	.005
	Within Groups	260.247	12	21.687		
	Total	628.650	14			
Sr	Between Groups	17894.963	2	8947.481	244.178	.000
	Within Groups	439.719	12	36.643		
	Total	18334.682	14			
Y	Between Groups	617.916	2	308.958	64.569	.000
	Within Groups	57.419	12	4.785		
	Total	675.334	14			
Zr	Between Groups	249084.237	2	124542.118	31.469	.000
	Within Groups	47490.930	12	3957.577		
	Total	296575.166	14			
Cr	Between Groups	.285	2	.143	14.199	.001
	Within Groups	.120	12	.010		
	Total	.405	14			
Ta	Between Groups	12.794	2	6.397	75.853	.000
	Within Groups	1.012	12	.084		
	Total	13.806	14			
Pb	Between Groups	121963.572	2	60981.786	26.290	.000
	Within Groups	27834.461	12	2319.538		
	Total	149798.033	14			
Th	Between Groups	31.721	2	15.861	12.631	.001
	Within Groups	15.068	12	1.256		
	Total	46.789	14			

Appendix 8.8.15: ANOVA Output for Reduced Element Set - London, April, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	29524403.674	2	14762201.837	5.562	.020
	Within Groups	31847420.520	12	2653951.710		
	Total	61371824.194	14			
Al	Between Groups	832470352.062	2	416235176.031	15.303	.000
	Within Groups	326400837.045	12	27200069.754		
	Total	1158871189.107	14			
Si	Between Groups	3852921436.030	2	1926460718.015	2.161	.158
	Within Groups	10698893802.845	12	891574483.570		
	Total	14551815238.874	14			
P	Between Groups	24094.154	2	12047.077	.164	.851
	Within Groups	883528.036	12	73627.336		
	Total	907622.190	14			
Ca	Between Groups	1210721872.133	2	605360936.066	7.807	.007
	Within Groups	930498595.965	12	77541549.664		
	Total	2141220468.098	14			
Fe	Between Groups	310796599.354	2	155398299.677	6.966	.010
	Within Groups	267699949.613	12	22308329.134		
	Total	578496548.967	14			
Co	Between Groups	373.649	2	186.825	9.325	.004
	Within Groups	240.427	12	20.036		
	Total	614.076	14			
Ni	Between Groups	1786.224	2	893.112	17.837	.000
	Within Groups	600.853	12	50.071		
	Total	2387.078	14			
Cu	Between Groups	10884.661	2	5442.331	6.682	.011
	Within Groups	9773.717	12	814.476		
	Total	20658.378	14			
Zn	Between Groups	87696.278	2	43848.139	4.860	.028
	Within Groups	108261.116	12	9021.760		
	Total	195957.393	14			
Ga	Between Groups	19.968	2	9.984	5.638	.019
	Within Groups	21.252	12	1.771		
	Total	41.220	14			
Se	Between Groups	1.211	2	.605	4.010	.046
	Within Groups	1.812	12	.151		
	Total	3.022	14			
Rb	Between Groups	205.751	2	102.875	4.304	.039
	Within Groups	286.860	12	23.905		
	Total	492.611	14			
Sr	Between Groups	23111.514	2	11555.757	7.316	.008
	Within Groups	18955.410	12	1579.617		
	Total	42066.924	14			
Y	Between Groups	269.615	2	134.807	10.941	.002
	Within Groups	147.862	12	12.322		
	Total	417.477	14			
Zr	Between Groups	88002.945	2	44001.473	4.073	.045
	Within Groups	129630.542	12	10802.545		
	Total	217633.487	14			
Cr	Between Groups	.116	2	.058	4.253	.040
	Within Groups	.163	12	.014		
	Total	.279	14			
Ta	Between Groups	6.426	2	3.213	6.617	.012
	Within Groups	5.826	12	.486		
	Total	12.252	14			
Pb	Between Groups	74513.756	2	37256.878	4.015	.046
	Within Groups	111362.774	12	9280.231		
	Total	185876.530	14			
Th	Between Groups	8.893	2	4.446	6.064	.015
	Within Groups	8.799	12	.733		
	Total	17.692	14			

Appendix 8.8.16: ANOVA Output for Reduced Element Set - London, July, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	78081543.372	2	39040771.686	19.276	.000
	Within Groups	24304167.880	12	2025347.323		
	Total	102385711.252	14			
Al	Between Groups	1292835442.643	2	646417721.321	46.751	.000
	Within Groups	165921608.427	12	13826800.702		
	Total	1458757051.070	14			
Si	Between Groups	13362107671.141	2	6681053835.570	21.217	.000
	Within Groups	3778774917.511	12	314897909.793		
	Total	17140882588.652	14			
P	Between Groups	1369830.619	2	684915.310	10.347	.002
	Within Groups	794328.430	12	66194.036		
	Total	2164159.049	14			
Ca	Between Groups	2489049758.216	2	1244524879.108	406.781	.000
	Within Groups	36713346.116	12	3059445.510		
	Total	2525763104.331	14			
Fe	Between Groups	695916145.932	2	347958072.966	138.843	.000
	Within Groups	30073461.360	12	2506121.780		
	Total	725989607.292	14			
Co	Between Groups	348.491	2	174.245	4.582	.033
	Within Groups	456.360	12	38.030		
	Total	804.851	14			
Ni	Between Groups	1266.859	2	633.430	16.992	.000
	Within Groups	447.331	12	37.278		
	Total	1714.190	14			
Cu	Between Groups	16207.417	2	8103.709	12.123	.001
	Within Groups	8021.751	12	668.479		
	Total	24229.168	14			
Zn	Between Groups	140381.922	2	70190.961	8.775	.004
	Within Groups	95983.681	12	7998.640		
	Total	236365.603	14			
Ga	Between Groups	17.848	2	8.924	5.307	.022
	Within Groups	20.178	12	1.681		
	Total	38.026	14			
Se	Between Groups	3.080	2	1.540	25.876	.000
	Within Groups	.714	12	.060		
	Total	3.794	14			
Rb	Between Groups	298.895	2	149.448	14.814	.001
	Within Groups	121.058	12	10.088		
	Total	419.954	14			
Sr	Between Groups	41829.800	2	20914.900	48.079	.000
	Within Groups	5220.098	12	435.008		
	Total	47049.898	14			
Y	Between Groups	650.223	2	325.111	55.449	.000
	Within Groups	70.359	12	5.863		
	Total	720.582	14			
Zr	Between Groups	163122.177	2	81561.089	42.651	.000
	Within Groups	22947.735	12	1912.311		
	Total	186069.913	14			
Cr	Between Groups	.406	2	.203	37.362	.000
	Within Groups	.065	12	.005		
	Total	.472	14			
Ta	Between Groups	9.399	2	4.700	14.770	.001
	Within Groups	3.818	12	.318		
	Total	13.217	14			
Pb	Between Groups	95588.162	2	47794.081	7.197	.009
	Within Groups	79685.796	12	6640.483		
	Total	175273.958	14			
Th	Between Groups	48.460	2	24.230	19.489	.000
	Within Groups	14.919	12	1.243		
	Total	63.379	14			

