GEOPHYSICAL EXPLORATION OF KİNET HÖYÜK: A COMPARISON OF THE MAGNETIC SURVEY WITH THE EXCAVATION RESULTS

A Master's Thesis

by

AYŞEGÜL VURAL

Department of
Archaeology and Art History

Bilkent University

Ankara

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The Institute of Economics and Social Sciences
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AYŞEGÜL VURAL

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ANKARA

April 2007

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in (Archeology and History of Art).

(Dr. Jacques Morin)
Supervisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in (Archeology and History of Art).

(Dr. Marie-Henriette Gates)
Examining Committee Member

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in (Archeology and History of Art).

(Dr. Timothy Beach)
Examining Committee Member

Approval of the Institute of Economics and Social Sciences

(Prof. Erdal Erel)
Director

To Meral

ABSTRACT

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Vural, Ayşegül

M.A., Department of Archaeology and Art History

Supervisor: Dr. Jacques Morin

January 2007

This thesis analyzes the results of the magnetic survey conducted at the prehistoric mound of Kinet Höyük, on the Issos Plain (Hatay, Turkey), and those of the test excavations, which were conducted according to this geophysical survey. The main focus of this study is to compare the magnetometer survey results with the data from the test excavations to verify how proficient this method is for revealing the subsurface features of Kinet Höyük and its surrounding area. This comparison should allow us to test the applicability of these kinds of methods for archaeology.

Keywords: Kinet Höyük, Geophysical survey methods, Archaeology, Magnetic survey.

ÖZET

KİNET HÖYÜK'ÜN JEOFİZİKSEL YÖNTEMLE ARAŞTIRILMASI: MANYETİK YÖNTEMLE YAPILAN YÜZEY ARAŞTIRMA SONUÇLARININ KAZI SONUÇLARI İLE KARŞILAŞTIRILMASI

Vural, Ayşegül

Yüksek Lisans, Arkeoloji ve Sanat Tarihi Bölümü

Tez Yöneticisi: Dr. Jacques Morin

Ocak 2007

Bu çalışma, Issos Ovasında yer alan Kinet Höyük'de gerçekleştirilen manyetik yüzey araştırması ve bu yüzey araştırmasına göre açılmış olan test açmalarının sonuçlarını değerlendirmiştir. Bu karşılaştırma ile manyetik yüzey araştırma yöntemlerinin Kinet Höyük ve onu çevreleyen bölge içerisinde bulunan arkeolojik değerlerin bulunmasına katkısı incelenmiştir. Bu karşılaştırma sonucu jeomanyetik yüzey araştırma yöntemlerinin arkeolojiye katkısını ölçmüştür.

Anahtar Kelimler: Kinet Höyük, Jeofiziksel yüzey araştırma yöntemleri, Arkeoloji, Manyetik yüzey araştırma metodu.

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CHAPTER I

INTRODUCTION

Within the development of archaeology as a discipline, different research methods and techniques from the earth sciences have been adopted or developed for archaeological purposes; among these, the methods of the geophysical sciences have contributed considerably and have been widely used since the second half of the 20th century. The magnetic method is considered as one of the best geophysical investigation techniques by archaeologists.

This M.A. thesis presents the results of the magnetic survey conducted at the prehistoric mound of Kinet Höyük, on the Issos Plain (Hatay, Turkey), and those of the test excavations, which were conducted according to this geophysical survey. The main focus of this study is to compare the magnetometer survey results with the data from the test excavations to verify how proficient this method is for revealing the subsurface features of Kinet Höyük and its surrounding area. This comparison should allow us to test the applicability of these kinds of methods for archaeology.

Traditional archeological methods of investigation even for small sites are limited to surface surveys and the excavation of very small portions of sites.

Therefore, they can only expose a small sample of the site fully with reasonable time and cost. Also, even though test excavations cannot reveal much about most of the surface area of any site, large-scale excavation procedures can be destructive of cultural resources. In contrast, a detailed geophysical survey can gather high-quality data with less expenditure of time, effort and money. It can provide preliminary information about the site (nature and location of strata, buried features, large objects and structures) and allow excavation programs to better address the purpose of research while limiting site destruction. As a result, these nondestructive methods are now widely used in archaeology, particularly after the introduction of advanced instruments, which reduce the need for traditional excavation more than in the past. When we consider the cost and time involved with undertaking excavation, as well as current laws that often require that sites be conserved, geophysical techniques have made a significant contribution to archaeology (Scollar *et al.,* 1990: 3; Conyers & Goodman, 1997: 11; Blau *et al.,* 2000: 117; Bevan & Roosevelt, 2003: 287; Abbas *et al.,* 2005: 537; Abdallatif *et al.,* 2005: 483).

Although these methods present many advantages over traditional archaeological practices, they have not been used often on Mediterranean sites in spite of the wealth of the archeological sites (Sarris & Jones, 2000: 3). This situation also has applied to Turkish archaeology until very recently. The limited number of geophysical investigations has increased within the last fifteen years. After the earliest examples of geophysical surveys at the tumuli of Nemrut and Gordion and the Keban Projects, the archaeological projects such as Bogazköy-Hattusa, Demircihöyük, Kuşaklı, Titriş Höyük, Kerkenes Dağ, Troy, Ziyaret Tepe, etc., have used geophysical methods either to generate the city plans and its structure, or to give momentum to surveys or excavations. In contrast to the increasing number of geophysical surveys, the publications of these survey results and their comparison with excavations are almost non-existent. Thus, in this study we aim to make a significant contribution to the application of geophysical survey methods in Turkish archaeology and the findings of this research may assist future work at similar sites in this region and elsewhere.

Magnetic prospecting, as one of the more frequently employed methods in archaeo-geophysical research, provides a great amount of high resolution magnetic data in a very short time (Chianese *et al.,* 2003: 633). This is why it was chosen for the Kinet Höyük survey after the consideration of difficulties to carry a resistivity survey at the site. At the end of the 2000 season 16,342 m^2 had been surveyed in detail which would not have been possible using traditional methods. This contribution to the Kinet Höyük excavation is highly significant for two specific reasons. Firstly, Kinet Höyük and its surrounding area are endangered because of rapid environmental changes resulting from human activity and industrialization. Hence, speed in revealing the archaeological potential of the site and the history of the area, especially considering the limited number of surveys and excavations in the region, is vital. Secondly, Kinet Höyük is an important historical place, since as one of the largest mount of the Issos plain, it is suggested to be the ancient city of Issos in the area of which the ‘Battle of Issos’ took place between Alexander the Great and Darius III in 333 BC (Hellenkemper & Hild, 1986: 102; Ozaner, 1995: 513-515).

The first chapter will provide background information on the geographical and geological settings of Kinet Höyük and its archeology by emphasizing environmental change in the region. This information can be used, in turn, to understand the magnetic noise resulting from the history of the area, and will illustrate the urgency of such kinds of surveys in the region.

The following chapter will start with a summary of geophysical prospecting methods in archaeology with a focus on their history and it will finish with a very brief summary of results of magnetic surveys elsewhere in Turkey. The aim of this chapter is to present background knowledge to understand the application of geophysical methods in archaeology, examine their limitations and potential, to provide a benchmark in discussing the logic behind the choice of the magnetic survey method at Kinet Höyük and to illustrate the accomplishments of previous work in Turkey.

Then, the third chapter will present the magnetic survey results with a discussion of the advantages of employing it on a site such as Kinet Höyük. The acquisition, processing and interpretation of data will be discussed in detail in this chapter.

The main focus of chapter four will be the test excavation results and their comparison with magnetic survey results. This chapter will, first, present the excavation methods specifically for this survey area and give the details of all related soundings. The excavation finds and the depth at which they were encountered will be presented in detail. The results of the geophysical survey will be correlated with those of the test excavations in order to asses the accuracy of the magnetic survey interpretation. Consequently, the survey results will be evaluated, and revised in the light of the results of the test-excavations.

As a result, it is hoped this study (the combined results of survey and test excavations) will assist to enlighten the history of Kinet Höyük and its surroundings and guide the future magnetic surveys in the region.

1.1. Geographical and Geological Setting

Kinet Höyük (Appendix A: map.1a &1b) as the largest mound of Eastern Cilicia is located at the south end of the Erzin (Issos) Plain, 6km northwest of Dörtyol (İskenderun, Hatay) and enclosed by the Amanus range on the eastern side, and the northeast shores of the İskenderun Gulf, an arm of the Mediterranean Sea, on the western side. The mound is 500m from the modern seashore and measures 120m north to south and 200m east to west; it extends over 3.3ha at its base and rises to 26m in height (Gates & Özgen, 1993: 392; Gates, 1994: 194; Ozaner, 1993: 340; Gates, 1999: 259).

A detailed survey of the area by Mülazımoğlu shows that a large portion of the older formation of the Amanus range includes quartzite, sand stones, and green-schist, dated either as Precambrian or as Paleozoic (Mülazımoğlu, 1979: 24-29). The mesozoic and tertiary formations consist of limestone, green schist, and serpentine layers (Tolun, 1975: 54-75; Mülazımoğlu, 1979: 1). The Pliocene shows a combination of calcareous and serpentine gravels which result in a conglomerate cast occupying wide ranging areas along the coastline; such deposits are more than 2000m thick (Ardos, 1984: 126-27).

The geomorphology of the Issos Plain was structured by fault lines that caused the area to subside; the depressions that formed were filled by alluvial and coastal, deposits and the products of volcanic eruptions which gradually amalgamated (Göney, 1976: 14; Mülazımoğlu, 1979: 67; Gates, 1994: 193; Ozaner, 1993: 338). Some suggest the region is a piedmont plain (Ardos, 1984:126; Tunçdilek, 1985: 78), but it is better viewed as an alluvial plain formed from colluvial bajadas, shifting river channels, and some coastal progradation (Beach & Luzzadder-Beach, 2007).

The area is modified by a continual deposit of alluvium, a process that since the Pliocene has covered the bedrock with more than 1600m of sediment and remains active today (Ozaner, 1993: 338). According to sondage results, quaternary alluviation is 20m thick in the Dörtyol plain and 75m in the Erzin plain (Doyuran, 1982: 151, 156)

The most important factors of this high rate of deposition in the region are that heavy wet-season rainfall leads to high runoff, erosion, and accelerated mass wasting on the steep Amanus Mountain and foothill slopes. The watersheds are characterized by winter and spring flooding, when they carry large sediment loads which are deposited at the foot of the mountains and accumulate as fans and bajadas. High runoff and sediment loads fill or "aggrade" the alluvial plain, part of which is sinking due to normal faulting along the coast lines. The sediment deposits are gravelly on the higher part, but become sandy and silty towards the lower elevation of the plain (Tunçdilek, 1985: 78). In the Kinet Höyük area, sedimentation depends in great part on the shifting and flooding Deli Çay channels flowing between İskenderun and Dörtyol.

According to the test sounding results of Dr. Timothy Beach, a geomorphologist who joined the Kinet excavations in 1998 for geoarchaeological research on the mound and neighboring region, the sedimentation rates on the plains around Kinet Höyük vary greatly (Beach & Luzzadder-Beach, 2007). The accumulation of sediments ranges from 5.3 to 2.1m near the mound and its surroundings for the previous 1500 years; between the Early and Late Bronze Age it measures near the mound c. 4.8m and around 1.3m at 1km from the mound. Deposition has slowed down since the Medieval period with around 50cm of deposits between then and the present. The collapsing structures from the mound and high erosion rates on its steep edge, in addition to the hydrological activity of the Deli Çay, are the reasons for this high rate of sedimentation at the site (Beach, 2004: 5).

The deposition process around Kinet Höyük's shoreline is consistent with a long-term rate of c.1m coastal aggradation per millennium and has started to increase since the Hellenistic period (Beach, 2004: 5). This result provides evidence for human impact on the environment (Andel *et al.*, 1990: 379-396; Yener *et al.*, 2000)

The climate of the region is defined by Mülazımoğlu as typical Mediterranean with hot and arid summers and warm and rainy autumns. The effects of the continental climate and high pressure make the summers very hot and the low-pressure systems from the west make the areas' winters rainy and warm (Mülazımoğlu, 1979: 8). However, a more recent study[1] that took special attention on the Dörtyol area rather than just the whole western slope of the Amanus range proves that the coastal area up to the colline landscapes reflects the humid to per-humid, Meso- to Submediterranean climatological conditions and real Eu-Mediterranean characteristics are not present in the Dörtyol region (Kehl, 1998).

According to the Dörtyol station, the annual average temperature for the last forty years is 19.3° C, with average highs of 32.2° C in August and lows of 6.8° C in January (Mülazımoğlu, 1979: 8; Doyuran, 1982: 152-53).

Spring and winter are the rainiest seasons, with heaviest precipitation between November and May. Summer drought is frequent and snow is almost never seen in winter on the western slope of the Amanus range (Mülazımoğlu, 1979:7). Annual precipitations average 1021.8mm in the region (Mülazımoğlu, 1979: 8). The amount

[1] The web site of http://www.agnos-online.de/e-f-abstract.htm gives the details of this study, which is called the Lökat project led by Dr. Harald Kehl of TU-Berlin Institute of Ecology.

and pattern of precipitation varies; however, summers with periodic downpours are seen (Kehl, 1998).

Forest once covered the entire region; however, this natural vegetation has been destroyed and replaced by maquis. According to the British Naval Intelligence report, the forests of the district started to be used as fuel for the new railway in 1914, which must have contributed to its deforestation (BNI, 1919: 37). Before the railway, forests probably reached the coastline. Nowadays, *Pinus brutia* (kızılçam) constitutes 34% of the tree population, which is generally dominant around the middle to upper colline belts of the Amanus from Osmaniye to Dörtyol (Mülazımoğlu, 1979: 9-11). The maquis, scattered from the coastline to an altitude of 800-900m, is made up of ruderal and segetal species, which grow on soils with high nitrogen and phosphate content, and may be areas of former intensive fertilization for cereal growing (Kehl, 1998: 21-22).

The natural vegetation has been cleared for agricultural activities in the coastal area in the southern part of the region, and today the entire coastal belt is subject to cultivation. In the Issos plain, orange groves are the most common agricultural plantations but cereals, vegetables, cotton, peanuts and sesame are other important crops of the region (Doyuran, 1982: 153; Mülazımoğlu, 1979: 11).

The region's soils show mixed characteristics because of the piedmont feature of the area. Intrazonal soils (brown forest soil without limestone, soil over basalt formations) and mixed soils (brown forest soils and regosols, brown forest and colluvial soils) are most common in the Kinet Höyük area (Mülazımoğlu, 1979: 11-18).

Today, on the western slope of the Amanus range, highly developed soils are seen on the middle montane belt where it is difficult to reach by human and animals (Kehl, 1998).

According to the Kinet Höyük faunal data and British Intelligence report, gazelle, wild goat (*capreolus*), wolf, hyena, fox, boar, and several different deer species were present in the region from the Bronze to the Medieval Age and cattle, sheep, goats and pigs were the domestic species (BNI, 1919: 33; Gates, 2003: 290). However, modern data shows that wildlife is generally limited to the mountain area.

The region has undergone deep sedimentation by natural and accelerated processes, and both factors have the potential to affect the geophysical survey results. First, the continuous sedimentation process causes changes in soil profiles by concentrating certain types of soil locally; for instance, a sandy soil concentration of low susceptibility causes unfavorable conditions for the magnetic survey. Then, naturally magnetized rocks, such as granite boulders, are deposited within the soil matrix, and alter slightly the magnetic field around them. Finally, intense sedimentation buries archaeological features deeply, making their detection more difficult. In addition, urbanization itself with its power lines, trains, cars, etc., cause magnetic fluctuations and undergrowth, while soil heaps and irregular ground surface resulting from the cultivation process produce minor anomalies on a survey. All feature prominently around Kinet Höyük and affect the survey. Therefore, the applicability of this method must be assessed taking into account the geological and cultural features of the site.

1.2. Archaeological and Historical Setting

The earliest survey of the Issos Plain was carried out by Seton-Williams in the summer of 1951. In this study, she mentioned Kinet Höyük as an important site with a thick Hellenistic and Roman occupation. Also, she identified it as the place where the battle of Issos took place between Alexander the Great and Darius III in 333 BC (Seton-Williams, 1954: 127; Gates & Özgen, 1993: 392; Ozaner,1993: 340; Ozaner & Çalık, 1995: 155; Gates, 1999: 260).

After the site was identified as Issos on the basis of the works of several classical authors who gave accounts of the Battle of Issos, including Aristobulus, Arrian, Callisthenes, Curtius, Diodorus, Justin, Plutarch, Polybius, Ptolemy, Xenophon and Strabo (Ozaner & Çalık, 1995: 154-155), the site started to draw special attention. Thus, the first excavation on the area started in July 1992, as a short season of sondage trenches by M.-H. Gates for Bilkent University and the Hatay Museum (Özgen & Gates, 1993: 193). In the following years, the Bilkent University team conducted large-scale excavations on the höyük and surrounding terraces, with breaks only for study seasons in 1996 and 2000.