Appendix 8.8.17: ANOVA Output for Reduced Element Set - London, October, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
V	Between Groups	402998943.333	2	201499471.667	31.595	.000
	Within Groups	76531966.400	12	6377663.867		
	Total	479530909.733	14			
Co	Between Groups	30514692.229	2	15257346.115	59.262	.000
	Within Groups	3089451.728	12	257454.311		
	Total	33604143.957	14			
Cu	Between Groups	320076306.629	2	160038153.315	31.749	.000
	Within Groups	60488687.920	12	5040723.993		
	Total	380564994.549	14			
Sr	Between Groups	56658095.508	2	28329047.754	80.726	.000
	Within Groups	4211153.256	12	350929.438		
	Total	60869248.764	14			
Y	Between Groups	307403544.112	2	153701772.056	43.114	.000
	Within Groups	42780208.112	12	3565017.343		
	Total	350183752.224	14			
Nb	Between Groups	5905803.029	2	2952901.515	11.245	.002
	Within Groups	3151167.904	12	262597.325		
	Total	9056970.933	14			
La	Between Groups	360942865.733	2	180471432.867	25.592	.000
	Within Groups	84622800.000	12	7051900.000		
	Total	445565665.733	14			
Ce	Between Groups	1677074678.533	2	838537339.267	24.735	.000
	Within Groups	406804061.200	12	33900338.433		
	Total	2083878739.733	14			
Pr	Between Groups	35578238.485	2	17789119.243	22.506	.000
	Within Groups	9484929.072	12	790410.756		
	Total	45063167.557	14			
Nd	Between Groups	19412143.504	2	9706071.752	22.065	.000
	Within Groups	5278575.600	12	439881.300		
	Total	24690719.104	14			
Sm	Between Groups	298265.237	2	149132.619	8.288	.005
	Within Groups	215916.112	12	17993.009		
	Total	514181.349	14			
Eu	Between Groups	326464.485	2	163232.243	8.998	.004
	Within Groups	217693.904	12	18141.159		
	Total	544158.389	14			
Gd	Between Groups	538466.512	2	269233.256	14.290	.001
	Within Groups	226088.672	12	18840.723		
	Total	764555.184	14			
Tb	Between Groups	428176.128	2	214088.064	9.977	.003
	Within Groups	257506.288	12	21458.857		
	Total	685682.416	14			
Dy	Between Groups	1043945.541	2	521972.771	15.574	.000
	Within Groups	402186.032	12	33515.503		
	Total	1446131.573	14			
Ho	Between Groups	557866.021	2	278933.011	14.713	.001
	Within Groups	227493.632	12	18957.803		
	Total	785359.653	14			
Er	Between Groups	451614.869	2	225807.435	11.592	.002
	Within Groups	233754.448	12	19479.537		
	Total	685369.317	14			
U	Between Groups	1150200.677	2	575100.339	9.731	.003
	Within Groups	709202.160	12	59100.180		
	Total	1859402.837	14			

Appendix 8.8.18: ANOVA Output for Reduced Element Set - London, January, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
V	Between Groups	248855200.533	2	124427600.267	18.676	.000
	Within Groups	79947896.800	12	6662324.733		
	Total	328803097.333	14			
Co	Between Groups	42748017.168	2	21374008.584	94.953	.000
	Within Groups	2701205.328	12	225100.444		
	Total	45449222.496	14			
Cu	Between Groups	397503389.248	2	198751694.624	36.523	.000
	Within Groups	65302279.888	12	5441856.657		
	Total	462805669.136	14			
Sr	Between Groups	58503588.604	2	29251794.302	178.515	.000
	Within Groups	1966346.732	12	163862.228		
	Total	60469935.336	14			
Y	Between Groups	334713697.605	2	167356848.803	52.270	.000
	Within Groups	38421638.432	12	3201803.203		
	Total	373135336.037	14			
Nb	Between Groups	12146612.501	2	6073306.251	11.938	.001
	Within Groups	6104701.488	12	508725.124		
	Total	18251313.989	14			
La	Between Groups	391465080.400	2	195732540.200	21.606	.000
	Within Groups	108710324.000	12	9059193.667		
	Total	500175404.400	14			
Ce	Between Groups	1693031621.200	2	846515810.600	19.940	.000
	Within Groups	509436232.400	12	42453019.367		
	Total	2202467853.600	14			
Pr	Between Groups	45549550.725	2	22774775.363	26.812	.000
	Within Groups	10193074.848	12	849422.904		
	Total	55742625.573	14			
Nd	Between Groups	26649999.957	2	13324999.979	32.179	.000
	Within Groups	4969054.240	12	414087.853		
	Total	31619054.197	14			
Sm	Between Groups	1674192.357	2	837096.179	57.721	.000
	Within Groups	174028.752	12	14502.396		
	Total	1848221.109	14			
Eu	Between Groups	1575540.549	2	787770.275	81.008	.000
	Within Groups	116694.464	12	9724.539		
	Total	1692235.013	14			
Gd	Between Groups	2144989.765	2	1072494.883	63.024	.000
	Within Groups	204207.712	12	17017.309		
	Total	2349197.477	14			
Tb	Between Groups	1875045.648	2	937522.824	74.341	.000
	Within Groups	151333.136	12	12611.095		
	Total	2026378.784	14			
Dy	Between Groups	3307039.877	2	1653519.939	58.755	.000
	Within Groups	337712.752	12	28142.729		
	Total	3644752.629	14			
Ho	Between Groups	2310005.488	2	1155002.744	59.233	.000
	Within Groups	233990.016	12	19499.168		
	Total	2543995.504	14			
Er	Between Groups	2097254.757	2	1048627.379	68.779	.000
	Within Groups	182956.832	12	15246.403		
	Total	2280211.589	14			
U	Between Groups	3303842.965	2	1651921.483	14.537	.001
	Within Groups	1363604.144	12	113633.679		
	Total	4667447.109	14			

Appendix 8.8.19: ANOVA Output for Reduced Element Set - London, April, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
V	Between Groups	506439827.200	2	253219913.600	16.974	.000
	Within Groups	179017158.400	12	14918096.533		
	Total	685456985.600	14			
Co	Between Groups	45875174.805	2	22937587.403	26.757	.000
	Within Groups	10287131.024	12	857260.919		
	Total	56162305.829	14			
Cu	Between Groups	483584169.168	2	241792084.584	14.969	.001
	Within Groups	193837289.056	12	16153107.421		
	Total	677421458.224	14			
Sr	Between Groups	122364025.057	2	61182012.529	59.946	.000
	Within Groups	12247333.012	12	1020611.084		
	Total	134611358.069	14			
Y	Between Groups	285513242.005	2	142756621.003	17.079	.000
	Within Groups	100305794.512	12	8358816.209		
	Total	385819036.517	14			
Nb	Between Groups	10556818.309	2	5278409.155	15.626	.000
	Within Groups	4053596.608	12	337799.717		
	Total	14610414.917	14			
La	Between Groups	224599182.400	2	112299591.200	7.607	.007
	Within Groups	177153709.200	12	14762809.100		
	Total	401752891.600	14			
Ce	Between Groups	1030403882.800	2	515201941.400	7.099	.009
	Within Groups	870840960.800	12	72570080.067		
	Total	1901244843.600	14			
Pr	Between Groups	27480735.664	2	13740367.832	8.469	.005
	Within Groups	19468951.280	12	1622412.607		
	Total	46949686.944	14			
Nd	Between Groups	17165877.808	2	8582938.904	8.924	.004
	Within Groups	11541699.008	12	961808.251		
	Total	28707576.816	14			
Sm	Between Groups	775203.781	2	387601.891	7.177	.009
	Within Groups	648103.568	12	54008.631		
	Total	1423307.349	14			
Eu	Between Groups	819341.488	2	409670.744	8.123	.006
	Within Groups	605180.032	12	50431.669		
	Total	1424521.520	14			
Gd	Between Groups	1130372.421	2	565186.211	7.942	.006
	Within Groups	853984.176	12	71165.348		
	Total	1984356.597	14			
Tb	Between Groups	1011577.669	2	505788.835	7.285	.008
	Within Groups	833126.528	12	69427.211		
	Total	1844704.197	14			
Dy	Between Groups	2062725.712	2	1031362.856	9.584	.003
	Within Groups	1291395.872	12	107616.323		
	Total	3354121.584	14			
Ho	Between Groups	1250794.757	2	625397.379	8.985	.004
	Within Groups	835260.400	12	69605.033		
	Total	2086055.157	14			
Er	Between Groups	1030003.589	2	515001.795	8.245	.006
	Within Groups	749508.208	12	62459.017		
	Total	1779511.797	14			
U	Between Groups	1398698.128	2	699349.064	4.190	.042
	Within Groups	2003134.848	12	166927.904		
	Total	3401832.976	14			

Appendix 8.8.20: ANOVA Output for Reduced Element Set - London, July, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
V	Between Groups	435046133.733	2	217523066.867	34.529	.000
	Within Groups	75596596.000	12	6299716.333		
	Total	510642729.733	14			
Co	Between Groups	40971850.672	2	20485925.336	100.043	.000
	Within Groups	2457266.064	12	204772.172		
	Total	43429116.736	14			
Cu	Between Groups	364322552.965	2	182161276.483	19.431	.000
	Within Groups	112497875.552	12	9374822.963		
	Total	476820428.517	14			
Sr	Between Groups	139611047.232	2	69805523.616	34.377	.000
	Within Groups	24367298.584	12	2030608.215		
	Total	163978345.816	14			
Y	Between Groups	339936948.933	2	169968474.467	54.447	.000
	Within Groups	37460713.120	12	3121726.093		
	Total	377397662.053	14			
Nb	Between Groups	8431796.016	2	4215898.008	10.554	.002
	Within Groups	4793446.304	12	399453.859		
	Total	13225242.320	14			
La	Between Groups	390852230.533	2	195426115.267	20.243	.000
	Within Groups	115845642.400	12	9653803.533		
	Total	506697872.933	14			
Ce	Between Groups	1744622600.533	2	872311300.267	20.254	.000
	Within Groups	516810674.800	12	43067556.233		
	Total	2261433275.333	14			
Pr	Between Groups	44939420.272	2	22469710.136	25.539	.000
	Within Groups	10557962.192	12	879830.183		
	Total	55497382.464	14			
Nd	Between Groups	26580552.869	2	13290276.435	28.411	.000
	Within Groups	5613376.720	12	467781.393		
	Total	32193929.589	14			
Sm	Between Groups	1208896.624	2	604448.312	37.903	.000
	Within Groups	191366.816	12	15947.235		
	Total	1400263.440	14			
Eu	Between Groups	1220565.168	2	610282.584	54.173	.000
	Within Groups	135185.328	12	11265.444		
	Total	1355750.496	14			
Gd	Between Groups	1861197.285	2	930598.643	48.936	.000
	Within Groups	228200.912	12	19016.743		
	Total	2089398.197	14			
Tb	Between Groups	1556637.733	2	778318.867	58.407	.000
	Within Groups	159910.320	12	13325.860		
	Total	1716548.053	14			
Dy	Between Groups	2918397.077	2	1459198.539	52.233	.000
	Within Groups	335238.720	12	27936.560		
	Total	3253635.797	14			
Ho	Between Groups	1862117.824	2	931058.912	51.253	.000
	Within Groups	217989.952	12	18165.829		
	Total	2080107.776	14			
Er	Between Groups	1720752.133	2	860376.067	56.200	.000
	Within Groups	183711.824	12	15309.319		
	Total	1904463.957	14			
U	Between Groups	2379717.669	2	1189858.835	12.167	.001
	Within Groups	1173489.344	12	97790.779		
	Total	3553207.013	14			

Appendix 8.8.21: ANOVA Output for Reduced Element Set - London, October, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	4362.516	2	2181.258	87.038	.000
	Within Groups	300.732	12	25.061		
	Total	4663.248	14			
Be	Between Groups	.000	2	.000	18.605	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2445.754	2	1222.877	59.883	.000
	Within Groups	245.052	12	20.421		
	Total	2690.806	14			
Mg	Between Groups	96.243	2	48.121	72.893	.000
	Within Groups	7.922	12	.660		
	Total	104.165	14			
Mn	Between Groups	1.364	2	.682	5.836	.017
	Within Groups	1.402	12	.117		
	Total	2.765	14			
Ni	Between Groups	.031	2	.015	27.335	.000
	Within Groups	.007	12	.001		
	Total	.037	14			
P	Between Groups	5.316	2	2.658	32.072	.000
	Within Groups	.995	12	.083		
	Total	6.311	14			
Ti	Between Groups	49.215	2	24.607	26.552	.000
	Within Groups	11.121	12	.927		
	Total	60.336	14			
Zn	Between Groups	.004	2	.002	9.357	.004
	Within Groups	.002	12	.000		
	Total	.006	14			

Appendix 8.8.22: ANOVA Output for Reduced Element Set - London, January, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3485.061	2	1742.530	31.806	.000
	Within Groups	657.431	12	54.786		
	Total	4142.491	14			
Be	Between Groups	.000	2	.000	59.671	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2281.633	2	1140.817	50.142	.000
	Within Groups	273.023	12	22.752		
	Total	2554.656	14			
Mg	Between Groups	76.636	2	38.318	51.206	.000
	Within Groups	8.980	12	.748		
	Total	85.615	14			
Mn	Between Groups	2.121	2	1.061	23.429	.000
	Within Groups	.543	12	.045		
	Total	2.665	14			
Ni	Between Groups	.025	2	.013	34.598	.000
	Within Groups	.004	12	.000		
	Total	.029	14			
P	Between Groups	8.752	2	4.376	66.412	.000
	Within Groups	.791	12	.066		
	Total	9.543	14			
Ti	Between Groups	56.913	2	28.456	11.991	.001
	Within Groups	28.478	12	2.373		
	Total	85.391	14			
Zn	Between Groups	.006	2	.003	19.351	.000
	Within Groups	.002	12	.000		
	Total	.009	14			