The excavations so far at Kinet Höyük show that the settlement history of the site goes back as early as the Late Neolithic period (6^{th} millennium B.C.). The initial settlement sat on a peninsula between two harbors which let the settlers benefit from the Eastern Mediterranean maritime commercial networks (Gates, 1999: 259).This early settlement continued to be occupied throughout the Chalcolithic period with Late Halaf -Ubaid cultural phases of the 5^{th}-4^{th} millennium B.C. (Gates, 2002b: 6-7). However, the excavations have focused on the Middle Bronze and Late Bronze Age (corresponding to the Hittite Zise or Izziya), the Iron Age (associated to the

Phoenician Harbor Sissu), and the Hellenistic period levels. The site was continuously occupied during these periods and had fortifications until the late Hellenistic town of the 2nd to mid-1st century B.C. Then, it was abandoned ca. 50 B.C. (Gates, 1999: 260; Gates, 2002b: 6; Gates, 2005: 3). The reason or reasons for this abandonment of the settlement are not clear. According to Ozaner, a geologist who carried a survey in the region in 1991, it must have strong connections with the shift of the Deli Çay's mouth, from the side of the mound to ca. 2 km south which caused the loss of Kinet's port facilities (Ozaner, 1993: 340-341; Ozaner, 1995: 513-27).

Although we uncovered evidence for Roman and early Medieval occupations (possibly Hisn el-Tinat (Castle of the Figs)) on the surrounding plains, the next occupational level of the site dates to the Crusader Middle Ages (12th-14th century A.D.). This reoccupation is related with the probable construction of an artificial harbor beside the mound's south terrace (Gates, 2002b: 6-7). Medieval Kinet has been associated with the Knights Templar, an organization of monastic knights as a part of the northern Crusader states who constructed and garrisoned several castles in the region. This military character of Kinet ended towards the late 13th century when the site was burned by Mamluk invaders. Then, it became a large village settlement without a defensive wall (Redford, 2005: 4-5).

The middle ages were the end of Kinet's history. With the establishment of Delta Petrol's oil and natural gas storage facilities and off-shore port, in the mid-1980s, at the very location of the suggested medieval artificial harbor, the site regained its economic dynamism of old (Gates, 1994: 194; Gates, 1999: 260; Gates, 2002b: 6-7).

The chronological phasing of the site is as follows:

Phase	Period/s	Date
I	1 1b	Medieval (? 10th-14th c. A.D.) Early Medieval, Al Tinat 7th-8th c. A.D.
II	3A-2	Roman Road, off mound Hellenistic (ca. 330-ca. 50 B.C.)
III:1	7-3B	Late Iron Age (7th-4th c. B.C.)
III:2	11-8	Middle Iron Age (9th-8th c. B.C.)
III:3	12	Early Iron Age (?12th-10th c. B.C.)
IV:1	15-14-13	Late Bronze II (13th c. B.C.)
V	16	Middle Bronze Age (2000-1500 B.C.)
VI	---	Early Bronze Age (3rd millennium B.C)

(updated from Gates,1999: 261)

Deducing from the excavation results, Kinet Höyük has a long settlement history proving that the site has had an important role in the inland and maritime commercial network of the area because of its harbors and strategic location between Cilicia, the Amuq plain, inland Syria and the Levant where commercial routes link west and east in the past as well as today (Gates, 1994: 194; Gates, 1999: 259). According to Gates, this strategic location of Kinet reflected on the excavation finds which suggested an international communication with Cypriots, Hittites, Canaanites, Mycenaean and Iron Age Greeks, Phoenicians, Assyrians, Phrygians, Persians and Crusaders (Gates, 2002b:7).

CHAPTER II

GEOPHYSICAL PROSPECTING IN ARCHAEOLOGY

The history of geophysics that began in the late 16th century made great progress in time, so that during the 20th century geophysical equipment underwent considerable development. The awaking consciousness about protecting the history and natural environment in western cultures after World War II led European physicists and geophysicists to experiment with these methods for archaeological aims which were first followed by European archaeologists and later on by American archaeologists (Drahor, 1992: 235; Weymouth & Huggins, 1985: 191-2).

The experiment of Pit Rivers in 1893 with a pick can be counted as the earliest geophysical prospecting method used in archaeology, which is later called “bosing”; it is based on hitting the ground with the end of a pick axe and listening to the echo of sounds reverberated on subterranean structures and holes that can be used to identify the location of ditches or pits (Aitken, 1961: 4; Coles, 1972: 34; Clark, 1996: 11, Drewett, 1999: 50).

The turning point of the experimental stage of using geophysics in archaeology is a resistivity survey, which was conducted by Richard Atkinson in 1946 in Dorchester, Oxfordshire (Drahor, 1992: 236; Clark, 1996: 14-16).

While exploiting the resistivity of soils and rocks to an electrical current remained for a long time as the most preferred method for archeology, the studies of geomagnetism created a new perspective to detect the subsurface features. The experiment of Folgheraiter in 1896 which proved that there are differences between the magnetic susceptibility of fired clay and raw clay and Le Borgne's experiment of 1955 proved that the magnetic susceptibility of soil is enhanced by burning (Tite *et al*., 1971: 209; Tabbagh, 1984:171). The results of these pioneering works of geomagnetic prospecting oriented the scientists to build instruments for archaeological aims and three basic models of magnetometers had been developed within the late 1950s to 1970s.

The initial model of a proton magnetometer built by the Cambridge University Department of Geodesy and Geophysics was tested by John Belshé in 1957 (Scollar *et al*., 1990: 513-14), then the manufactured model of this magnetometer started to be used in 1960 (Scollar, 1970: 110). In 1964, the first optically pumped magnetometer was used in Sybaris, Italy by Beth Ralph from the University of Pennsylvania Museum (Ralph, 1964: 20) and a fluxgate gradiometer was constructed by J.C. Alldred at the Laboratory of Oxford and started to be used in archaeology (Alldred, 1964).

These early usages of the geophysical instruments made apparent the necessity to present the data taken from the instruments as an image. The studies of Irwin Scollar on resistivity and magnetic data between 1959 and 1963 gave successful results and he produced the first images from magnetic data in 1977 (Scollar *et al*., 1990: 515). With the production of portable computers in the early 1980s, the data processing of geophysical surveys became easier and geophysical prospecting in archaeology acquired its latest development (Clark, 1996: 25).

While these developments occurred in European and American archaeology, the archeologists researching in Turkey could not stay away from the methods which promise to lessen the economical and time burden-of traditional archaeology. Most of the earliest systematic archaeological surveys in Turkish archaeology were carried out by European and American archeologists who had knowledge of the usage of geophysical methods for archaeological purposes; as a result, the application of these methods in Turkish archeology comes up as early as European and American archaeology. Thus, the Nemrut Dağ Project supported by the Bollingen Foundation and the National Geographic Society (Sanders, 1996) and the Gordion excavations by the University of Pennsylvania used geophysical methods in Turkey in the 1960s to investigate the tumuli on the sites (Kohler, 1995; Dinçer, 2006)[2]. The Keban Project in 1968 by a team from the Department of Applied Geophysics, Faculty of Science, İstanbul University was the earliest Turkish scientists' experiment with these methods. In the scope of this project, they chose three sites, Ağın, Tepecik and Norşun Tepe to test the effectiveness of the resistivity method and their works revealed its value (Yaramancı, 1970: 21-28). In the 1970s, the magnetic survey at the site of the Hittite settlement of Bogazköy (Becker, 1980: 312-318) and the EBA settlement of Demircihöyük (Becker, 1979: 48-61) were conducted with success. In the 1990s, the use of geophysical survey techniques increased noticeably and large-scale surveys were conducted at the sites of Kuşaklı, Titriş Höyük, Kerkenes Dağ, Troy and Ziyaret Tepe. As a result of these works, geophysical prospecting has

[2] See the web page http://paleoberkay.cjb.net.

become a significant component of archaeological surveys and excavations in today's Turkish archaeology. Although the number of geophysical surveys has increased in Turkish archaeology, my research showed me that the publication of these surveys is not detailed enough except for a few large-scale projects, which causes difficulties in making a comparative study. For this reason, in this part of my study I want to present a chart, which was prepared within the boundary of available sources of information, to make a summary of geophysical surveys carried in Turkey.

The geophysical surveys in Turkey

Site Name & Locations & Surveyed Level	**Geophysical Methods& Detected Features**	**Publications**
Ağın (SE -Turkey) (Byzantine Period)	Res[3]: walls,tombs,calcerous rocks	Yarmancı, 1970
Acemhöyük (C-Turkey) (EBA-Hittite Period)	Res: architectural structures	Drahor, 1994
Aphrodisias (W-Turkey) (Greek and Roman Periods)	Res: architectural structures Mag[4]: negative	Smith & Ratte, 1995-2000
Ahmetli-Çiftlikırı Tumulus (W-Turkey)	Res: layout of tumuli	Drahor, 1993
Bogazköy-Hattusa (C-Turkey) (Hittite Period)	Mag: architectural structures	Becker, 1980
Çatalhöyük(Central Turkey) (Neolithic Period)	Res: location of settlements Mag: mud-brick walls	Shell, 1996 Watkins, 1995
Demircihöyük (W-Turkey) (EBA Period)	Mag: kilns	Becker, 1979
Ganos (W-Turkey) (Greek Period)	Mag: kilns	Günsenin, 1994
Göltepe (C-Anatolia) (EBA Period)	Res: walls	Drahor, 1993
Halikarnassos(W-Turkey) (Hellenistic/Roman Period)	Res: architectural structures Mag: negative (magnetic noises sources)	Pedersen, 1990
Hisarönü & Reşadiye (W-Turkey) (7^{th} c. B.C to 7^{th} c. A.D.)	EM[5]: pottery workshops	Hesse, 1992

3 Resistivity Survey
4 Magnetic Survey
5 Electromagnetic Survey

Hierapolis (W-Turkey) (Hellenistic Period)	Res: architectural structures GPR: architectural structures	Negri & Leucci, 2006
Kerkenes (C-Turkey) (Iron Age)	Mag: walls, gates, street, houses Res & GPR: architectural structures	Summers & Summers, 2002
Kinet Höyük (Roman Period)	Mag: roads	Veronese, 2000
Kulhöyük (E-Turkey) (Hittite Period)	Res, Mag & GPR: walls	Erçan et al., 1996
Kuşaklı (Central Anatolia) (Hittite Period)	Mag: architectural structures (walls, gates)	Stumpel, 1995
Kösemtuğ Tumulus (NW-Turkey)	Res: burial chamber	Pınar & Akçığ, 1993
Magnesia Ad Meandrum (W-Turkey)	Res: burial chamber	Başkur, 1993
Menekşe Çatagı (W-Turkey) (Greek Period)	Mag: burnt features	Sayın, 1996
Metropolis (W-Turkey) (Roman & Byzantine Periods)	Res: architectural structures	Drahor, 1992
Millet (W-Turkey) (Roman Period)	EM, Mag & GPR: drainage system	Yalçın, 1994
Norşuntepe (SE- Turkey) (Neolithic Period)	Res: stone structures	Yarmancı, 1970
Tepecik (SE-Turkey) (Neolithic Period)	Res: mud-brick structures	Yarmancı, 1970
Troy (W-Turkey) (Roman Period)	Mag: streets	Becker, 1993
Titriş Höyük (SE-Turkey) (Early Bronze Age)	Mag & Res: settlement	Algaze et al., 1989 & 1993
Tell Kurdu (SE-Turkey) (E.-M. Chalcholithic)	Mag: walls, burnt structures	Gürbüz et al., 2000

As a result of the brief account of the history of archeo-physics, it can be concluded that, since the application of these methods has increased especially in the second half of the 20th century with technologically sophisticated instruments both in Turkey and around the world, these methods give hopeful results and have value for archaeology. However, it must be kept in mind that before applying any of these methods, the most important point is that it is essential to know well how they work and under what conditions they can give best results. Although these techniques are still mostly applied by geophysicists, both archeologists and geophysicists must give the decision about which method can work best on the site. Therefore, it is the place to discuss the details of these methods.

2.1. Geophysical Methods

Geophysical methods are based on the measurement of different physical properties of subsurface soils and rocks, formed by both geophysical processes and human alterations (Linington, 1970: 91; Tite, 1972: 8).

These methods are classified in two groups: passive and active. Passive methods measure directly gravitational or magnetic fields produced by subsurface features; the magnetic survey is the only method used for archaeology in this category. Active methods, on the other hand, use an artificially produced pulse whose reflection is measured by an instrument: electrical resistivity, ground penetrating radar, and electromagnetic measurements are the main active methods that have value for archaeology (Hester *et al.*, 1997: 60-61; Herz & Garrison, 1998: 148).

The main factors in choosing one or several methods for an archeological survey relate to the geological conditions of the site, the type of archeological structures expected underground, environmental noise level, and the size of the area to be surveyed. Generally, to employ two methods at the same time that can complement each other, such as magnetometer and resistivity, provides the best results (Veronese, 2000).

Since in this study around Kinet Höyük, we will emphasize mainly the magnetic survey, the magnetic method will be discussed in detail after a general introduction of the other three main methods.

2.1.1. Electrical Resistivity

Electrical resistivity is based on the measurement by electrodes or probes of the electrical resistivity or conductivity of the soil in a limited volume close to the surface (Weymouth, 1986: 318; Sarris & Jones, 2000: 12). The method consists of inserting pairs of electrodes into the ground, applying voltage to them and measuring soil resistance to the flow of the electric current (Clark, 1970: 695-696; Linington, 1970: 101-103; Tite, 1972: 25; Parrington, 1983:113; Weymouth & Huggins, 1985: 217).

The electrical resistance of soil depends on several different factors, including the amount of water and its ion content in the soil, the soil structure, the porosity of the soil and climatic conditions (Tite, 1972: 25; Weymouth, 1986: 313; Hester *et al.*, 1997: 61). The method works best on moist ground where soils or sediments contain different amounts of moisture or dissolved ions. It is most successful in locating walls, tombs and related features (Coles, 1972: 34-35; Tite, 1972: 25; Aitken, 1974: 266-267; George & Christopher, 1998: 186; Sarris & Jones, 2000: 14).

One of the advantages of the method over geomagnetic survey is that the results of resistivity cannot be affected by any iron source, which eliminates the negative effects of modern settlements near the research area. Also, this method allows the surveyor to control the depth of the research by varying the distance between the electrodes. However, it has also some disadvantages: moving the probes in a large area makes it slow (George & Christopher, 1998: 186; Tite, 1972: 25); the resistivity or the anomalies detected by the instrument depend very much on climatic conditions, probe configuration, and the shape and size of the subsurface features, so results are difficult to correlate from one place to the next and one time to the next in the same area (Weymouth & Huggins, 1985: 191; Clark, 1996).

2.1.2. Ground Penetrating Radar (hereafter GPR)

This method was initially designed by civil engineers to locate buried objects or cavities such as pipes, tunnels, and mine shafts. In time it was modified to detect geological features such as lithological contacts, faults, bedding planes and joint systems in rocks, buried soil units and depth of ground water (Conyers & Goodman, 1997: 18; George & Christopher, 1998: 186).

This method principally measures the radar pulses which are first created by the instrument, then sent to the surface of soil and reflected by subsurface features. According to the reflected radar pulses, the information about the nature and depth of the subsurface features can be gathered (Weymouth, 1986: 370; Conyers & Goodman, 1997: 23; George & Christopher, 1998: 188). Soil and sediment mineralogy, clay content, ground moisture, depth of burial, surface topography, and vegetation are the main factors affecting GPR survey success (Conyers & Goodman, 1997: 16).

Archaeological surveys show that GPR has been successful in intra-site investigations, locating shallow graves, mapping historic-period fortifications, defining the outline of features such as walls, floors, pits and cellars. The presence of metals does not hinder detection, thus the method can easily be used on modern settlements (George & Christopher, 1998: 188; Weymouth, 1986: 386). Its most important advantage is that it provides quite direct information on depth and allows generating a vertical stratigraphy at multi-level sites, such as höyüks or tumuli (Sarris & Jones, 2000: 32-36).

On the other hand, this method is more expensive than resistivity or magnetometry, complicated in operation and interpretation and not very useful for regional surveys (Hester *et al.*, 1997: 61; Weymouth, 1986: 370, 386).

2.1.3. Electromagnetic Method

The electromagnetic method was first designed to discover metals after World War II; however, with the realization that the instruments are also useful for detecting magnetic soil anomalies, it started to be employed for archaeological aims in order to develop a better method which can eliminate the weaknesses of the resistivity method (Linington, 1970: 103). Although the experimentations with this method for archeological purposes have been continued, it has been proved that it is a more rapid and successful method in dry conditions than the resistivity method (Coles, 1972: 41; Scollar *et al.*, 1990: 525; George & Christopher, 1998: 188; Herz & Garrison, 1998: 161).

There are two main types of this instrument: metal detectors for detecting the metal objects and EM series for larger scale surveys. These instruments work with a principle of the earth's reaction to an electromagnetic field. The transmitter of the instrument creates a primary electromagnetic field that penetrates the ground; in the presence of conducting material in the ground, a secondary electromagnetic field is created by induction, which the receiver reads. The differences between the primary and secondary fields enable to gain information about the subsurface features (Linington, 1970: 103-104; Coles, 1971: 41-45; Tite, 1972: 32-33; Tabbagh, 1984: 171).