Appendix 8.8.23: : ANOVA Output for Reduced Element Set - London, April, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	4318.998	2	2159.499	16.543	.000
	Within Groups	1566.417	12	130.535		
	Total	5885.415	14			
Be	Between Groups	.000	2	.000	21.831	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2637.999	2	1319.000	59.741	.000
	Within Groups	264.945	12	22.079		
	Total	2902.944	14			
Mg	Between Groups	184.169	2	92.085	12.418	.001
	Within Groups	88.983	12	7.415		
	Total	273.153	14			
Mn	Between Groups	2.103	2	1.052	11.526	.002
	Within Groups	1.095	12	.091		
	Total	3.198	14			
Ni	Between Groups	.029	2	.014	37.212	.000
	Within Groups	.005	12	.000		
	Total	.033	14			
P	Between Groups	6.755	2	3.378	34.587	.000
	Within Groups	1.172	12	.098		
	Total	7.927	14			
Ti	Between Groups	40.624	2	20.312	25.628	.000
	Within Groups	9.511	12	.793		
	Total	50.134	14			
Zn	Between Groups	.005	2	.003	13.970	.001
	Within Groups	.002	12	.000		
	Total	.008	14			

Appendix 8.8.24: ANOVA Output for Reduced Element Set - London, July, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	6809.953	2	3404.977	34.242	34.242
	Within Groups	1193.251	12	99.438		
	Total	8003.204	14			
Be	Between Groups	.000	2	.000	23.536	23.536
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	3351.214	2	1675.607	138.307	138.307
	Within Groups	145.381	12	12.115		
	Total	3496.595	14			
Mg	Between Groups	255.101	2	127.551	18.929	18.929
	Within Groups	80.861	12	6.738		
	Total	335.962	14			
Mn	Between Groups	1.857	2	.929	6.780	6.780
	Within Groups	1.644	12	.137		
	Total	3.501	14			
Ni	Between Groups	.035	2	.018	22.985	22.985
	Within Groups	.009	12	.001		
	Total	.045	14			
P	Between Groups	7.969	2	3.984	17.095	17.095
	Within Groups	2.797	12	.233		
	Total	10.765	14			
Ti	Between Groups	29.351	2	14.675	13.994	13.994
	Within Groups	12.584	12	1.049		
	Total	41.935	14			
Zn	Between Groups	.006	2	.003	10.898	10.898
	Within Groups	.003	12	.000		
	Total	.009	14			

Appendix 88.25: ANOVA Output for Common Reduced Elements - Nottingham, October, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	19062937.763	2	9531468.881	33.370	.000
	Within Groups	3427555.552	12	285629.629		
	Total	22490493.315	14			
Al	Between Groups	227630739.224	2	113815369.612	33.620	.000
	Within Groups	40624435.536	12	3385369.628		
	Total	268255174.761	14			
Si	Between Groups	576147111.972	2	288073555.986	5.107	.025
	Within Groups	676901333.831	12	56408444.486		
	Total	1253048445.802	14			
P	Between Groups	1502296.948	2	751148.474	11.507	.002
	Within Groups	783299.245	12	65274.937		
	Total	2285596.192	14			
Ca	Between Groups	183241538.108	2	91620769.054	12.911	.001
	Within Groups	85156901.177	12	7096408.431		
	Total	268398439.285	14			
Fe	Between Groups	53374019.304	2	26687009.652	72.368	.000
	Within Groups	4425240.015	12	368770.001		
	Total	57799259.319	14			
Zn	Between Groups	2271.443	2	1135.722	11.663	.002
	Within Groups	1168.575	12	97.381		
	Total	3440.018	14			
Ga	Between Groups	6.710	2	3.355	7.636	.007
	Within Groups	5.272	12	.439		
	Total	11.982	14			
Rb	Between Groups	393.160	2	196.580	22.831	.000
	Within Groups	103.324	12	8.610		
	Total	496.485	14			
Sr	Between Groups	754.016	2	377.008	32.716	.000
	Within Groups	138.285	12	11.524		
	Total	892.301	14			
Y	Between Groups	15.640	2	7.820	6.603	.012
	Within Groups	14.212	12	1.184		
	Total	29.853	14			
Pb	Between Groups	3166.870	2	1583.435	9.249	.004
	Within Groups	2054.436	12	171.203		
	Total	5221.306	14			

Appendix 88.26: ANOVA Output for Common Reduced Elements - Nottingham, January, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	27295094.803	2	13647547.401	15.414	.000
	Within Groups	10624475.554	12	885372.963		
	Total	37919570.357	14			
Al	Between Groups	330547183.486	2	165273591.743	25.216	.000
	Within Groups	78651879.971	12	6554323.331		
	Total	409199063.457	14			
Si	Between Groups	7813288539.541	2	3906644269.771	78.623	.000
	Within Groups	596259031.286	12	49688252.607		
	Total	8409547570.828	14			
P	Between Groups	740761.969	2	370380.985	21.685	.000
	Within Groups	204957.517	12	17079.793		
	Total	945719.486	14			
Ca	Between Groups	82833747.385	2	41416873.692	6.787	.011
	Within Groups	73224080.608	12	6102006.717		
	Total	156057827.993	14			
Fe	Between Groups	81582748.257	2	40791374.128	17.941	.000
	Within Groups	27284354.278	12	2273696.190		
	Total	108867102.535	14			
Zn	Between Groups	3784.203	2	1892.102	13.090	.001
	Within Groups	1734.495	12	144.541		
	Total	5518.698	14			
Ga	Between Groups	25.560	2	12.780	26.996	.000
	Within Groups	5.681	12	.473		
	Total	31.241	14			
Rb	Between Groups	939.205	2	469.602	20.638	.000
	Within Groups	273.052	12	22.754		
	Total	1212.257	14			
Sr	Between Groups	1524.216	2	762.108	27.546	.000
	Within Groups	331.996	12	27.666		
	Total	1856.212	14			
Y	Between Groups	136.404	2	68.202	36.959	.000
	Within Groups	22.144	12	1.845		
	Total	158.548	14			
Pb	Between Groups	3931.094	2	1965.547	14.036	.001
	Within Groups	1680.404	12	140.034		
	Total	5611.498	14			

Appendix 8.8.27: ANOVA Output for Common Reduced Elements - Nottingham, April, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	49528534.910	2	24764267.455	63.381	.000
	Within Groups	4688683.125	12	390723.594		
	Total	54217218.034	14			
Al	Between Groups	438979302.849	2	219489651.424	82.200	.000
	Within Groups	32042190.271	12	2670182.523		
	Total	471021493.120	14			
Si	Between Groups	2534091408.030	2	1267045704.015	77.574	.000
	Within Groups	196001428.667	12	16333452.389		
	Total	2730092836.696	14			
P	Between Groups	2890525.574	2	1445262.787	31.937	.000
	Within Groups	543049.186	12	45254.099		
	Total	3433574.760	14			
Ca	Between Groups	125397337.747	2	62698668.873	10.308	.002
	Within Groups	72989573.170	12	6082464.431		
	Total	198386910.917	14			
Fe	Between Groups	77833854.074	2	38916927.037	34.330	.000
	Within Groups	13603234.907	12	1133602.909		
	Total	91437088.981	14			
Zn	Between Groups	2505.780	2	1252.890	37.103	.000
	Within Groups	405.210	12	33.767		
	Total	2910.989	14			
Ga	Between Groups	14.152	2	7.076	26.672	.000
	Within Groups	3.184	12	.265		
	Total	17.336	14			
Rb	Between Groups	565.348	2	282.674	31.991	.000
	Within Groups	106.032	12	8.836		
	Total	671.380	14			
Sr	Between Groups	302.233	2	151.116	4.339	.038
	Within Groups	417.919	12	34.827		
	Total	720.152	14			
Y	Between Groups	53.771	2	26.886	48.973	.000
	Within Groups	6.588	12	.549		
	Total	60.359	14			
Pb	Between Groups	8023.574	2	4011.787	22.304	.000
	Within Groups	2158.411	12	179.868		
	Total	10181.985	14			

Appendix 8.8.28: ANOVA Output for Common Reduced Elements - Nottingham, July, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	21476226.492	2	10738113.246	15.272	.001
	Within Groups	8437215.760	12	703101.313		
	Total	29913442.252	14			
Al	Between Groups	274195973.834	2	137097986.917	17.022	.000
	Within Groups	96651425.707	12	8054285.476		
	Total	370847399.541	14			
Si	Between Groups	1395040725.985	2	697520362.993	11.264	.002
	Within Groups	743089111.067	12	61924092.589		
	Total	2138129837.052	14			
P	Between Groups	1703267.159	2	851633.580	19.298	.000
	Within Groups	529576.713	12	44131.393		
	Total	2232843.872	14			
Ca	Between Groups	181457622.439	2	90728811.219	9.914	.003
	Within Groups	109823765.251	12	9151980.438		
	Total	291281387.690	14			
Fe	Between Groups	42777296.142	2	21388648.071	18.603	.000
	Within Groups	13797067.080	12	1149755.590		
	Total	56574363.222	14			
Zn	Between Groups	2561.232	2	1280.616	25.328	.000
	Within Groups	606.737	12	50.561		
	Total	3167.969	14			
Ga	Between Groups	9.921	2	4.961	9.346	.004
	Within Groups	6.369	12	.531		
	Total	16.290	14			
Rb	Between Groups	312.561	2	156.280	15.211	.001
	Within Groups	123.294	12	10.274		
	Total	435.854	14			
Sr	Between Groups	477.730	2	238.865	6.686	.011
	Within Groups	428.688	12	35.724		
	Total	906.418	14			
Y	Between Groups	30.821	2	15.410	18.565	.000
	Within Groups	9.961	12	.830		
	Total	40.782	14			
Pb	Between Groups	4309.437	2	2154.718	19.438	.000
	Within Groups	1330.222	12	110.852		
	Total	5639.659	14			

Appendix 8.8.29: ANOVA Output for Common Reduced Elements - Nottingham, October, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	315506.501	2	157753.251	7.081	.009
	Within Groups	267341.216	12	22278.435		
	Total	582847.717	14			
Eu	Between Groups	264390.400	2	132195.200	6.611	.012
	Within Groups	239937.424	12	19994.785		
	Total	504327.824	14			
Gd	Between Groups	283664.149	2	141832.075	6.275	.014
	Within Groups	271244.288	12	22603.691		
	Total	554908.437	14			
Tb	Between Groups	296529.557	2	148264.779	7.337	.008
	Within Groups	242491.600	12	20207.633		
	Total	539021.157	14			
Dy	Between Groups	351440.469	2	175720.235	7.084	.009
	Within Groups	297650.400	12	24804.200		
	Total	649090.869	14			
Ho	Between Groups	322696.336	2	161348.168	8.485	.005
	Within Groups	228196.048	12	19016.337		
	Total	550892.384	14			
Er	Between Groups	258047.429	2	129023.715	5.893	.016
	Within Groups	262734.448	12	21894.537		
	Total	520781.877	14			
U	Between Groups	2201463.077	2	1100731.539	4.165	.042
	Within Groups	3171357.072	12	264279.756		
	Total	5372820.149	14			

Appendix 8.8.30: ANOVA Output for Common Reduced Elements - Nottingham, January, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	262440.901	2	131220.451	9.807	.003
	Within Groups	160560.928	12	13380.077		
	Total	423001.829	14			
Eu	Between Groups	189527.376	2	94763.688	6.489	.012
	Within Groups	175247.040	12	14603.920		
	Total	364774.416	14			
Gd	Between Groups	225660.437	2	112830.219	6.476	.012
	Within Groups	209073.680	12	17422.807		
	Total	434734.117	14			
Tb	Between Groups	287231.685	2	143615.843	8.327	.005
	Within Groups	206972.032	12	17247.669		
	Total	494203.717	14			
Dy	Between Groups	202812.549	2	101406.275	4.592	.033
	Within Groups	265018.128	12	22084.844		
	Total	467830.677	14			
Ho	Between Groups	246508.485	2	123254.243	7.039	.009
	Within Groups	210110.704	12	17509.225		
	Total	456619.189	14			
Er	Between Groups	294415.125	2	147207.563	9.478	.003
	Within Groups	186375.472	12	15531.289		
	Total	480790.597	14			
U	Between Groups	598328.229	2	299164.115	5.134	.024
	Within Groups	699283.680	12	58273.640		
	Total	1297611.909	14			

Appendix 8.8.31: ANOVA Output for Common Reduced Elements - Nottingham, April, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	144878.224	2	72439.112	18.327	.000
	Within Groups	47431.120	12	3952.593		
	Total	192309.344	14			
Eu	Between Groups	93330.789	2	46665.395	21.796	.000
	Within Groups	25691.504	12	2140.959		
	Total	119022.293	14			
Gd	Between Groups	147080.005	2	73540.003	18.989	.000
	Within Groups	46474.064	12	3872.839		
	Total	193554.069	14			
Tb	Between Groups	108088.752	2	54044.376	22.534	.000
	Within Groups	28780.704	12	2398.392		
	Total	136869.456	14			
Dy	Between Groups	167788.848	2	83894.424	18.271	.000
	Within Groups	55099.392	12	4591.616		
	Total	222888.240	14			
Ho	Between Groups	138971.941	2	69485.971	27.271	.000
	Within Groups	30575.232	12	2547.936		
	Total	169547.173	14			
Er	Between Groups	134997.269	2	67498.635	29.591	.000
	Within Groups	27372.240	12	2281.020		
	Total	162369.509	14			
U	Between Groups	805164.485	2	402582.243	15.612	.000
	Within Groups	309443.072	12	25786.923		
	Total	1114607.557	14			

Appendix 8.8.32: ANOVA Output for Common Reduced Elements - Nottingham, July, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	102473.424	2	51236.712	6.176	.014
	Within Groups	99557.120	12	8296.427		
	Total	202030.544	14			
Eu	Between Groups	93142.037	2	46571.019	6.425	.013
	Within Groups	86979.840	12	7248.320		
	Total	180121.877	14			
Gd	Between Groups	99205.525	2	49602.763	6.800	.011
	Within Groups	87534.592	12	7294.549		
	Total	186740.117	14			
Tb	Between Groups	80158.229	2	40079.115	4.891	.028
	Within Groups	98326.128	12	8193.844		
	Total	178484.357	14			
Dy	Between Groups	148179.605	2	74089.803	6.913	.010
	Within Groups	128600.704	12	10716.725		
	Total	276780.309	14			
Ho	Between Groups	75319.216	2	37659.608	4.368	.038
	Within Groups	103454.880	12	8621.240		
	Total	178774.096	14			
Er	Between Groups	99186.021	2	49593.011	4.742	.030
	Within Groups	125497.536	12	10458.128		
	Total	224683.557	14			
U	Between Groups	787758.405	2	393879.203	16.414	.000
	Within Groups	287956.384	12	23996.365		
	Total	1075714.789	14			