The metal detectors have value to detect the areas known to contain graves with possible grave goods or modern iron debris as a preliminary survey or shallow buried and highly conductive objects, especially metal (Weymouth, 1986: 317; Sarris & Jones, 2000: 31). Also, the computer equipped EM series can be used with magnetometer or GPR and give promising results in archeological prospecting (Clark, 1996; Sarris & Jones, 2000: 30-31). However, the use of this method is still very limited.

2.1.4. Magnetic Method

The detection of magnetism in the search for minerals has been used by geophysicists for several decades, but until the development of the proton magnetometer, this method was not very useful for defining archaeological features. However, after tests showed its value for archaeological work, it started to take the place of resistivity surveying (Linington, 1970: 104).

As a passive technique, it is based on the measurement of changes in the earth's magnetic field, affected by variations in the magnetism of the sub-surface features such as, for archaeology: sediments, rocks, and buried remains, iron objects, fired structures (kilns, furnaces, ovens and hearths), pits and ditches filled with top-soil or rubbish, walls, foundations, roads and tombs (Aitken, 1970; Aitken, 1974: 207-208; Coles, 1972: 38; Tite & Mullins, 1971: 209; Weymouth, 1986: 341; Weymouth & Huggins, 1985: 192; Sarris & Jones, 2000: 23).

2.1.4.1. Magnetic Theory and Units of Measurement

According to magnetic theory, there are vector lines on the earth's surface oriented from the Southern Hemisphere to the Northern Hemisphere called the earth's magnetic field. The Southern Hemisphere is accepted as the location of the geomagnetic South Pole and the Northern Hemisphere as that of the geomagnetic North Pole of the earth (Halliday *et al*., 1993). Two geomagnetic elements define the earth's total magnetic field at any point: inclination, or dip (the angle between the total field and the magnetic north) and declination (the angle between geographic north and the magnetic north). The nanotesla ($nT = T \times 10^{-9}$) in the SI unit system is the preferred unit of measurement of the magnetic field strength of archaeological features which is equal to gamma in the CGS unit system (Clark, 1996: 64; Weymouth, 1986: 341; Weymouth & Huggins, 1985: 193).

The magnetic field of the earth shows variations with time. In a day, 20 or 30 gamma is an average measurement of diurnal variation between morning and evening values; however, if there is a magnetic storm, larger variations can be observed (Weymouth & Huggins, 1985: 194).

2.1.4.2. Magnetic Susceptibility of Soils

The measure of the response of a material to be magnetized is termed its magnetic susceptibility (Weymouth & Huggins, 1985: 194-195; Clark, 1996: 100; Herz & Garrison, 1998: 165).

Soil and sediments carry different amounts of iron because of their formation process from natural bedrock by weathering, root action and human activities. The amount of iron in the matrix of the soil defines its ability to be magnetized in the presence of a magnetic field. The success of a magnetic survey depends on the differences in magnetic susceptibility of the soil and its surrounding features (Weymouth, 1986: 342; Telford *et al.,* 1990: 672; Sarris & Jones, 2000: 23).

The fermentation and burning process causes the enhancement of magnetic susceptibility of soils (Aitken, 1974: 221) because the low susceptible magnetic mineral hematite in iron, which is contained in most of the soil and rocks, converts in such conditions to maghemite, a mineral of high magnetic susceptibility (Aitken, 1961: 18-19; Tite, 1972: 229; Tabbagh, 1984: 171; George & Christopher, 1998: 184; Tite & Mullins, 1971: 209; Weymouth & Huggins, 1985: 194; Sarris & Jones, 2000: 23). According to Tite and Linington (1975) the Mediterranean soils contain a high percentage of maghemite resulting from the fermentation process during the region's dry summers and humid winters (Sarris & Jones, 2000: 23).

The Magnetic Susceptibility of Some Relevant Materials

Type of soil	Susceptibility (uemu/g)[6]
Limestone, some unbaked clays	10
Subsoils	10-100
Topsoils	100-1000
Heated soils, fired clays, volcanic rocks	1000-5000

Taken from Aitken (1974:238)

Three types of magnetization, induced, remanent and thermo remanent may cause magnetic anomalies. Magnetization produced by an applied magnetic field is called induced magnetization. When the field disappears, some materials still show magnetization, which is called remanent magnetization, a product of an object's composition and its thermal, depositional, and diagenetic history (Herz & Garrison,

[6] 100 000 gamma = 1 oersted (G.G.S. emu)

1998: 165). If the remanent magnetization is a result of heating, it is called thermo remanent magnetism (TRM). The basic igneous rocks such as basalt or granite are especially magnetic because they have been magnetized during their initial cooling or crystallizing period (Clark, 1990: 65). As a result, buildings made of basalt, granite or any other igneous rocks will show up in magnetic surveys as anomalies (Aitken, 1970: 683).

2.1.4.3. Archaeological Features and Magnetic Anomalies

Buried archaeological features cause localized fluctuations in the Earth's magnetic field intensity, called magnetic anomalies (Tite, 1972: 15). There are two kinds of anomalies: normal dipole and nonnormal dipole. A normal dipole anomaly results from induced magnetism where polarization shows the same alignment as the earth's magnetic field. When the magnetism is permanent, a nonnormal anomaly occurs that differs from the earth's magnetic field (Weymouth & Huggins, 1985: 195).

Burnt features such as pottery kilns show strong nonnormal dipole anomalies because they are made mostly of clay which acquired thermo remanent magnetism while cooling after firing. Other burnt features such as furnaces, ovens, and domestic hearths show weaker anomalies than kilns because the amount of baked clay is less on those features but they are still detectable as long as the depth of burial is not too great (Aitken, 1974: 214-220; Tite, 1972: 15-18; Weymouth, 1986: 343).

Pits appear as normal dipole anomalies during a magnetic survey. Ancient humans used pits to dispose of waste while settlements were in use, but after they left, the pits gradually filled by natural silting; as a result, magnetic anomalies can be observed over pits. The same kind of anomaly is also seen above ditches (Aitken, 1974: 227-229).

Except bricks and volcanic rock, the materials for the construction of walls and roads, also produce normal dipole anomalies. The susceptibility of walls depends on the amount of soil in their structure. However, walls are less easily detectable than ditches because their remains are often fragmentary. Thick soil cover over some part of ancient roads also can produce magnetic anomalies (Aitken, 1974: 232). Finally, iron objects or remains also appear as high normal dipole anomalies (Aitken, 1974: 233).

2.1.4.4. Field Application of the Magnetic Method

Before applying a magnetic method for an archaeological survey, some factors must be taken into consideration. The survey area must be away from highways or roads because motor vehicles can cause magnetic fluctuations. The thermo-remanent magnetism of igneous rocks such as basalt and granite, especially of the tertiary and later eras is strong enough to mask archaeological anomalies, so the survey area cannot be full of these rocks. Previous excavation of the area, human settlement and trees and undergrowth are the other impediments for this survey technique because modern remains or the destruction of top soil will affect the survey results (Aitken, 1974: 235-39). A fairly uniform, fine-grained soil with a reasonable magnetic susceptibility and a good choice of grid unit, which can be determined by taking measurements at distances not larger than about half the size of anticipated anomalies, will give the best results for a magnetic survey. Alternately, one can use the now standard 1m grid as a reading interval (Weymouth, 1986: 345-349; Clark, 1990: 71).

During survey operations any iron object must be kept away from the surveyor and the survey area because it may distort measurements. Electrical interference and instrumental noise must be kept at the lowest level. The magnetometer must be stable. A reasonable height for the sensor, 40-60 cm above ground level, must be used because if the sensor is too high, weaker anomalies will be lost; in contrast, if the sensor is too low, soil surface irregularities will have too strong an influence. Extreme hot or cold weather conditions can affect the instrument's sensitiveness, so measurements must be taken in temperate weather conditions (Weymouth, 1986: 345-349).

To eliminate the noises caused by diurnal variation, the instrumental approach is best, involving either the use of two magnetometers in what is termed differential mode or of one magnetometer in gradiometric mode. When two magnetometers are used, one takes a measurement at a fixed point while the other takes readings throughout the survey area. However, using a gradiometer with two sensors gives better results. In this method, two sensors are placed one above each other with a 50 cm to 1 m distance; both take measurements of the vertical gradient of the earth's magnetic field and the difference between the two readings is the value employed. Although, the objective of both approaches is to remove the effects of strong local gradients and diurnal variation, this system is not effective for deep exploration (Weymouth, 1986: 345-349; Herz & Garrison, 1998: 167; Veronese, 2000).

The measurement noise should be determined by repeating the measurements of a row of points and examining the difference in the diurnally corrected values (Weymouth, 1986: 349).

In conclusion, all the geophysical methods applied to archaeology have their own advantages and disadvantages. Although, applying more than one method provides more qualified knowledge about the existing archeological structures, it takes more time and is costly. If only one method can be used, it has been proved that magnetic survey is the most cost-effective geophysical method.

2.1.5. Magnetic Surveys in Turkey

The success of the geophysical survey results is mostly related with the site geological and geomorphological conditions in accordance with the chosen method. For this reason, six geomagnetic surveys from different regions of Turkey with a different background of geology, geomorphology and archaeology will be presented in this part of study in order to see the significance of those features in geophysical surveys and to use their results while discussing the Kinet survey results. Therefore, many other surveys have been deliberately ignored to present a sample representing the types of environments and archaeological contexts of Turkey.

Kerkenes Dağ

The city on Kerkenes Dağı is located on a c.1.500m high granitic mountain-top in Şahmuratlı village within the borders of Yozgat province (Summers, 1994: 567). This relatively flat valley marked by low hills is watered by only one main stream, the Eğri Özü Su, and several small springs (Summers & Summers, 1998a). The continental climate dominating central Anatolia with hot summers and snowy cold winter is also typical for this region. The rainiest season of the area is the spring; however, precipitation is not abundant which causes summer drought. As a consequence of this climate and precipitation regime the village economy is based on dry farming of cereals (Yakar, 1999: 226-229).

The earliest survey on the site was carried in 1927 by Von der Osten and F.H. Blackburn (Von der Osten, 1928) and the first excavation was conducted in 1928 (Schmidt, 1929: 83). Since 1993, the site has been excavated by a team under the direction of Geoffrey Summers from Middle East Technical University, Ankara, Turkey.

The ancient city is surrounded with a huge defensive wall 7.5 km long with towers, buttresses, gates and glacis which were mostly made out of granite and occupies a 2.5 km square area. The authors state that this city is the largest pre-Hellenistic site in Anatolia so far known (Summers & Summers, 1995: 100-101).The surveys supported and the excavations show that the site was an Iron Age settlement that was abandoned after massive burning, presumably at the hands of Croesus in c. 547 B.C. (Summers, 1994).

The initial survey at Kerkenes Dağı started in 1993 with the aim of generating the city plan by using balloon photography (Summers, 1994: 569-572). However, Lewis Somers conducted some experimental surveys by resistivitymeter (RM15) and fluxgatemeter (FM36) in that session. After the promising results of these surveys, especially the gradiometer survey, it was decided to conduct a long-term geomagnetic exploration. In 1998, the geophysical survey of Kerkenes Dağı aimed at mapping the whole site, which was completed in 2002 (Summers *et al*., 2002).

The reasons justifying the choice of these methods are based on the facts that the structures of the settlement were made of granite as a result of the site's geological formation, the history of burning at the settlement, its single level of occupation with a depth of between 80-100cm, and the efficiency of a gradiometer survey over such a big area (Aydın, 2001: 37-38).

During the survey, the measurements were made at 1m intervals with a gradiometer, and transferred to a computer using the Geoplot and Surfer programs. In order to check the geophysical maps, the ground truthing method was used which is based on a comparison of the magnetic map results with structures visible on the ground of the survey area (Aydın, 2001: 38- 52).

At the end of the 2000 study session, a total of 1512 units of subsurface features were identified and when they were digitized from geophysical data, they appeared either as small rectangular features subdivided into smaller spaces (individual buildings with rooms) and large rectangular features surrounding open spaces (courtyards *vel sim.*) (Aydın, 2001: 81-85).

The prominent fortification wall of the site, visible both on the surface and balloon photographs, and a system of three defensive trenches also appeared on the geophysical survey maps after the first session of the survey (Summers & Summers, 1995). In 1996, to test the geomagnetic survey results, five trenches were opened and its accuracy was proved with these soundings which revealed a columned hall and two-roomed structures prominent on the geomagnetic maps (Summers *et al*., 1998b). A number of diagonal streets and isolated anomalies which can be structural elements of the settlement (Summers *et al*., 1998c), considerable detail of the "Palace Complex Façade" containing a number of independent monumental buildings (Summers *et al*., 1999), and a large open public place (Summers *et al*., 2001: 7) are the other features identified according to the geomagnetic maps of Kerkenes.

In addition to the geomagnetic survey, resistivity and GPR methods were also experimented at Kerkenes Dağı. However, the most informative results were gained from the geomagnetic survey maps. The reason for the success of the magnetic survey at Kerkenes is mainly the site's geology, geomorphology and burning history. Thus, this result supports the idea that if a site is located over a flat surface of granite rock in arid climate conditions, the geomagnetic method can be most appropriate since the structures of the settlement were constructed from granite and are buried in a shallow fashion.

Ziyaret Tepe

Ziyaret Tepe is located along the banks of the broad alluvial plain of the Tigris River in the Diyarbakir Province of southeastern Turkey. The geographical setting of the area is shaped by wide hills with an elevation of 600m above sea level and open plateaus at an elevation of 540m. The site lies over Pleistocene terraces shaped by limestone and young basalt caprock (Matney, 1998: 255-256, &2006)[7].

The annual precipitation of about 580mm is seen almost only in the winter months. The vegetation is characteristic of the Oro-Mediterranean and steppe forest. The economy is based on the farming of crops, including cotton and tobacco, which require intensive irrigation efforts (Matney, 1998: 255-256, &2006).

The site is a large multi-period mound of the Late Neolithic or Early Chalcolithic, Middle Bronze Age, Late Bronze, Iron Age, Late Roman, Sassanian and Islamic periods. The most important occupation period of Ziayeret Tepe was from the

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[7] See the web page http://www3.uakron.edu/ziyaret/learn.html.

Late Bronze Age to Late Iron Ages between the late 2^{nd} millennium B.C. and the first half of the 1^{st} millennium B.C. (Matney, 1999: 137). According to cuneiform texts, the site was an urban center and a provincial capital at the northern edge of the Assyrian Empire during the late Iron Age (c. 900-600 BC); it was presumably abandoned after the collapse of the Assyrian Empire and the sack of Nineveh in 612 BC by the Medes and the Babylonians (Matney, 2000: 38-39).

Because of its historical importance and known size (32 hectares) an international team directed by Tim Matney started work by creating a topographic map of the site and making a systematic surface collection of artifacts in 1997 with the aim of mapping its complete layout (Matney, 1998: 256). In 1998, it was decided to use a large scale magnetic survey to accomplish the aims of this research more rapidly. At the end of two more magnetic survey sessions in 2002 and 2003, about 75% of the site was mapped (Matney *et al*., 2003, 175-221, & 2006). In the 2004 and 2006 field seasons, the range of archaeo-geophysical techniques was expanded to include electrical resistivity. These surveys and excavations so far revealed that the mound at Ziyaret Tepe has two distinct areas: the upper town or citadel and the lower town which was surrounded by a fortification system (Matney & Bauer, 2000, 120-121).

The magnetic survey at Ziyaret Tepe was carried by Lewis Somers with an FM36 fluxgate gradiometer with a sensitivity of 0.1 nT. The survey area was gridded at 20x20 m intervals and Geoplot software was used to process the data. In 1998, the survey was conducted in four different areas; two of them on the high mound and the other two in the Lower Town. The survey on the western lobe of the high mound's largest flat area indicated some linear feature identified as the stone foundations of the building and city fortification with gates and towers with a magnetic density ranging between 20 and -20 nT. The survey on the Lower Town localized an external city wall, its gate structures, a defensive ditch or a road at the same magnetic low range as that of the Upper Town (Matney, 1999: 138-142).

In 1999, a large area in the Lower Town was mapped; however, the 1998 maps are much clearer than the 1999 one. The reason for that was the shorter sample interval (0.125m. against 0.25m) of the earlier survey. The greater interval in 1999 was chosen to speed up the survey at the expense of its precision because irrigation on those parts of the site threatened the settlement (Matney & Bauer, 2000, 122-124). However, the city walls were still recognizable on these survey maps.

During the next excavation sessions, the small test trenches were dug to confirm the magnetic gradiometry maps; the city wall, several gates, large buildings, and major streets in the Upper and Lower Town appearing prominent on geomagnetic maps were accurately traced with these soundings (Matney, 2006).

The electrical resistivity survey of the area also gave positive results because the site location on the flood plain of the Tigris provided a high moisture density for the subsurface features.

The survey at Ziyaret Tepe highlights two positive features of a magnetic survey: to locate the stone foundation structures and to speed up the surveys which are under the danger of flood.

Çatalhöyük

One of the most popular Neolithic sites in central Anatolia near the modern town of Konya is located by the Çarşamba River which flows into the Konya Plain forming a rich alluvial fan. J. Mellaart started the earliest excavation in the 1960s, and the site is being excavated by I. Hodder's team since 1993 (Watkins, 1995: 422).