Appendix 8.8.33: ANOVA Output for Common Reduced Elements - Nottingham, October, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	1672393201.200	2	836196600.600	24.663	.000
	Within Groups	406863030.800	12	33905252.567		
	Total	2079256232.000	14			
Be	Between Groups	18604.312	2	9302.156	3.616	.059
	Within Groups	30865.990	12	2572.166		
	Total	49470.302	14			
Fe	Between Groups	1494012000.133	2	747006000.067	33.429	.000
	Within Groups	268153429.200	12	22346119.100		
	Total	1762165429.333	14			
Mn	Between Groups	6881270.539	2	3440635.270	2.687	.109
	Within Groups	15363617.291	12	1280301.441		
	Total	22244887.830	14			
Ni	Between Groups	743.913	2	371.956	5.332	.022
	Within Groups	837.177	12	69.765		
	Total	1581.090	14			
P	Between Groups	1432351.721	2	716175.861	10.157	.003
	Within Groups	846110.617	12	70509.218		
	Total	2278462.339	14			
Ti	Between Groups	511884.620	2	255942.310	17.385	.000
	Within Groups	176662.519	12	14721.877		
	Total	688547.139	14			

Appendix 8.8.34: ANOVA Output for Common Reduced Elements - Nottingham, January, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	2010808890.133	2	1005404445.067	15.332	.000
	Within Groups	786891983.600	12	65574331.967		
	Total	2797700873.733	14			
Be	Between Groups	126115.260	2	63057.630	19.036	.000
	Within Groups	39751.193	12	3312.599		
	Total	165866.453	14			
Fe	Between Groups	3789776100.933	2	1894888050.467	81.620	.000
	Within Groups	278591918.800	12	23215993.233		
	Total	4068368019.733	14			
Mn	Between Groups	8358731.474	2	4179365.737	4.110	.044
	Within Groups	12201531.038	12	1016794.253		
	Total	20560262.512	14			
Ni	Between Groups	3127.026	2	1563.513	27.160	.000
	Within Groups	690.801	12	57.567		
	Total	3817.826	14			
P	Between Groups	869809.229	2	434904.615	19.557	.000
	Within Groups	266847.895	12	22237.325		
	Total	1136657.125	14			
Ti	Between Groups	290312.406	2	145156.203	3.216	.076
	Within Groups	541656.041	12	45138.003		
	Total	831968.447	14			

Appendix 8.8.35: ANOVA Output for Common Reduced Elements - Nottingham, April, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3515156441.733	2	1757578220.867	45.902	.000
	Within Groups	459479297.200	12	38289941.433		
	Total	3974635738.933	14			
Be	Between Groups	40534.183	2	20267.091	4.483	.035
	Within Groups	54252.891	12	4521.074		
	Total	94787.074	14			
Fe	Between Groups	2223873856.533	2	1111936928.267	37.842	.000
	Within Groups	352601290.400	12	29383440.867		
	Total	2576475146.933	14			
Mn	Between Groups	57122653.744	2	28561326.872	5.614	.019
	Within Groups	61054353.920	12	5087862.827		
	Total	118177007.664	14			
Ni	Between Groups	677.822	2	338.911	7.723	.007
	Within Groups	526.589	12	43.882		
	Total	1204.412	14			
P	Between Groups	3213824.789	2	1606912.395	37.806	.000
	Within Groups	510045.612	12	42503.801		
	Total	3723870.401	14			
Ti	Between Groups	1069180.255	2	534590.128	57.271	.000
	Within Groups	112013.173	12	9334.431		
	Total	1181193.428	14			

Appendix 8.8.36: ANOVA Output for Common Reduced Elements - Nottingham, July, ICP-AESS

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3457498022.533	2	1728749011.267	29.346	.000
	Within Groups	706901847.200	12	58908487.267		
	Total	4164399869.733	14			
Be	Between Groups	41434.581	2	20717.290	10.338	.002
	Within Groups	24048.257	12	2004.021		
	Total	65482.838	14			
Fe	Between Groups	1854196563.333	2	927098281.667	23.909	.000
	Within Groups	465320759.600	12	38776729.967		
	Total	2319517322.933	14			
Mn	Between Groups	30837663.316	2	15418831.658	6.003	.016
	Within Groups	30820063.400	12	2568338.617		
	Total	61657726.716	14			
Ni	Between Groups	1614.602	2	807.301	13.573	.001
	Within Groups	713.722	12	59.477		
	Total	2328.324	14			
P	Between Groups	2249474.583	2	1124737.292	40.636	.000
	Within Groups	332142.162	12	27678.513		
	Total	2581616.745	14			
Ti	Between Groups	1333913.410	2	666956.705	35.424	.000
	Within Groups	225933.288	12	18827.774		
	Total	1559846.698	14			

Appendix 88.37: ANOVA Output for Common Reduced Elements - London, October, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	33372991.109	2	16686495.554	41.399	.000
	Within Groups	4836808.891	12	403067.408		
	Total	38209799.999	14			
Al	Between Groups	1370733013.156	2	685366506.578	200.633	.000
	Within Groups	40992315.611	12	3416026.301		
	Total	1411725328.767	14			
Si	Between Groups	6067673035.989	2	3033836517.995	11.188	.002
	Within Groups	3254112442.746	12	271176036.896		
	Total	9321785478.735	14			
P	Between Groups	1663871.512	2	831935.756	26.469	.000
	Within Groups	377164.267	12	31430.356		
	Total	2041035.779	14			
Ca	Between Groups	2081803460.121	2	1040901730.060	178.992	.000
	Within Groups	69784423.090	12	5815368.591		
	Total	2151587883.211	14			
Fe	Between Groups	574358001.678	2	287179000.839	108.261	.000
	Within Groups	31831924.476	12	2652660.373		
	Total	606189926.155	14			
Zn	Between Groups	76389.997	2	38194.998	3.749	.054
	Within Groups	122244.614	12	10187.051		
	Total	198634.611	14			
Ga	Between Groups	13.553	2	6.777	14.415	.001
	Within Groups	5.641	12	.470		
	Total	19.194	14			
Rb	Between Groups	290.354	2	145.177	16.504	.000
	Within Groups	105.558	12	8.796		
	Total	395.912	14			
Sr	Between Groups	17433.136	2	8716.568	179.533	.000
	Within Groups	582.617	12	48.551		
	Total	18015.753	14			
Y	Between Groups	626.278	2	313.139	58.743	.000
	Within Groups	63.968	12	5.331		
	Total	690.246	14			
Pb	Between Groups	96463.525	2	48231.762	9.632	.003
	Within Groups	60087.526	12	5007.294		
	Total	156551.051	14			

Appendix 88.38: ANOVA Output for Common Reduced Elements - London, January, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	12827364.444	2	6413682.222	45.162	.000
	Within Groups	1704191.111	12	142015.926		
	Total	14531555.555	14			
Al	Between Groups	808756076.969	2	404378038.485	60.543	.000
	Within Groups	80150386.619	12	6679198.885		
	Total	888906463.588	14			
Si	Between Groups	7750856442.973	2	3875428221.486	10.391	.002
	Within Groups	4475687993.456	12	372973999.455		
	Total	12226544436.429	14			
P	Between Groups	2473397.884	2	1236698.942	37.182	.000
	Within Groups	399125.644	12	33260.470		
	Total	2872523.528	14			
Ca	Between Groups	1833958966.895	2	916979483.448	412.887	.000
	Within Groups	26650741.325	12	2220895.110		
	Total	1860609708.220	14			
Fe	Between Groups	585045085.980	2	292522542.990	71.068	.000
	Within Groups	49392968.861	12	4116080.738		
	Total	634438054.840	14			
Zn	Between Groups	178745.986	2	89372.993	26.283	.000
	Within Groups	40804.469	12	3400.372		
	Total	219550.455	14			
Ga	Between Groups	14.409	2	7.205	8.014	.006
	Within Groups	10.788	12	.899		
	Total	25.197	14			
Rb	Between Groups	368.404	2	184.202	8.494	.005
	Within Groups	260.247	12	21.687		
	Total	628.650	14			
Sr	Between Groups	17894.963	2	8947.481	244.178	.000
	Within Groups	439.719	12	36.643		
	Total	18334.682	14			
Y	Between Groups	617.916	2	308.958	64.569	.000
	Within Groups	57.419	12	4.785		
	Total	675.334	14			
Pb	Between Groups	121963.572	2	60981.786	26.290	.000
	Within Groups	27834.461	12	2319.538		
	Total	149798.033	14			

Appendix 8.8.39: ANOVA Output for Common Reduced Elements - London, April, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	29524403.674	2	14762201.837	5.562	.020
	Within Groups	31847420.520	12	2653951.710		
	Total	61371824.194	14			
Al	Between Groups	832470352.062	2	416235176.031	15.303	.000
	Within Groups	326400837.045	12	27200069.754		
	Total	1158871189.107	14			
Si	Between Groups	3852921436.030	2	1926460718.015	2.161	.158
	Within Groups	10698893802.845	12	891574483.570		
	Total	14551815238.874	14			
P	Between Groups	24094.154	2	12047.077	.164	.851
	Within Groups	883528.036	12	73627.336		
	Total	907622.190	14			
Ca	Between Groups	1210721872.133	2	605360936.066	7.807	.007
	Within Groups	930498595.965	12	77541549.664		
	Total	2141220468.098	14			
Fe	Between Groups	310796599.354	2	155398299.677	6.966	.010
	Within Groups	267699949.613	12	22308329.134		
	Total	578496548.967	14			
Zn	Between Groups	87696.278	2	43848.139	4.860	.028
	Within Groups	108261.116	12	9021.760		
	Total	195957.393	14			
Ga	Between Groups	19.968	2	9.984	5.638	.019
	Within Groups	21.252	12	1.771		
	Total	41.220	14			
Rb	Between Groups	205.751	2	102.875	4.304	.039
	Within Groups	286.860	12	23.905		
	Total	492.611	14			
Sr	Between Groups	23111.514	2	11555.757	7.316	.008
	Within Groups	18955.410	12	1579.617		
	Total	42066.924	14			
Y	Between Groups	269.615	2	134.807	10.941	.002
	Within Groups	147.862	12	12.322		
	Total	417.477	14			
Pb	Between Groups	74513.756	2	37256.878	4.015	.046
	Within Groups	111362.774	12	9280.231		
	Total	185876.530	14			

Appendix 88.40: ANOVA Output for Common Reduced Elements - London, July, XRF

Element		Sum of Squares	df	Mean Square	F	Sig.
Mg	Between Groups	78081543.372	2	39040771.686	19.276	.000
	Within Groups	24304167.880	12	2025347.323		
	Total	102385711.252	14			
Al	Between Groups	1292835442.643	2	646417721.321	46.751	.000
	Within Groups	165921608.427	12	13826800.702		
	Total	1458757051.070	14			
Si	Between Groups	13362107671.141	2	6681053835.570	21.217	.000
	Within Groups	3778774917.511	12	314897909.793		
	Total	17140882588.652	14			
P	Between Groups	1369830.619	2	684915.310	10.347	.002
	Within Groups	794328.430	12	66194.036		
	Total	2164159.049	14			
Ca	Between Groups	2489049758.216	2	1244524879.108	406.781	.000
	Within Groups	36713346.116	12	3059445.510		
	Total	2525763104.331	14			
Fe	Between Groups	695916145.932	2	347958072.966	138.843	.000
	Within Groups	30073461.360	12	2506121.780		
	Total	725989607.292	14			
Zn	Between Groups	140381.922	2	70190.961	8.775	.004
	Within Groups	95983.681	12	7998.640		
	Total	236365.603	14			
Ga	Between Groups	17.848	2	8.924	5.307	.022
	Within Groups	20.178	12	1.681		
	Total	38.026	14			
Rb	Between Groups	298.895	2	149.448	14.814	.001
	Within Groups	121.058	12	10.088		
	Total	419.954	14			
Sr	Between Groups	41829.800	2	20914.900	48.079	.000
	Within Groups	5220.098	12	435.008		
	Total	47049.898	14			
Y	Between Groups	650.223	2	325.111	55.449	.000
	Within Groups	70.359	12	5.863		
	Total	720.582	14			
Pb	Between Groups	95588.162	2	47794.081	7.197	.009
	Within Groups	79685.796	12	6640.483		
	Total	175273.958	14			

Appendix 8.8.41: ANOVA Output for Common Reduced Elements - London, October, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	298265.237	2	149132.619	8.288	.005
	Within Groups	215916.112	12	17993.009		
	Total	514181.349	14			
Eu	Between Groups	326464.485	2	163232.243	8.998	.004
	Within Groups	217693.904	12	18141.159		
	Total	544158.389	14			
Gd	Between Groups	538466.512	2	269233.256	14.290	.001
	Within Groups	226088.672	12	18840.723		
	Total	764555.184	14			
Tb	Between Groups	428176.128	2	214088.064	9.977	.003
	Within Groups	257506.288	12	21458.857		
	Total	685682.416	14			
Dy	Between Groups	1043945.541	2	521972.771	15.574	.000
	Within Groups	402186.032	12	33515.503		
	Total	1446131.573	14			
Ho	Between Groups	557866.021	2	278933.011	14.713	.001
	Within Groups	227493.632	12	18957.803		
	Total	785359.653	14			
Er	Between Groups	451614.869	2	225807.435	11.592	.002
	Within Groups	233754.448	12	19479.537		
	Total	685369.317	14			
U	Between Groups	1150200.677	2	575100.339	9.731	.003
	Within Groups	709202.160	12	59100.180		
	Total	1859402.837	14			

Appendix 88.42: ANOVA Output for Common Reduced Elements - London, January, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	1674192.357	2	837096.179	57.721	.000
	Within Groups	174028.752	12	14502.396		
	Total	1848221.109	14			
Eu	Between Groups	1575540.549	2	787770.275	81.008	.000
	Within Groups	116694.464	12	9724.539		
	Total	1692235.013	14			
Gd	Between Groups	2144989.765	2	1072494.883	63.024	.000
	Within Groups	204207.712	12	17017.309		
	Total	2349197.477	14			
Tb	Between Groups	1875045.648	2	937522.824	74.341	.000
	Within Groups	151333.136	12	12611.095		
	Total	2026378.784	14			
Dy	Between Groups	3307039.877	2	1653519.939	58.755	.000
	Within Groups	337712.752	12	28142.729		
	Total	3644752.629	14			
Ho	Between Groups	2310005.488	2	1155002.744	59.233	.000
	Within Groups	233990.016	12	19499.168		
	Total	2543995.504	14			
Er	Between Groups	2097254.757	2	1048627.379	68.779	.000
	Within Groups	182956.832	12	15246.403		
	Total	2280211.589	14			
U	Between Groups	3303842.965	2	1651921.483	14.537	.001
	Within Groups	1363604.144	12	113633.679		
	Total	4667447.109	14			