The geomagnetic survey at Çatalhöyük was conducted on the west part of the mound in the 1993 and 1994 excavation sessions (Hodder, 1996: 17). Although this area was covered by soil erosion, the top of the continuous layer of mud brick and burnt structures was traceable from the surface after scraping. However, the investigation of these structures was possible by scraping in small areas only, since the mound was too large to apply this method everywhere. Thus, it was decided to test the ability of magnetic surveying to detect the features related with mud brick structures which can assist in laying out the building plans over a large area (Shell, 1996: 101-13).

The high amount of iron content in the soil, the location of features near the surface and the existence of burnt structures were the reasons to choose this method (Shell, 1996: 101-13).

The survey area was gridded out into 20 x 20m squares and measurements were taken at 0.25 m intervals with a Geoscan Research FM36 fluxgate gradiometer with a reading resolution of 0.1nT. The processed data showed three kinds of low intensity anomalies ranging between -5nT and +5nT, higher intensities up to 50-60nT and highest intensities around 100-200nT. When the results were tested, it became apparent that the low intensity anomalies corresponded with the mud brick walls or the presence of a wall boundary, high intensity regions corresponded to burnt sediments and hearths near the surface, and very high values were associated with iron objects (Shell, 1997: 333-342).

The result of the survey showed that a magnetic survey has the capability to locate the mud brick structures lying near the surface.

Troy

Troy is located in the northwest of Turkey at the entrance of the Dardanelles and lies on a limestone plateau. After the excavations conducted by Schliemann from 1870 to1890, by Wilhelm Dörpfeld between 1893-1894 and by C.W. Belgen from Cincinnati University between 1932-38, the excavations at Troy resumed under the direction of Manfred Korfmann from the University of Tübingen, with the cooperation of Brian Rose from the Department of Classics at the University of Cincinnati in 1988 (Korfmann, 1989: 283).

The geomagnetic survey at Troy was carried out with a Geoscan FM 36 fluxgate gradiometer from1988 to 1991, covering approximately 6 hectares, and with a caesium magnetometer from 1992 to 1995, covering approximately 14 hectares. The sampling and grid intervals of the 1988 survey were 1m, and those of 1989 0.5 m. The aim of this survey was to map the lower city of Troy which was intensively occupied during the Roman period and generate the plan of the city. The magnetic mapping of 1988, 1989, and 1990 localized the linear and rectangular features with a magnetic density of approximately 6nT (Korfmann, 1989: 287; Korfmann, 1991: 430).). The excavations located according to these anomalies revealed the street plan of the Roman city (Troy IX) (Korfmann, 1992: 381). The rectilinear features of the magnetic map of 1992 were proven to be the city's sewage canal system in the excavations of the same year (Korfmann, 1993: 326). A course of Bronze Age ditches (Troy VI/ VII) was also discovered after the 1993-1994 magnetic survey (Blindow, *et al*, 2000: 123-133; Korfmann, 1995: 285).

Kyme

Kyme on the Aegean coast of Anatolia has been excavated by a team from the University of Catania (Italy) since 1982. Although the greater part of the port area (IVth century B.C.), a theatre (Ist century B.C. – AD 180), a defence wall and a tetrastyle temple devoted to Isis (IVth century A.D.) and the medieval citadel (XII-XIIIth centuries A.D.) of the city have been revealed so far (Lagona, 1993: 143-163), most of the site is still entirely unexplored which led the director to conduct a magnetic survey on the areas having potential archaeological value (Ciminale, 2003: 119-130).

In the 1999 and 2000 summer sessions, a 37,000 m^2 area was surveyed. However, the existence of trees, dry walls, cultivation, pylons and such features in the survey area caused it to be abandoned (Ciminale, 2003: 119-130).

After the data processing, many anomalies indicating curved or linear features were detected. One of them close to the theatre was prominent on the maps and to find out the origin of this anomaly, a test sounding was opened in 1999. A marble column was found at a depth of about 0.8 m. and a pavement made of blocks of granite stone were discovered at a depth of 1.1 m (Ciminale, 2003: 119-130).

Aphrodisias

The ancient city of Aphrodisias is located on a flat portion of a plateau in the Meander River basin, in a fertile valley 160 km southeast of the port of Izmir, in western Turkey. It is one of the most important sites of the Greek and Roman periods from the first century B.C. through the sixth century A.D. After preliminary excavations in the early 20th century, in 1961 a survey (and excavation) of the ancient city was started by Kenan Erim (Erim, 1986: 37-53). After his death in 1995, R.R.R. Smith and C. Ratte from New York University continued to excavate the site. The results of the studies so far show that the city has an elaborate fortification system enclosing the area of temples, agoras, theatres, baths and an acropolis (Smith & Ratte, 1995: 1-22).

The geophysical survey of Aphrodisias was carried out in 1995 by Lewis Somers with the aim of exploring the subsurface features of the unexcavated areas between the Temple of Aphrodite and the Stadium in order to determine the relationship between the city center and the residential areas (Smith & Ratte, 1995: 10). The area chosen for surveying was flat however it had been cultivated until 1990. After this area was gridded out in 20 x 20m squares, each square was divided into 1m strips. An RM15 resistivity meter and an FX36 fluxgate gradiometer were used and over 40,000 m^2 were surveyed. Three test trenches were opened according to the result of this survey which were completed in 1996 and revealed part of a street and parts of small-scale buildings on both sides of it (Smith & Ratte, 2000: 223).

In 1997 and 1998, the geophysical survey was extended to the rest of the open area within the city wall and excavations there revealed other architectural structures of the city, such as houses, a street, and drain. As a result of these finds, it has been suggested that the city center and the residential areas of Aphrodisias were occupied up to the sixth and seventh century as a prosperous city (Smith & Ratte, 2000: 225).

In Aphrodisias, although the combined results of both geophysical surveys were used, the resitivity survey results were more informative than the magnetic survey and it was mostly used for the aim of excavations. This high resolution of the resisitivty maps could be explained by the moist climate of the area.

CHAPTER III

THE GEOPHYSICAL SURVEY OF KİNET HÖYÜK

Sandro Veronese with help from a team from Kinet used a magnetometer to geophysically survey part of the mound and surrounding areas of interest in the 2000 excavation season. The survey was done on the East Terrace and neighboring citrus grove and in the open fields to the northwest and northeast of the mound (Appendix A: map.2).The primary aim of the survey was a non invasive assessment of potentially buried archaeological features. Off mound excavations by Beach and his geomorphic team in unit Q revealed one major stratum of Hellenistic structures buried at a depth of 2.4m (Beach & Luzzadder-Beach, 2000). Moreover, Redford had hypothesized from Medieval Arabic sources that an early medieval occupation might be located in the area (Redford *et al.,* 2002). Since the Hellenistic layer was about 2.4m deep, the Kinet team reasoned that an Early Medieval occupation may be buried more shallowly and a broad survey might identify it. They reasoned further that the geomagnetic method should be the primary geophysical prospecting method for this survey for the following reasons. Firstly, the geological structure of the site was convenient for geomagnetic survey. Much of the watershed is composed of an ophiolite complex with much limestone, and the fluvial sediments that cover the area derive from these rocks. These sediments, soils and river limestone have a broad range of magnetized minerals, though their concentration for the most part is quite low. Hence, no highly magnetized sediments covered most magnetic anomalies.

Secondly, a ground-penetrating-radar (GPR) survey is difficult to carry out in the geomorphological conditions of deep alluvial sediments without certain bedrock or a high water table surfaces.

Thirdly, plans called for a test survey of a substantial area in the limited time of one field season to see if the geophysical survey could provide promised results; a resistivity or GPR survey would take too long to finish.

Lastly, field work took place in July when temperatures are at their peak and rainfall rare. As a result, the structure of the soil would be too dry for the high resistivity values that match archeological structures. Resistivity anomalies would thus be rare and success in locating features unlikely.

3.1. The Survey[8]

In total, this study surveyed 16,362m^2 in four areas. Area A, measuring 162m^2, was located on the mound to the west and southwest of trench K2; area B measuring 1800m^2 was located on the mound and extending through the terrace covered with orange tress now; area C spread over 8,400m^2 to the north east of the mound; and area D extended over 6,000m^2 to the north of the mound (Appendix A: map.2).

The survey was carried out using a Geometrics G 856 portable proton magnetometer with two magnetic sensors. The instrument had a theoretical sensitivity

[8] The summary of this survey and its results is based on S. Veronese's report of the magnetometer survey of Kinet Höyük (2000).

of 0.1 gamma and a practical sensitivity of 1 gamma, which was proved by the repeatability of readings.

The magnetometer was used in differential mode to take measurements. On each station two sensors were located at different heights - the bottom sensor at 30cm, the top at 70cm from the surface of the ground.

Readings were taken and recorded on a 1 meter sampling grid. At the end of the survey, nearly 33,000 measurements had been made, which were first stored in the memory of the gradiometer and transmitted to a portable computer after the survey. The data files included X and Y direction coordinates with the gradiometer readings as Z values for every point of the grid. Golden Graphics Surfer software was used to process the data and create colored contour maps and image maps. On the maps, the strength of magnetic anomalies ranged between red-magenta to blue from highest to lowest range in gammas for each. Capital letters (A, B, C, D, etc.) denote interesting finds and the best suggested locations for investigating possible archaeological features.

3.2. Magnetic Data Processing

Two main types of vulnerabilities could affect the accuracy of the acquired magnetic data in this survey. The first includes the most common field errors: tilting the gradiometer, discontinuities between grid edges, and stripping of traverses. The second was the presence of magnetic noise sources because of intense human industrial activity, which has caused geophysical changes around the site. The main magnetic noise sources are:

(a) The Delta Petroleum Company storage facility located in Kinet Höyük (the main magnetic noise source) because the large metal infrastructure modifies the Earth's magnetic field and potentially spreads magnetic anomalies into the archaeological area (Appendix B: pl.1),

(b) A large number of electrical wires, vehicles, and radio transmitters very close to the site.

(c) The survey area has been cultivated, and settlements are very close to it, as a result modern garbage was scattered around the survey area.

(d) The area also experiences diurnal variation in the Earth's magnetic field.

Magnetic noise can hide or resemble the anomalies resulting from archaeological features. Hence, to determine the best method to eliminate deceptive anomalies, the survey team conducted a test survey in an area of 20 x 30m on the northwest part of the mound, in Area C. After taking the data, the maps of the Earth's magnetic field (Appendix A: map.3a), its horizontal (Appendix A: 3b) and vertical (Appendix A: 3c) gradients were prepared for this survey area.

The magnetometric map showed two anomalies; anomaly A was near the lower left corner and anomaly B was at the right top corner. Both anomalies are located in an approximately 112m^2 surface area in red-magenta and their magnetic low ranged between 46,040 and 46,420 gammas/m. When these anomalies were correlated with those on the horizontal and vertical gradients of the Earth's magnetic field, it was proved that they are false because they were not traced on those maps. However, magnetic anomaly A took the form of an individual anomaly on the vertical gradient map's lower left corner. As a result, this exercise demonstrates the superiority of the vertical gradient of the magnetic field on the overall magnetic field.

Using the differential mode and taking measurements at the same time by the top and bottom sensors and very closely comparing these to the diurnal variations showed that the effect of the changing Earth's magnetic field was the same on both readings, so diurnal variations were also removed (Veronese, 2000).

Although taking the measurement of the vertical gradient of the Earth's magnetic field eliminates artificial noises totally or partially, it can not eliminate the magnetic anomalies created by soils' changing mineralogical composition. Intensity, dimension, shape and other such characteristics help in recognizing archeological anomalies and those produced by different soil types. Such factors were taken in consideration during the data evaluation procedure (Veronese, 2000).

3.3. The Survey Results

The geophysical maps indicate a number of anthropogenic features of different sizes. All the major anomalies given here are based on the description of Veronese's survey report because of two main reasons: firstly, he was the geophysicist of this survey and also according to his interpretation test trenches were opened; secondly, my aim with this study is to discuss the accuracy of his finds by comparing the test results rather than to reinterpret the survey maps without any evidences from the test trenches. My addition to his work is to produce a clearer description of the anomalies' size, shape and location and their possible origin.

Area A

Veronese's team had two aims by surveying on the mound to the west of trench K2, area A. The first was to ensure the reliability and accuracy of the data, or repeatability, and assess the measurement of noise, and the second was to find the anomalies that could correspond to structures related to features uncovered in the bordering trench K2.

To test for repeatability, Veronese took two different non-concurrent surveys of the same points of Area A to verify whether the data collected in two surveys overlapped each other. The maps of the Earth's vertical gradient were made for each survey (Appendix A: maps 4a & 4b). Then, the data revealed on both maps was checked with a differences map, however, the differences map did not reveal repeatability (Appendix A: map 4c). The magnetic noise sources and the field errors were accepted as the reason for this result. However, if it was already considered that the location of area A is very close to the iron entrance gate to the höyük, the chosen area for repeatability was the most inappropriate place for such an operation and its result is not unexpected.

Although the repeatability test showed some inconsistency, the vertical gradient maps revealed major anomalies which could be considered more or less accurate because their general layout on both vertical gradient maps are similar and the southern border of these maps, which is the area much closer to the metallic fence, indicate a very high density anomaly, anomaly A.

On both maps anomaly A corresponded to an approximately $16m^2$ area on the southern edge with a gradiometric intensity ranging between 2500 and -200 gammas/m; anomaly B occupied a $16m^2$ area in the central area with a magnetic intensity ranging between 100 and -100 gammas/m; and other small anomalies were scattered on the upper part and in the left corner of the maps with a gradiometric intensity ranging between 100 and -100 gammas/m. The southern border anomaly, anomaly A, had the highest magnetic low of the map which probably resulted from the metallic fence on this side of the mound, as stated before. Although the other anomalies on the upper parts of the maps did not highlight any specific shape of a feature or structure, the way in which they were arranged around that area reminded one of collapsed architectural structures.

The result of this survey is negative since the repeatability of the readings was not accurate. On the other hand, the survey area close to K2 trench did reveal some anomalies which can be related with structures in trench K2.

Area B

Area B was located on the east terrace of the mound and extended to the fields east of the site. The contour map of the Earth's vertical gradients revealed many small anomalies which were spread on the whole map area with a magnetic density ranging between 2500/-2500 gammas/m; they mostly appear as yellow and green areas with the exception of a medium size anomaly, anomaly A, in the south-west part in a $10m^2$ area of a magnetic density of 50 gammas/m (Appendix A: map.5). While the small anomalies did not indicate any specific feature and must be the result of sedimentation, anomaly A gave the impression of corresponding to a wall or any such kind of structure made out of metamorphic rocks because of its linear shape.

Area C

The survey results of the north-east of the mound, Area C, revealed strong anomalies. These anomalies were concentrated on the western and central parts of the earth's magnetic field map (Appendix A: map.6), and its vertical gradient map (Appendix A: map.7). In addition to these anomalies, the image (Appendix A: map.11) map of area C revealed some other groups of anomalies on the eastern part of Area C.

On the vertical gradient map (Appendix A: map. 7), appear the anomalies labeled as A, B, and C by Veronese. Anomaly A extended approximately in a 340m^2 surface area on the middle part of the western edge of the map. The magenta part of anomaly A had a circular shape and its highest magnetic intensity ranged between 500 and 3000 gammas/m; this could be a pit or metal objects. The red part of anomaly A with a magnetic low between 40 and 100 gammas/m could be a road because of its linear appearance and magnetic intensity range. The blue part could be a ditch or a feature like a road or a wall buried beneath the red part of the anomaly since its magnetic low was less than the parts surrounding it.

Anomaly B occupied an approximately 100m^2 surface area in red, yellow and green to the left of anomaly A. Since the magnetic density of this anomaly ranged between 10 and 50gammas/m and it had a kind of linear shape, it could be a collapsed stone wall.

Anomaly C, in red and blue, measured 100m^2 in surface area to the north east of anomalies A and B with a magnetic low ranging between 150 and -150 gammas/m. The circular shape of the blue area was surrounded by red. This anomaly showed a kind of separate feature which did not connect with the other anomalies in area C. Thus, the possible origin of this anomaly could be sedimentation, a pit or a ditch.

The other groups of anomalies, labeled as D, E, and F by Veronese were dispersed from the central to the eastern part of the map and showed less magnetic intensity than the western part anomalies. Anomaly D spread over approximately 50 m^2 almost in the center of the map, anomaly E extended over 50 m^2 next to D, and anomaly F again measured approximately 50 m^2 in the south east part of the map. All these anomalies had magnetic intensities ranging between 150 and -150 gammas/m shown in red and blue. Both the red and blue parts of these anomalies were circular in shape. Their possible origin could be either sedimentation or ditches.

Also two linear anomalies were localized on the western and southern part of the map by Veronese. Anomaly X,X' extended around 40m in length on the west of the southern part of the area with a magnetic intensity ranging between 10 and 50 gammas/m; it could be a wall segment. Anomaly Y,Y' was around 100m long in the eastern part of the southern area with a magnetic intensity ranging between -10 and -50 gammas/m; it could be the result of sedimentation (Appendix A: map.7).

This map also resolved three groups of short linear anomalies spreading in length all in the same axis which were not traced on the contour map. The first group measured around 50 m in length, was oriented northeast-southwest on the western side of the map and was labeled Z,Z'; it had a magnetic intensity ranging between 10 and 30 gammas/m showed in red, yellow and green. The second group, R,R' running for a length of about 30m in a northeast-southwest direction and located on the eastern side of the area showed a magnetic low ranging between -10 and -50 gammas/m; it included over seven separate anomalies in linear arrangement, following one another. And the third group was one linear anomaly K,K', measuring around 60 m in length and running to the north of strong anomaly A with a magnetic density ranging between 40 and 100 gammas/m. Although all the anomalies showed as linear features, the very low magnetic value of anomaly K,K' could indicate the presence of a segment of a road while the others could be either walls or sedimentation.

The finer grained maps of earth's vertical gradient of area C (Appendix A: maps. 8, 9 & 10) showed many other anomalies in addition to those discussed above. These anomalies were smaller in size and seen on the green areas of the maps. The magnetic density of these anomalies ranged around 10 gammas/m which highly indicates sedimentation; however, Veronese suggested to dig test trenches to explain what caused these weaker anomalies and he positioned some best locations for these tests on maps 8, 9, & 10 (Veronese, 2000).

In addition to the above-mentioned major anomalies, Veronese localized two more linear anomalies on the image map (Appendix A: map.11) of the area: anomaly, W,W' oriented southeast-northwest stretching 35m in length between anomalies D and F of the vertical gradient map and anomaly, V,V' labeled with red arrows, just above Z,Z' which seemed to connect with Z,Z'. A group of parallel linear anomalies became visible on the eastern part of this map whose origin can be related with recent human activities such as plantation because of their strict parallelism and regular spacing.

The general concluding remarks of Veronese for area C is that the high-value anomalies A, B, X,X', K,K', Z,Z', W,W', may correspond to roads, walls or buildings made with igneous or metamorphic rocks, or again result from the existence of buried metallic objects. On the other hand, the weak linear anomalies in the eastern part of the area could originate from buried structures or a modern structure connected with agriculture. The other anomalies with lower values D, E, and F may correspond to underground structures, modern formations, and ditches as the case for V,V'. Also, Veronese recommended examining the possibility of a continuous structure formed by V,V' and Z,Z'. While I agree with him about the origin of A, B, X,X', D, E, F the better explanation for anomalies Z,Z', W,W and V,V' could be sedimentation. However, the best way to say something about the anomalies C, D, E, and F is to open trenches.

Area D

Area D was located on the north-west part of the mound. The contour map of the vertical gradient of the Earth's magnetic field of this area (Appendix A: map.12) indicated a great number of scattered anomalies mainly on the western half of the area with a 2500 and -2500 gammas/m magnetic intensity range. To see these anomalies in detail, Veronese divided the survey area into three parts, and he prepared three separate contour maps for each area.

In the first detailed contour map (Appendix A: map.13), he identified seven major anomalies. Two of them, A and B, were of considerably high intensity to the south corner of the area. Anomaly A covered a $50m^2$ surface area with a magnetic low ranging between -10 and -60 gammas/m. The negative value of this anomaly indicated the presence of deeply buried features which could be either a wall segment or a building. Anomaly B occupied a $65m^2$ area with a magnetic low ranging between 15 and 100 gammas/m; it could be part of a building, a wall or a road segment.

On the western lower part of this map, to the left of the above mentioned anomalies, anomaly C was localized oriented northwest-southeast covering $100m^2$ with a magnetic low ranging between 15 and 100 gammas/m. Anomaly D occupied a $50m^2$ area in the central part of the map; its magnetic intensity ranged between 10 and 40 gammas/m which indicated most probably a wall. Anomaly E covered a surface area of $120m^2$ to the right of D with a magnetic density ranging between 100 and -100 gammas/m. Both of these anomalies were spreading in an east-west direction. The other two anomalies, H and F covered a surface area of $150m^2$ on the upper part of the map with a magnetic low ranging between 100 and -100 gammas/m. Both were aligned in a north-south direction and H was located to the west of F. The general appearance and magnetic intensity of all these anomalies signified both building structures.

On the second map (Appendix A: map.14) the anomalies, G and I were easily recognized due to their intensity ranging between 100 and -100 gammas/m on the north part of the area and both of them were reminiscent of a concentration of stone heaps which could correspond to either a road or a wall.

In terms of the identification of any archaeological feature, the third map (Appendix A: map.15) gave negative results although some medium-scale anomalies at the centre and on the lower side can be traced. Their low magnetic density and arrangement inconsistently make them considered as sedimentation.

The image map led us to look at the area from a more general perspective (Appendix A: map.16). This map also indicated the major anomalies apparent on the high-resolution vertical gradient maps, however, the image map revealed a kind of rectangular shaped anomaly in the east upper corner. The most possible interpretation for this anomaly is that it corresponds to a rectangular building as Veronese suggested, seeing that any naturally occurring feature cannot take that regular shape coincidentally.

In conclusion, the magnetic survey revealed many anomalies in all the areas but major anomalies located specifically in Area C and Area D. The negative results in Area A and Area B must be attributed to their closeness to the major sources of magnetic noise around Kinet, such as the Petroleum Company, roads, vehicles, and electrical interferences. Whatever interpretation was suggested for each anomaly on the basis of the survey alone, the best way to ascertain their true nature is to open test trenches since the technology is still not adequate enough to identify their exact shape, size and location.

CHAPTER IV

COMPARISONS OF THE GEOPHYSICAL INTERPRETATION WITH THE EXCAVATIONS

4.1. Archaeological Test Excavations

The examination of the anomalies localized on the magnetic survey map was important for they were clear and widespread, and they had a high archaeological potential. Therefore, a total of eight test excavations were placed in Area C and Area D, specifically to test the strong anomalies in the magnetic survey. Three test soundings in 2001, three test soundings in 2002, and two test soundings in 2005 were located on the north-east side of the mound to investigate the archaeological features of those areas and to map Kinet's "lower town" (Appendix A: map.2). In addition to these, other soundings were opened in the magnetic survey Areas C and D without considering testing survey results. However, the results of some of them will be presented here since they help to evaluate the magnetic survey results.

4.2. Excavation Procedures

The size and placement of each test trench was determined by the space available between orange trees. Obtaining permission from the owner of the garden to open trenches between trees was very difficult and it was not possible to remove any orange trees because their production constitutes an important part of the revenue of the local people. The initial size of some trenches was extended later due to the necessity to follow some structures beyond the original baulks or finds observed on sections.

All the plants, eroded material and modern garbage on the topsoil of each trench and their close surrounding area were removed before excavation started.

The excavation of each trench was carried out over two weeks to a month between July and August, the most important time in the region for agricultural activity, when it is essential to water the plants to get adequate production. When we considered the surveyed area located in the tree gardens around the höyük, some test trenches were thus in danger of being flooded. To minimize risk, the soil shoveled from the trenches was heaped around the soundings to serve as a barrier between water and trenches.

In some trenches, when there were no finds or they were not worth excavating, only a small part was dug up to save time in case something significant appeared lower.

Each trench was excavated to the depth where the structures appearing as anomalies on the magnetic maps could be recognized or to the water table, no standard depth was used.

All major objects and samples were uncovered manually; wall fragments were plotted and recorded *in-situ* in the vertical and horizontal dimensions. Depths were recorded in centimeters below ground level, which was defined as the highest point adjacent to the edge of the excavation. Each plan view and cross-section was drawn. The sediment from the excavations was processed by screening and flotation. Soil samples were taken in every soil layer.

All the finds were taken to the excavation house to be studied (numbered, recorded, drawn and photographed).

4.3. Test Trenches in Area C[9]

Operation T1[10]

In the 2000 excavation season, three test trenches, R, S, and T1 each measuring 1.5 x 5m were opened to continue documenting the sedimentation process of Kinet's harbor, a project begun in 1999. Although the primary aim of each of these trenches was geomorphological research, the result of the test trench T is given here since it was located within the geophysical survey Area C.

Sounding T1 was placed at the south-west corner of Area C, 70m north of the mound's east end, and aligned north-south. On the Earth's vertical gradient map, the location of T1 indicated a few small negligible anomalies with a very low magnetic intensity around -10 gammas/m, showed in blue.

The test was dug to a depth of 5m without reaching the water table. It produced a sedimentary sequence of thick gray and yellow clays and thin sandy layers all containing rare pottery sherds. The limited number of sherds within the first 1m was dated to the medieval and post-medieval periods and to Hellenistic times between 2 and 5m in depth. However no architectural structure was encountered in this sounding.

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[9] The location of the test excavations on magnetic map of the area C can be seen on Map.17.
[10] The summary given here is based the day notes and the end session report of the excavation session by the trench supervisor C. Bodet.

The result of test T1 shows that this part of Area C results only from sedimentation with occasional sherds (wash from mound) dispersed in the soil matrix which totally matches the magnetic survey result.

Operation T2[11]

Sounding T2 was placed to the north west of area C in the 2002 excavation session. Its aim was to test the origin of strong magnetic anomalies, A and K,K'. Anomaly A can be divided in two parts: the highest magnetic reading within it, in the western part of T2, ranged between 500 and 3000 gammas/m, while the portion with a magnetic density between 40 and 100 gammas/m was located towards the eastern part of T2. Magnetic anomaly K,K' with a magnetic density ranging between 40 and 100 gammas/m was located on the eastern part of T2 where it connected with anomaly A.

The trench measured 1 x 20m, was oriented east-west and was excavated to a depth of about 2m. After the removal of the plough zone stratum, a layer of gravely loam sand mixed with murex shells, rounded gravel and cobble stones was exposed at a depth of ca. 35cm extending down to about 65cm.

In the next layer, at a depth of 70cm, the top of a pit was encountered in the western part, which was identified as medieval, and dated to the 12th-13th centuries A.D. Below this, at a depth between 80 and 90cm, a single basalt boulder was discovered.

At a depth of ca.1m, the western part of the trench showed as a layer of bone, and burnt ceramic, while a road ran north-south in its eastern part. A second road was uncovered beneath the first at a depth of ca.1.60m. Three coins were found in the

[11] This summary given here is based on the day notes and end session report of the trench supervisors, J. Mitchell, and J. Conrad.

flood-laid loam layer of the two roads at a depth around 1.30m. However, the western part of the trench did not produce any architectural structures (Appendix B: pl.2).

The test revealed that the area with the lowest magnetic reading of anomaly A corresponds to a pit, the basalt boulder and the coin lying at 1.30m depth, while the magnetic low ranging between 40 and 100 gammas/m (A and K,K') corresponds to the roads lying at a depth between 1 and 1.60m.

Operation T3[12]

T3 was placed 12m north of T2 in the north-west portion of Area C in the 2002 excavation session. The aim was to find out the extension of the road discovered in trench T2 and testing anomaly K,K' with a magnetic density between 40 and 100 gammas/m that cut through the trench on its western part. The trench was 1 x 25m in size and laid out in an east-west orientation.

After removal of a 10cm top soil, a 15cm layer of sandy soil with pebbles was exposed, but no pottery sherds or bone fragments were recorded. No significant finds were made either in the underlying strata until at a depth of 1.10m was exposed the expected road on the west side of the trench. This first road surface layer was mixed with pebbles, gravel all around the paving stones but no bone fragments, metal objects or coins as in T2. Beneath this road at a depth of 1.77m, a second road was encountered. On this lower road level, sherds and metal fragments were also collected.

This trench also provided the expected roads, but 10cm deeper than in trench T2. The location of the roads in the trench corresponds to magnetic anomaly K,K'. Thus, the resulting map proves its accuracy here again (Appendix B: pl.3).

[12] The summary of T3 is based on the day notes and end session report of the trench supervisors, E. Beyazçam and G. Özgönül.

Operation T4[13]

T4 was located in the south-west lower corner of Area C in 2002. It was a 1 x 30m trench, located 37.50m south of T2 and laid out in a west-east orientation to find out the extension of the roads of T2 and T3 and to make clear the reason for the linear anomaly X,X' with a magnetic low between 10 and 50 gammas/m that passes in the middle of this trench.

The finds within 30cm of the surface were pottery sherds, glass objects and bone fragments. However, the following layers were bare except for some pottery sherds but at a depth of 75cm, the top of a medieval wall was revealed within a dark, pebbly and gravelly soil along with metal, glass and pottery finds. Then ca.1m below the surface, the upper road appeared overlying the lower road by 70cm in the eastern part of the trench (Appendix B: pl.4).

The finds of this trench show that magnetic anomaly X,X' results from the medieval wall as both are located in the same area of the trench, on the other hand, the roads do not appear on the magnetic map of the trench.

Operation T5[14]

In the 2005 excavation session, T5 was opened specifically to test the magnetic survey and located in the middle of the western part of Area C where linear magnetic anomaly Z, Z' passed the middle of the trench with a magnetic intensity between 10 and 30 gammas/m. The initial size of the trench was 1.2 x 20m laid out in a north-south orientation; however, it was lengthened by 10m to the north in the course of excavation.

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[13] The summary of T4 is based on the day notes and end session report of the trench supervisors, E. Beyazçam and G. Özgönül.
[14] The summary given here is based on my personal observations and day notes as the trench supervisor.

The trench was excavated to ca.1.75m in depth. The only significant find of this excavation was the change in color and texture of the soil layers.

From the surface to at a depth of 40cm, a dark-brown compact soil with a small amount of worn medieval, Middle Islamic and Hellenistic pottery was uncovered. Below this level, between 50 and 60cm in depth, the color of the soil changed to light-brown and small stones started to appear in the southern and central parts of the trench. At a depth of ca.70cm the soil color turned to reddish brown which continued until a depth of 90cm from the surface. At this point the soil became very soft and light brown in all parts of the trench. After removal of 10cm of soil from this level, the color of the sediment remained constant, however it became damp.

At a depth of 1.40m, three different soil colors appeared in different parts of the trench: the first 7m from the north showed a layer around 20cm thick of red soil with small stones; the area from 7 to14m was a sandy and gravely dark brown soil also 20cm thick; and from 14 to 30m was the 20cm brown layer of earlier levels.

The aim of extending the northern part of the trench was to see if the layer of red soil continued in that direction. Red soils in young sediments are often not natural, but caused by burning. For this reason, there was a possibility to come across traces of a kiln on the extended side; however, excavation revealed nothing that could be identified as a fragment of a kiln. Thus excavation of the trench was ended since no finds correlated with the magnetic survey results (Appendix B: pl.5).

The result of this test showed that the magnetic anomaly Z,Z' results from the sedimentation, possibly from erosion of an adjacent kiln site, an old red soil, or oxidation of trampled, devegetated surface.

Operation T6[15]

Test T6 was opened in area C's north-west in 2005. It was intended to test magnetic anomaly B with a magnetic density between 10 and 50gammas/m in addition to find the possible extension of the roads found in the other "T" trenches. It was located between T2 and T4, 20m from each of them and 30m east of the irrigation channel located between the Z (a test on the north of mound) and T trenches; it was laid out in a west-east orientation. The trench initially measured 1.1 x 15m but was later lengthened to the north-east by 3m. The trench was dug to a depth of 1.85m below ground level where the second road was found.

The plough zone of 30cm revealed a layer of brown compact soil whose cultural contents consisted of small pieces of mostly medieval pottery. A layer of soft and sandy soil was encountered at a depth of 40cm, and after removal of 10cm from this layer, the top of a medieval wall was discovered at 3.50m from the western edge of the trench.

The soil showed three distinct textures and colors at a depth of 76cm: The easternmost third of the trench was gravely, the middle third was water borne sand and the last third was dark brown. Below this phase, at a depth of 1m a burial was encountered in the south-west part of the trench. 10cm below this surface the soil became light brown throughout the trench. The finds indicate that the eastern part of the trench most probably dates to the medieval period.

Under a layer of a very hard compact reddish soil mixed with small pebbles, the first road - width of 3.30m - was encountered in the eastern part of the trench at a depth of 1.20m. The removal of this road was impossible according to antiquities'

[15] The summary given here is based on my personal observations and my day notes as the trench supervisor.

service regulations, so, the digging process continued along both of its edges to investigate beneath. A 60cm layer of soil was removed to its west, revealing the second road; this road segment extended 5.30m to the west. However, it was not possible to find out the eastern segment of the second road and its exact width because it was lying beneath the first road and we did not have sufficient time or access on the eastern part of the first road to reveal its full extent (Appendix B: pl.6a & 6b).

Magnetic anomaly B in the western part of the trench was revealed as a wall segment and the eastern part of the trench located near the edge of anomaly A's end exposed the roads.

Operation WA, WB, and WC[16]

The test trenches W were placed in the 2001 excavation session to investigate the origin of anomalies D, E, and F in the central part of Area C, which showed a magnetic low that ranged between 150 and -150 gammas/m in red and blue. The trenches were placed at the edge of the anomalies where a very low magnetic intensity, between 10 and -10 gammas/m was registered; however anomaly W,W's northern edge ended in the middle of trench WA, so this test enabled us to verify its origin.

The size of all three trenches was 1.5 x 5m and they were all excavated down to around 2.5m below ground level. WA and WC, west of WB, were aligned in a west-east direction and WB was oriented north-south.