Appendix 8.8.43: ANOVA Output for Common Reduced Elements - London, April, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	775203.781	2	387601.891	7.177	.009
	Within Groups	648103.568	12	54008.631		
	Total	1423307.349	14			
Eu	Between Groups	819341.488	2	409670.744	8.123	.006
	Within Groups	605180.032	12	50431.669		
	Total	1424521.520	14			
Gd	Between Groups	1130372.421	2	565186.211	7.942	.006
	Within Groups	853984.176	12	71165.348		
	Total	1984356.597	14			
Tb	Between Groups	1011577.669	2	505788.835	7.285	.008
	Within Groups	833126.528	12	69427.211		
	Total	1844704.197	14			
Dy	Between Groups	2062725.712	2	1031362.856	9.584	.003
	Within Groups	1291395.872	12	107616.323		
	Total	3354121.584	14			
Ho	Between Groups	1250794.757	2	625397.379	8.985	.004
	Within Groups	835260.400	12	69605.033		
	Total	2086055.157	14			
Er	Between Groups	1030003.589	2	515001.795	8.245	.006
	Within Groups	749508.208	12	62459.017		
	Total	1779511.797	14			
U	Between Groups	1398698.128	2	699349.064	4.190	.042
	Within Groups	2003134.848	12	166927.904		
	Total	3401832.976	14			

Appendix 8.8.44: ANOVA Output for Common Reduced Elements - London, July, ICP-MS

Element		Sum of Squares	df	Mean Square	F	Sig.
Sm	Between Groups	1208896.624	2	604448.312	37.903	.000
	Within Groups	191366.816	12	15947.235		
	Total	1400263.440	14			
Eu	Between Groups	1220565.168	2	610282.584	54.173	.000
	Within Groups	135185.328	12	11265.444		
	Total	1355750.496	14			
Gd	Between Groups	1861197.285	2	930598.643	48.936	.000
	Within Groups	228200.912	12	19016.743		
	Total	2089398.197	14			
Tb	Between Groups	1556637.733	2	778318.867	58.407	.000
	Within Groups	159910.320	12	13325.860		
	Total	1716548.053	14			
Dy	Between Groups	2918397.077	2	1459198.539	52.233	.000
	Within Groups	335238.720	12	27936.560		
	Total	3253635.797	14			
Ho	Between Groups	1862117.824	2	931058.912	51.253	.000
	Within Groups	217989.952	12	18165.829		
	Total	2080107.776	14			
Er	Between Groups	1720752.133	2	860376.067	56.200	.000
	Within Groups	183711.824	12	15309.319		
	Total	1904463.957	14			
U	Between Groups	2379717.669	2	1189858.835	12.167	.001
	Within Groups	1173489.344	12	97790.779		
	Total	3553207.013	14			

Appendix 8.8.45: ANOVA Output for Common Reduced Elements - London, October, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	4362.516	2	2181.258	87.038	.000
	Within Groups	300.732	12	25.061		
	Total	4663.248	14			
Be	Between Groups	.000	2	.000	18.605	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2445.754	2	1222.877	59.883	.000
	Within Groups	245.052	12	20.421		
	Total	2690.806	14			
Mn	Between Groups	1.364	2	.682	5.836	.017
	Within Groups	1.402	12	.117		
	Total	2.765	14			
Ni	Between Groups	.031	2	.015	27.335	.000
	Within Groups	.007	12	.001		
	Total	.037	14			
P	Between Groups	5.316	2	2.658	32.072	.000
	Within Groups	.995	12	.083		
	Total	6.311	14			
Ti	Between Groups	49.215	2	24.607	26.552	.000
	Within Groups	11.121	12	.927		
	Total	60.336	14			

Appendix 8.8.46: ANOVA Output for Common Reduced Elements - London, January, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	3485.061	2	1742.530	31.806	.000
	Within Groups	657.431	12	54.786		
	Total	4142.491	14			
Be	Between Groups	.000	2	.000	59.671	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2281.633	2	1140.817	50.142	.000
	Within Groups	273.023	12	22.752		
	Total	2554.656	14			
Mn	Between Groups	2.121	2	1.061	23.429	.000
	Within Groups	.543	12	.045		
	Total	2.665	14			
Ni	Between Groups	.025	2	.013	34.598	.000
	Within Groups	.004	12	.000		
	Total	.029	14			
P	Between Groups	8.752	2	4.376	66.412	.000
	Within Groups	.791	12	.066		
	Total	9.543	14			
Ti	Between Groups	56.913	2	28.456	11.991	.001
	Within Groups	28.478	12	2.373		
	Total	85.391	14			

Appendix 8.8.47: ANOVA Output for Common Reduced Elements - London, April, ICP-AES

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	4318.998	2	2159.499	16.543	.000
	Within Groups	1566.417	12	130.535		
	Total	5885.415	14			
Be	Between Groups	.000	2	.000	21.831	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	2637.999	2	1319.000	59.741	.000
	Within Groups	264.945	12	22.079		
	Total	2902.944	14			
Mn	Between Groups	2.103	2		11.526	.002
	Within Groups	1.095	12	1.052		
	Total	3.198	14	.091		
Ni	Between Groups	.029	2		37.212	.000
	Within Groups	.005	12	.014		
	Total	.033	14	.000		
P	Between Groups	6.755	2		34.587	.000
	Within Groups	1.172	12	3.378		
	Total	7.927	14	.098		
Ti	Between Groups	40.624	2		25.628	.000
	Within Groups	9.511	12	20.312		
	Total	50.134	14	.793		

Appendix 8.8.48: ANOVA Output for Common Reduced Elements - London, July, ICP-AESS

Element		Sum of Squares	df	Mean Square	F	Sig.
Al	Between Groups	6809.953	2	3404.977	34.242	.000
	Within Groups	1193.251	12	99.438		
	Total	8003.204	14			
Be	Between Groups	.000	2	.000	23.536	.000
	Within Groups	.000	12	.000		
	Total	.000	14			
Fe	Between Groups	3351.214	2	1675.607	138.307	.000
	Within Groups	145.381	12	12.115		
	Total	3496.595	14			
Mn	Between Groups	1.857	2	.929	6.780	.011
	Within Groups	1.644	12	.137		
	Total	3.501	14			
Ni	Between Groups	.035	2	.018	22.985	.000
	Within Groups	.009	12	.001		
	Total	.045	14			
P	Between Groups	7.969	2	3.984	17.095	.000
	Within Groups	2.797	12	.233		
	Total	10.765	14			
Ti	Between Groups	29.351	2	14.675	13.994	.001
	Within Groups	12.584	12	1.049		
	Total	41.935	14			