The upper layers of all W trenches were a layer of disturbed dark brown soil, corresponding to a plough zone; they contained some modern garbage, some sherds,

[16] The summary given here is based on the day notes and the session report of trench supervisor, A. Çagan with B. Yener.

and bone fragments (the top 60cm in WA, 20cm in WB and 30cm in WC). Under this horizon was found a wet soil layer about 50cm thick in WA and 70cm in WB, and 1.50m in WC which was followed by a dense gravel deposit about 30cm thick in each trench. This gravel deposit was identified as the bed of an ancient (Medieval or later) high energy flood by the director of the excavation (Gates, 2003: 288).The only finds of this gravel layer in all trenches were badly worn medieval sherds. A dark-brown soil layer was the last stratum in all the trenches (Appendix B: pl.7a, 7b & 7c).

The result of these tests also proved that the magnetic low of anomaly W,W' at around 10 and -10 gammas/m only corresponds to sedimentation instead of any archaeological feature.

4.4. Test Trenches in Area D[17]

The Operation VB[18]

Two soundings, VA and VB, measuring 2 x 4m were opened on the north-west part of the mound in 2001 with the main objective of investigating whether there was a Late Bronze Age port on this part of the höyük. The results in VB are also significant in terms of their correlation with the magnetic survey as this trench was also located in the geophysical survey area.

Sounding VB was placed on the western border of anomaly G in the upper central part of Area D, and oriented north-south. The high magnetic reading of part of anomaly G, at around 50 gammas/m, cut through the north-east part of trench VB.

From the surface to about 30cm a plough zone layer was uncovered which contained a mix of medieval and Hellenistic pottery. The subsequent layer was a

[17] The location of test excavations on magnetic map of Area D can be seen on Map.18.
[18] This summary is based on the day notes and the end session report of the trench supervisor, M. Akar.

20cm thick light gray soil layer with a tamped earth surface; its cultural contents consisted of mixed Hellenistic, Medieval and Iron Age artifacts. After a layer of light brown clayish soil 1m thick, the following layers revealed two walls; the first one started to appear at a depth of 1.70m in the western part of the trench, and was mixed with the remains of human skeletons; the second was just below the first in the east part of the trench, at a depth of 1.90m. A third wall segment appeared at a depth of 2.30m in the north part. Underneath this level, at a depth of ca.3.00m a deposit of charcoal in the middle of the trench was uncovered and excavation was stopped at a depth of 3.58m below ground level (Appendix B: pl.8a&8b).

The accuracy of the magnetic survey results for this part of the survey area is proved in this trench by the fact that the expected walls and the anomalies are at the same location.

4.5. The Summary of Results

The overall picture of the test trenches shows that the excavations located in Area C and D produced significant finds such as walls, pits, and roads and other archaeological features as well as sedimentation at a depth varying between 70cm and 2m. All these finds are suggested from the geomagnetic survey results; however, in some parts of the survey area the results of the magnetic survey are negative, so it is essential to reevaluate the magnetic survey results in the light of these because the geomagnetic survey maps prepared for Kinet are only the colored contour maps and black-and-white image maps which can only highlight the possible location of features and cannot identify reliably their nature.

First of all, we may start from the instances where results of magnetic survey and excavation prove positive, by correlating the magnetic densities observed during the survey with specific types of structures. Thus discrete magnetic ranges may be found to correspond to certain types of structures, as the table below illustrates. You will notice that several categories overlap, so that determination by survey alone will be inaccurate in some cases.

Feature	Magnetic Density (gammas/m)
Pit/metal objects	500-2500
Road	40-100
Wall	10-50
Sedimentation	30-(-10)

Area C is the most productive in terms of the correlation of magnetic survey and tests. According to the interpretation of magnetic survey map by Veronese, anomalies A, B, K,K', X,X', Z,Z', W,W' may result from architectural structures. While excavation confirms that anomalies A, B, K,K' and X,X' represent the suggested features, anomalies Z,Z', W,W' (revealed on the image map and just cut through WA) are product of sedimentation. The discussion of the earlier chapters gave the reasons for the magnetic noises affecting the survey area, so this negative result can be attributed to the magnetic noise sources. On the other hand, these tests enabled us to recognize a magnetic density for sedimentation and proved that sedimentation has the potential to be seen as magnetic anomalies in geophysical surveys.

The origin of other anomalies of Area C suggested by the magnetic survey (C, D, E, F, R,R', V,V', Y,Y') could not be tested because of the limited number of excavations; however, anomalies V,V' and Y,Y' seem to correspond to sedimentation because of their magnetic low. In addition, V,V' is connected to anomaly Z,Z' whose origin has been identified as sedimentation.

Area C can be interpreted mainly as a zone of deep alluviation, where sedimentation is many meters deep. However, two roads oriented northwest to southeast pass in its western part and the walling of a collapsed structure is located west of the roads.

Area C

Anomaly	Density (gammas/m)	Suggested origin	Excavation Result	Depth (cm)
Anomaly A	500-3000	metal object, pit	pit, basalt boulder, a coin	70/80/1.30
Anomaly A	40-100	road	two roads	1/1.60
Anomaly B	10-50	wall	wall	50
Anomaly C	150-(-150)	sedim., pit, ditch		
Anomaly D	150-(-150)	sedim., pit, ditch		
Anomaly E	150-(-150)	sedim., pit, ditch		
Anomaly F	150-(-150)	sedim., pit, ditch		
Anomaly C	150-(-150)	sedim., pit, ditch		
Anomaly X, X'	10-50	a wall segment	wall, two roads	75/1/1.70
Anomaly K, K'	40-100	road	two roads	1/1.60
Anomaly Z, Z'	10-30	wall	sedimentation	
Anomaly Y,Y'	10-(-50)	sedimentation		
Anomaly R, R'	10-(-50)	sedimentation		
Anomaly V, V'		m.f, u.s/, itch[19]		
Anomaly W,W'		road, wall		

Area D proved the magnetic survey accuracy by revealing wall segments in test VB. According to obtained magnetic values of features from Area C, Area D also shows a layer of sedimentation on most parts of the west and east portion. However,

[19] m.f stands for modern features, u.s stands for underground structures.

these sedimented areas seem to be interrupted by some pieces of walls. Evident from their size and arrangement, these wall pieces could be erosional pieces from the mound. On the other hand, the upper middle part of Area D obviously is covered with extensive building structures. The general layout of this area gives more promise than Area C because the anomalies in this area are more likely architectural structures having potential to cover a large area.

Area D

Anomaly	Density (gammas/m)	Suggested origin	Excavation Result	Depth (cm)
Anomaly A	-10-(-60)	wall		
Anomaly B	15-100	road, wall		
Anomaly C	15-100	road, wall		
Anomaly D	10-40	wall		
Anomaly E	100-(-100)	building structures		
Anomaly F	100-(-100)	building structures		
Anomaly G	100-(-100)	road, wall	wall	
Anomaly H	100-(-100)	building structures		
Anomaly I	100-(-100)	road, wall		

For Areas A and B, there is nothing much to say in the scope of this survey because the magnetic survey there was conducted to test the survey procedures. However, according to the chart of the magnetic density of the features, magnetic anomaly A in Area A may result from metal object(s) or a pit and anomaly B could demonstrate sedimentation. For area B, magnetic anomaly A should correspond to a wall.

Area A

Anomaly	Density (gammas/m)	Suggested origin	Excavation Result	Depth (cm)
Anomaly A	2500-(-200)	metal object		
Anomaly B	100- (-100)	sedimentation		

Area B

Anomaly	Density (gammas/m)	Suggested origin	Excavation Result	Depth (cm)
Anomaly A	50	wall		

In conclusion, the comparison of the results of the magnetic survey with those of the test excavations shows that, although a magnetic survey is a demonstrably useful method for locating archaeological features, its results must be correlated with excavations.

CHAPTER V

CONCLUSION

Geophysical surveys and preliminary test excavations were carried out at Kinet to gather data on the patterning of the sediments, structures and objects that could inform the history and organization of the site community. The aim of the thesis was to test the accuracy of the magnetic survey results by correlating them with the information collected from test excavations in the magnetic survey area. The result of this study has produced some important conclusions both about the magnetic survey itself, Kinet's lower town and in general about magnetic surveys for archaeological prospecting.

The geophysical survey at Kinet has successfully provided information for archaeological features in Area C and Area D for a depth extending between 70cm and 2m. The test excavations opened according to the anomalies in these areas demonstrate that most originate with roads, walls and pits as was predicted by the magnetic survey. This result supports the notion that the magnetic survey is most successful to locate building structures at a depth of less than 2m.

The combined results of the magnetic survey and the test excavations enabled us to approximate the magnetic density range of some features at Kinet: pits or metal objects (500-2500 gammas/m), roads (40 to 100 gammas/m), walls (10 to 50 gammas/m), and sedimentation (30 to -10 gammas/m). Such values are paralleled at other sites, thus their accuracy is highly trustworthy. As a result, these data can be used in other studies conducted in similar geological and geomorphological conditions.

Also, it is widely accepted that detecting archaeological remains in areas under deeply stratified sediment sequences within the lower reaches of major river system platforms or on prograding coastal platforms is difficult with conventional archaeological surveying techniques because of the excessive depth of the sequences, the high level of the water table and the invisibility of the buried archaeology. Thus, it is necessary to use multiple techniques to explore these kinds of areas (Bates, 2000: 845-858). Since the magnetic survey at Kinet gave positive results in most of the areas which were buried deeply by sedimentation, geomagnetic surveys can be accepted as a useful method for archaeological feature prospecting within alluvial environments.

Although the results of the magnetometer investigation clearly indicated most of the subsurface features; in some parts of the survey area the anomalies did not correspond to any finds. This demonstrates that magnetic noise constitutes a significant impediment to the total reliability of the survey at Kinet.

In addition, the combined result of survey and excavations allowed gathering further archaeological information about the höyük's lower town.
Although soundings T1, WA, WB, WC and T5 on the north-east part of the mound did not reveal any architectural structures or any traces of settlement for any period except for small amounts of worn pottery sherds of Hellenistic or medieval date, the

results obtained in T demonstrate that the northeast periphery of the mound was not occupied during the Hellenistic period while the gravelly deposits found in all W trenches possibly indicate the presence of an ancient river in those areas (Gates 2002a: 56, Gates, 2003: 288- 289). The results of these trenches were important in terms of providing information about the geomorphology of the mound's surroundings and environmental changes around the höyük over time, and in contributing to the reconstruction of Kinet's environmental history.

The most important finds of test soundings T2, T3, T4, and T6 in Area C were the two roads lying one above the other. The upper road had a width of approximately 3.6m. Its surface was constructed with cobbles and irregular fragments of circular tiles and a line of large stones in the central part divided it into two lanes. The second road shared the features of the first. However, it may have been twice as wide, estimated at ca. 7.5m. (KK, T5 showed a greater width than this). Between the two roads was a water-laid sediment around 50cm thick. According to a suggestion provided by Coockson to Dr. M-H Gates (2004: 410), the upper road could be the repaired version of the lower road and they would be part of a major communications axis linking Cilicia to Antioch. They may also have a connection with a Late Antique bridge built 1km to Kinet's south before the Deliçay's shift to its present course (Gates, 2004: 410) and the possible site of Al Tinat about 1 km north (Eger field report, 2006).

Sounding VB produced highly significant architectural remains showing that Kinet's North Bay was occupied in the tenth-eighth centuries B.C. but was later abandoned. Seven distinct architectural phases were identified within this sounding (Gates, 2003: 289).

In addition, the different colored soil layers of all trenches are a product of the sedimentation process that occurred as a result of flooding over time according to Timothy Beach.

In conclusion, this work has demonstrated that despite some limitations, the magnetic survey can be a useful technique in locating buried archaeological structures and guiding excavations in an alluvial environment in limited time. Although the unpromising environmental conditions and the presence of the magnetic noise sources can affect the survey result a great deal, it is still possible to obtain much by using the most proper geophysical survey method or methods.

Abbreviations

AnatSt Anatolian Studies.

ANES Ancient Near Eastern Studies.

AST Araştırma Sonuçları Toplantısı.

KST Kazı Sonuçları Toplantısı.

TJKB Türkiye Jeoloji Kurumu Bülteni

Phil. Trans. Roy. Soc. London.A. Philosophical Transactions of the Royal Society

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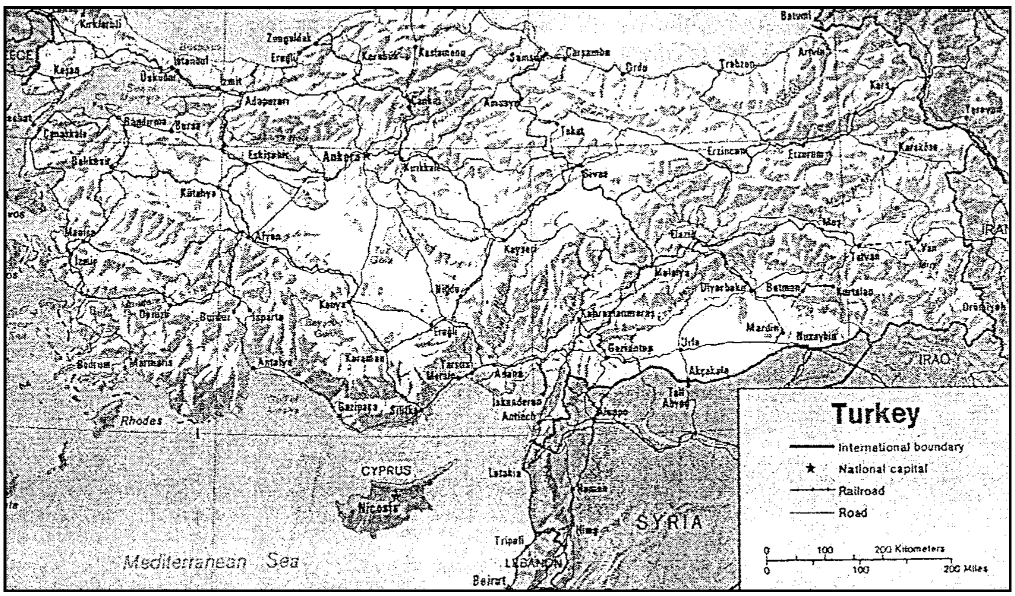
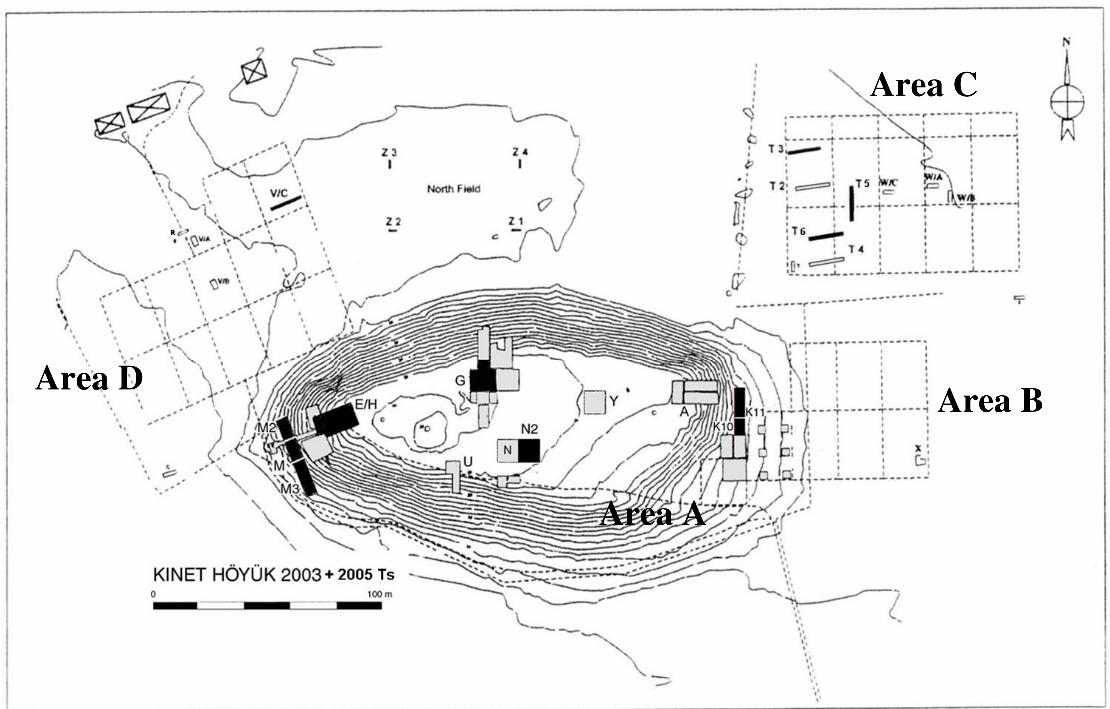
Appendix A



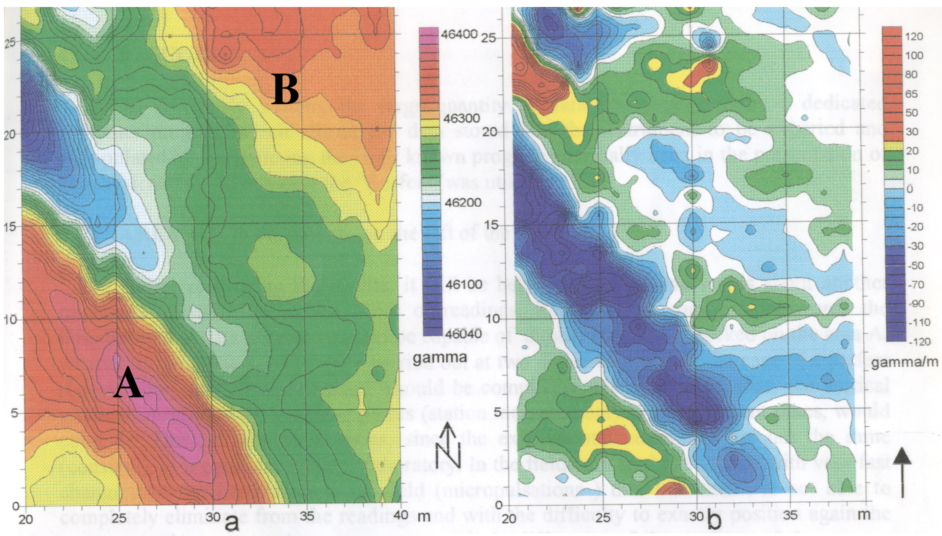
Map.1a. Map Turkey

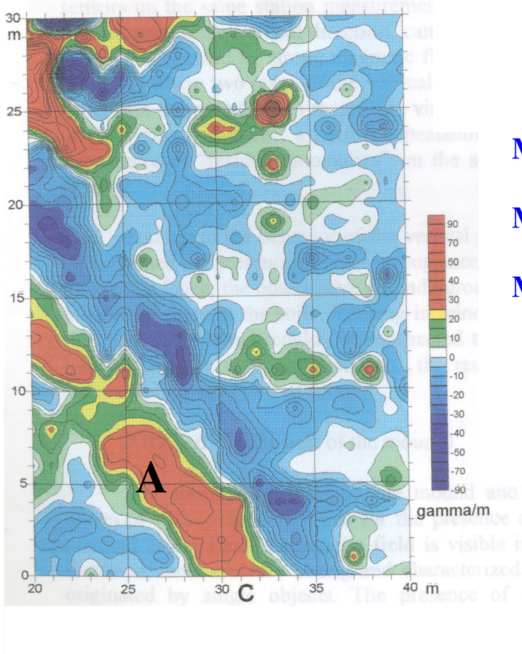
Map.1b. The Location of Kinet Höyük



Map.2. Kinet Höyük and Geomagnetic Survey Areas

Test survey maps of Area C





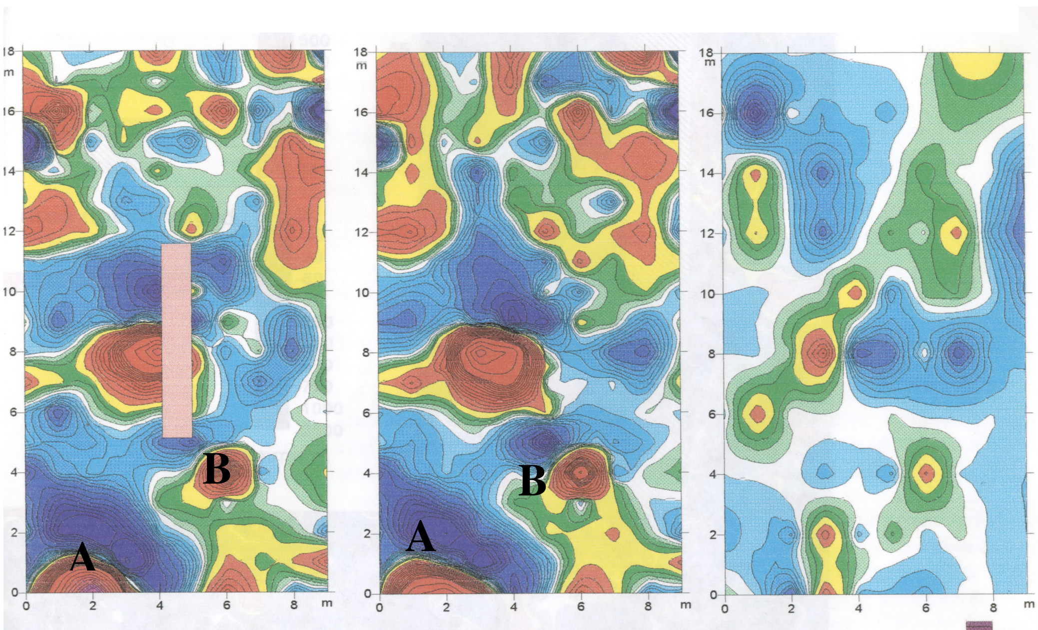
Map.3a. Earth's Magnetic Field

Map.3b. Horizontal gradient map

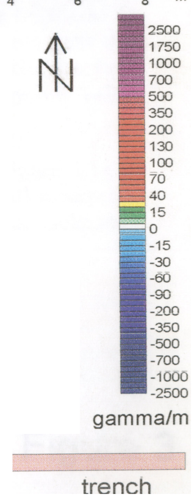
Map.3c. Vertical gradient map

(Veronese, 2000)

Vertical gradient maps of Area A and difference map



4a 4b 4c

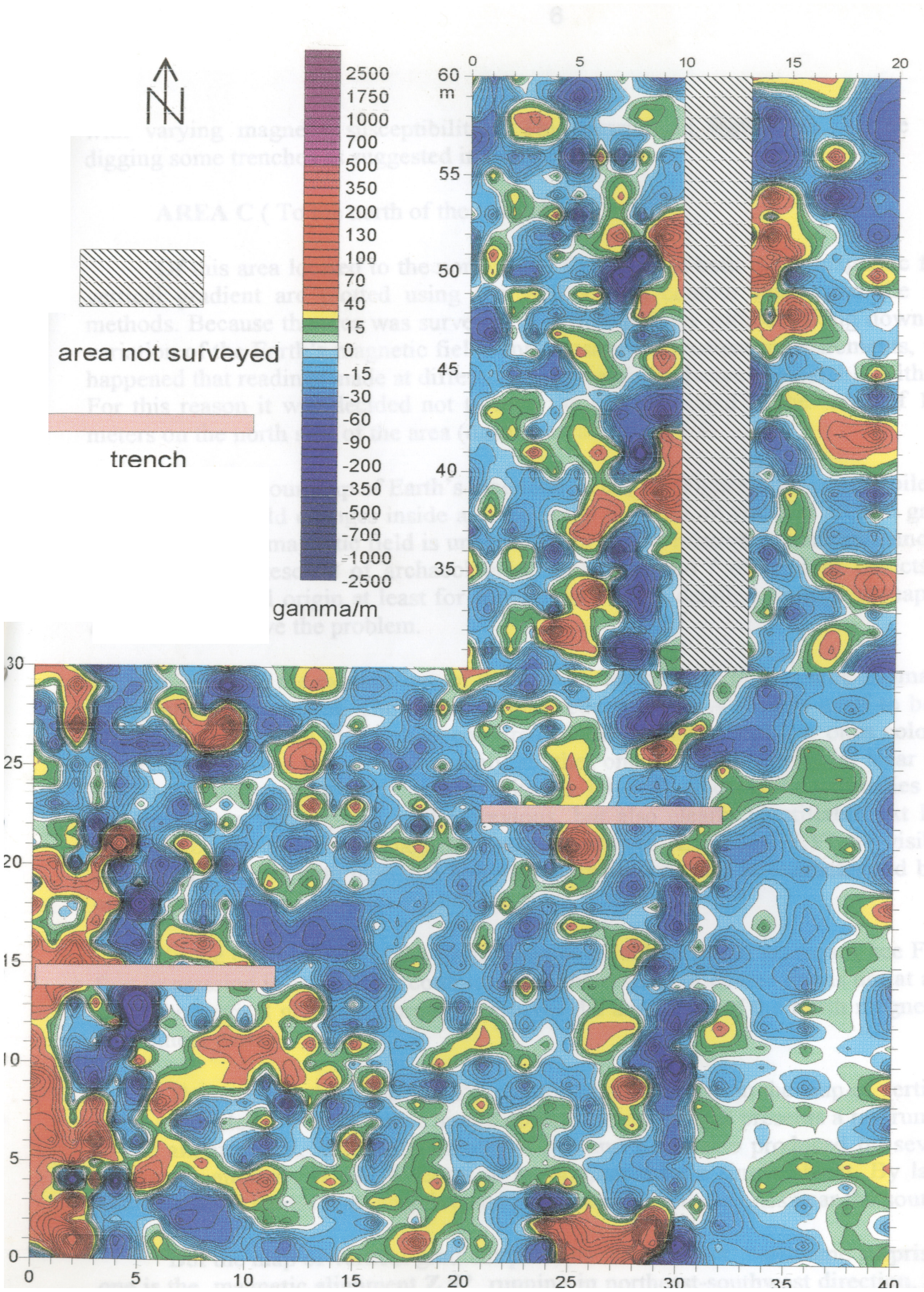


Map.4a&4b. The vertical gradient map of the Earth's magnetic field

Map.4c. Difference map

(Veronese, 2000)

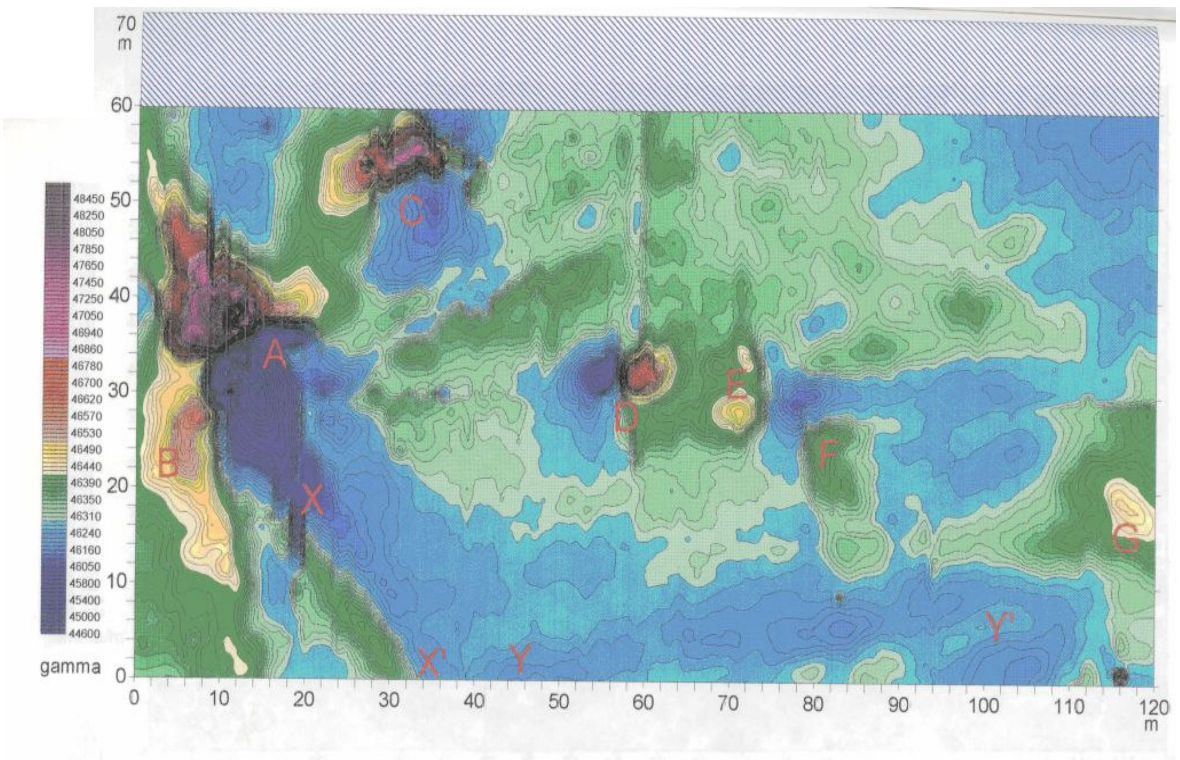
Area B



Map.5. Vertical gradient map

(Veronese, 2000)

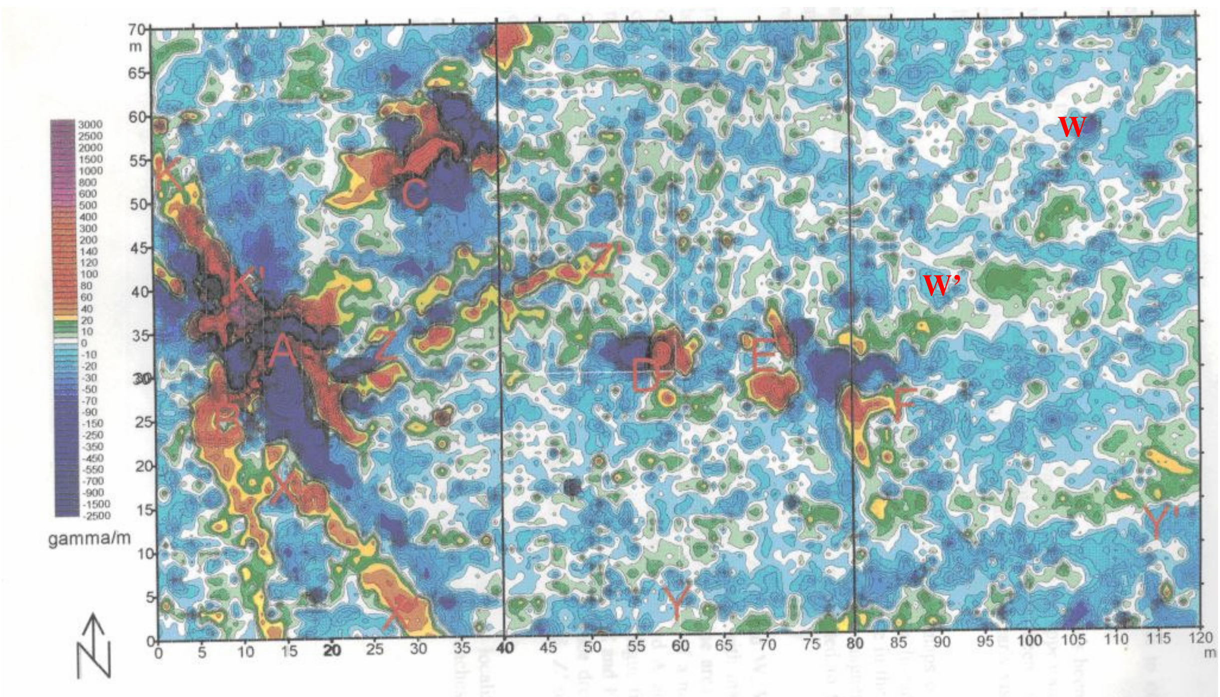
Area C



Map.6. Earth's magnetic map

(Veronese, 2000)

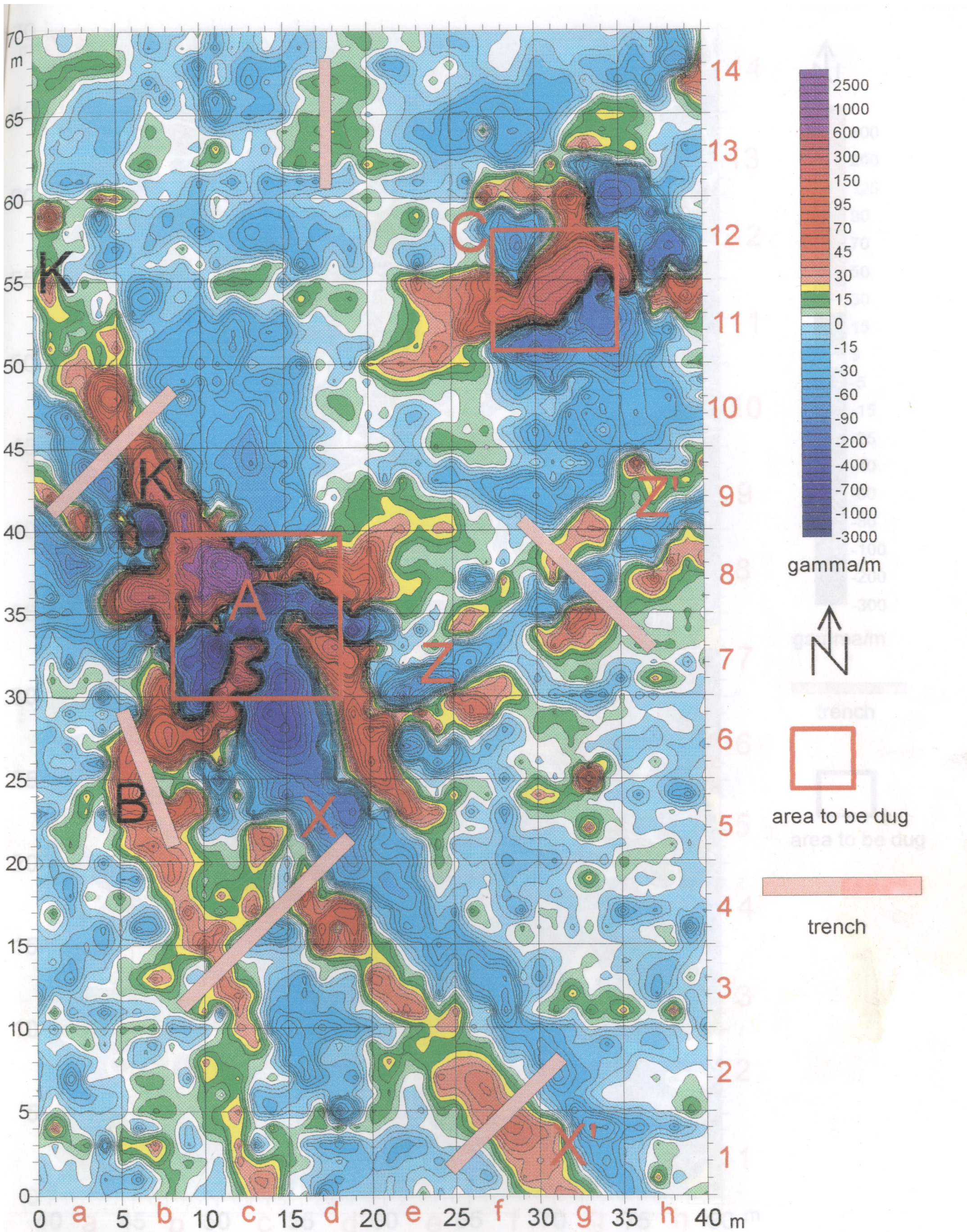
Area C



Map.7. Vertical gradient map

(Veronese, 2000)

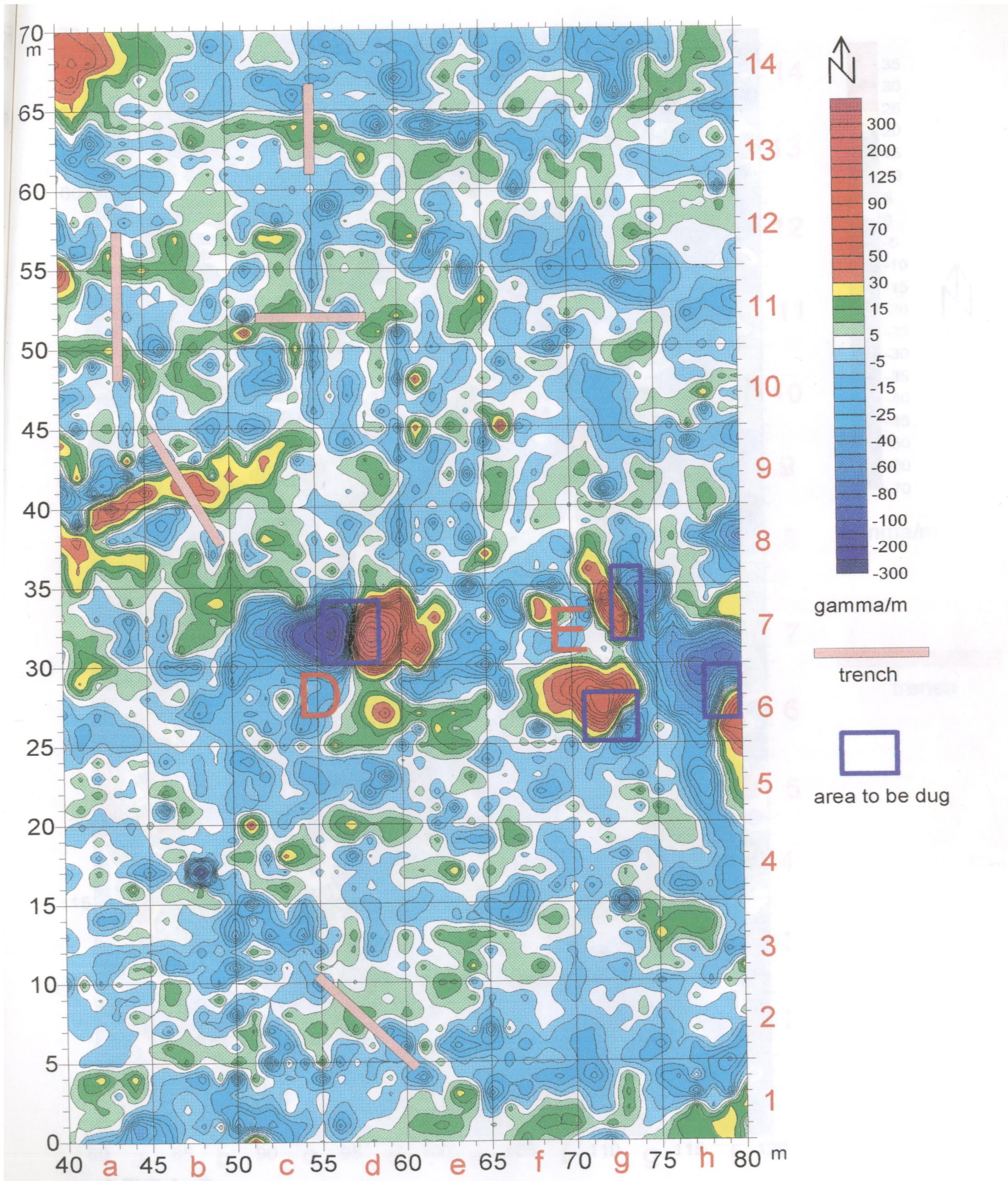
Area C



Map.8. High resolution map of Earth's vertical gradient

(Veronese, 2000)

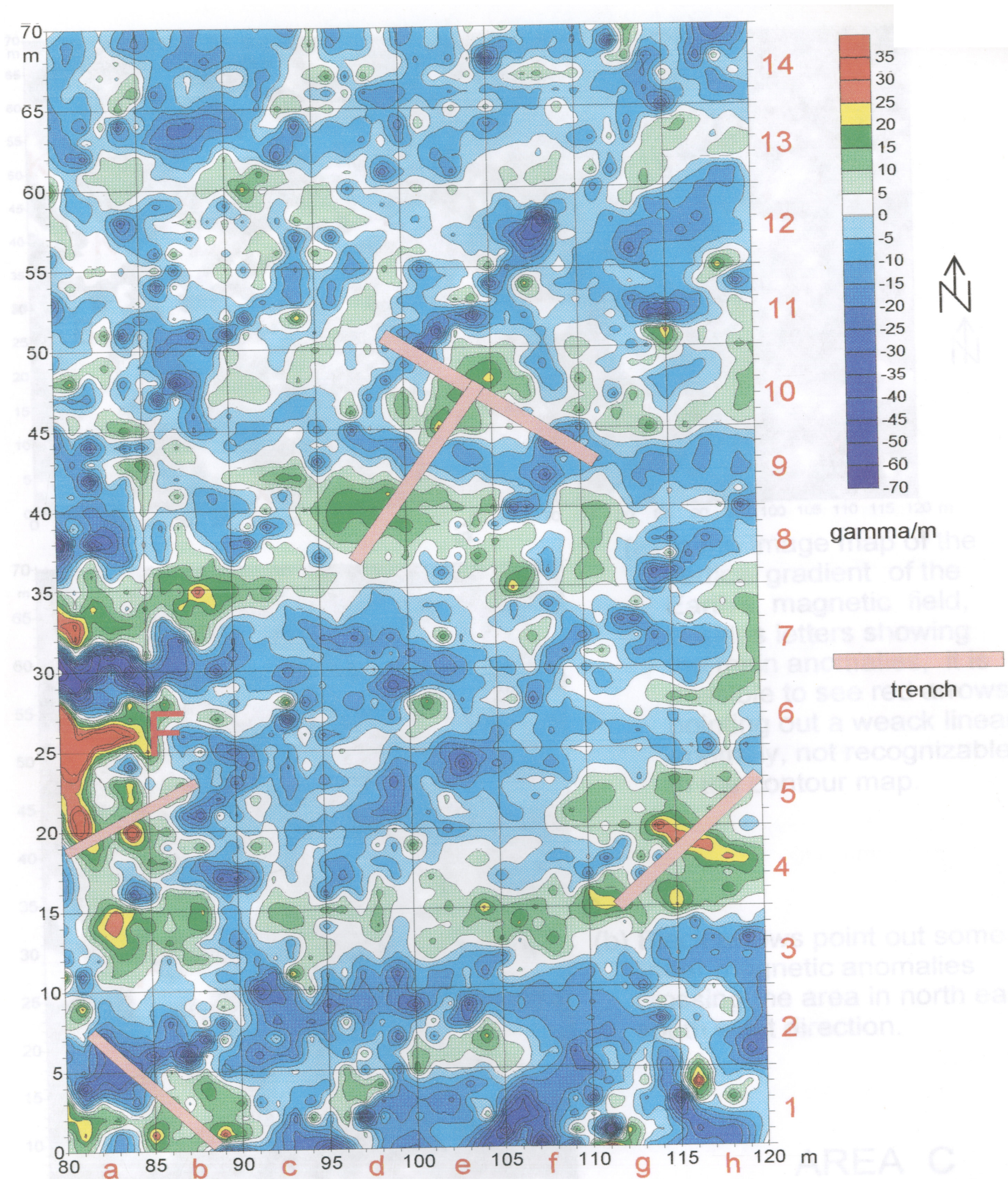
Area C



Map.9. High resolution map of Earth's vertical gradient

(Veronese, 2000)

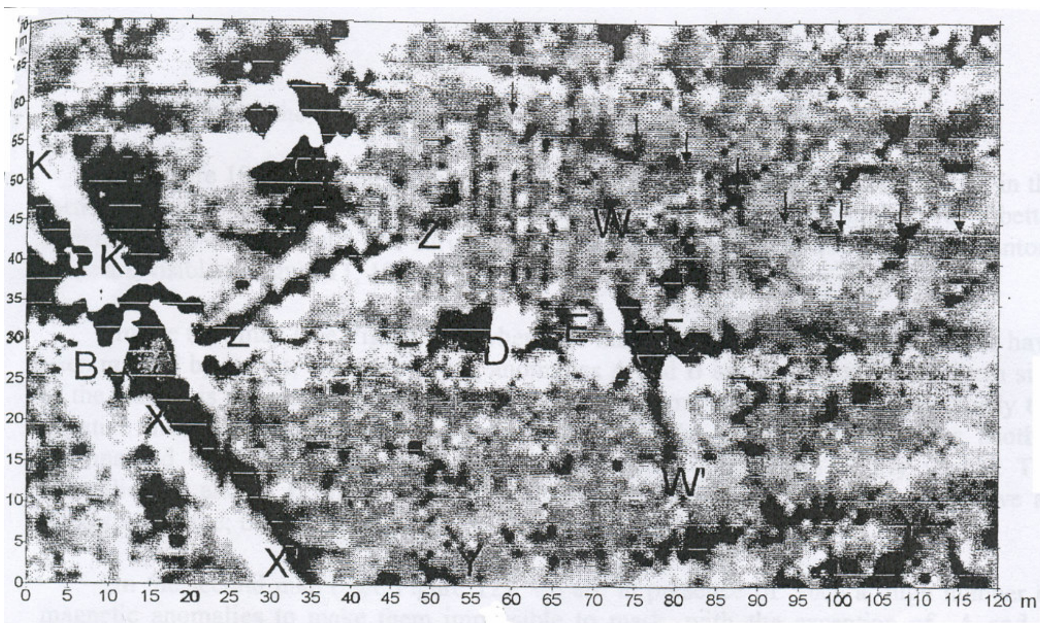
Area C



Map.10. High resolution map of Earth's vertical gradient

(Veronese, 2000)

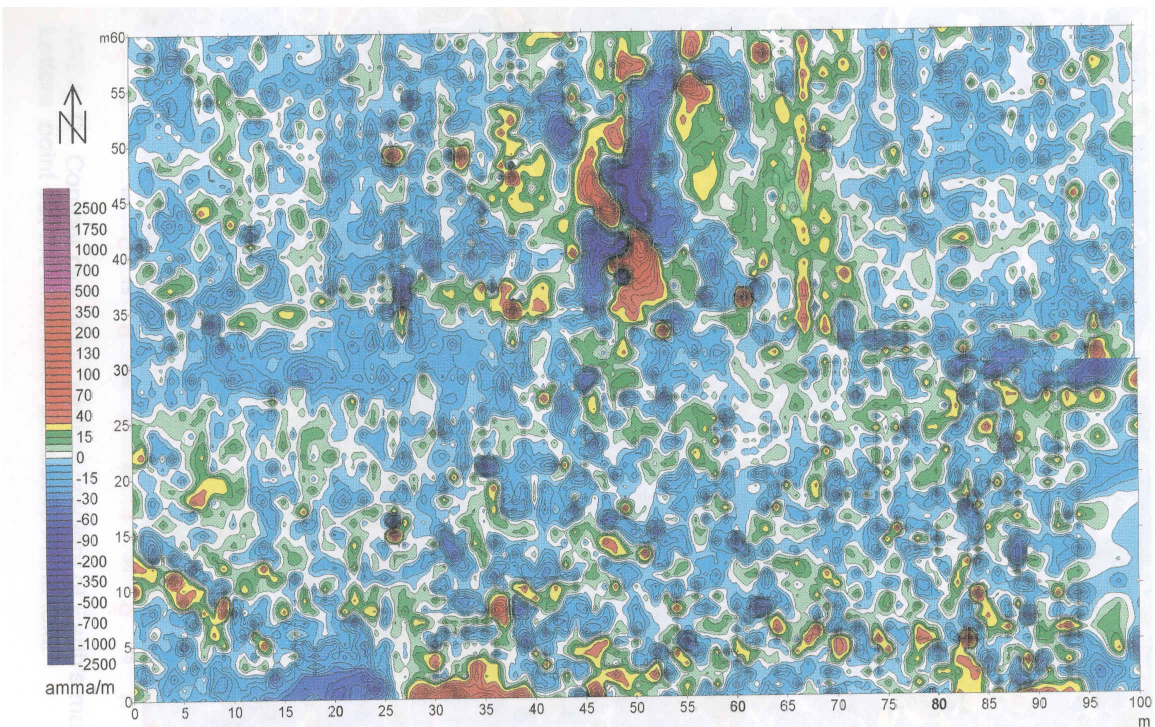
Area C



Map.11. Image map

(Veronese, 2000)

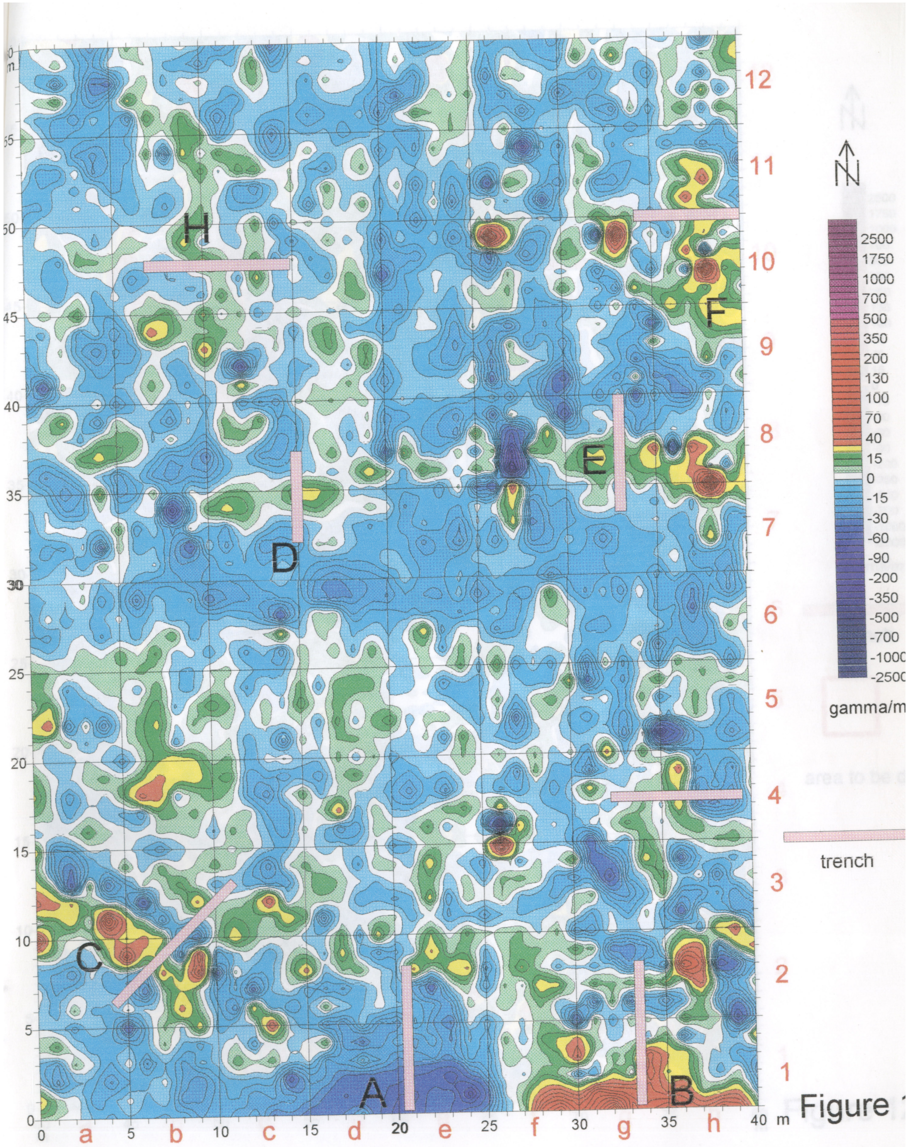
Area D



Map.12. Earth's vertical gradient map

(Veronese, 2000)

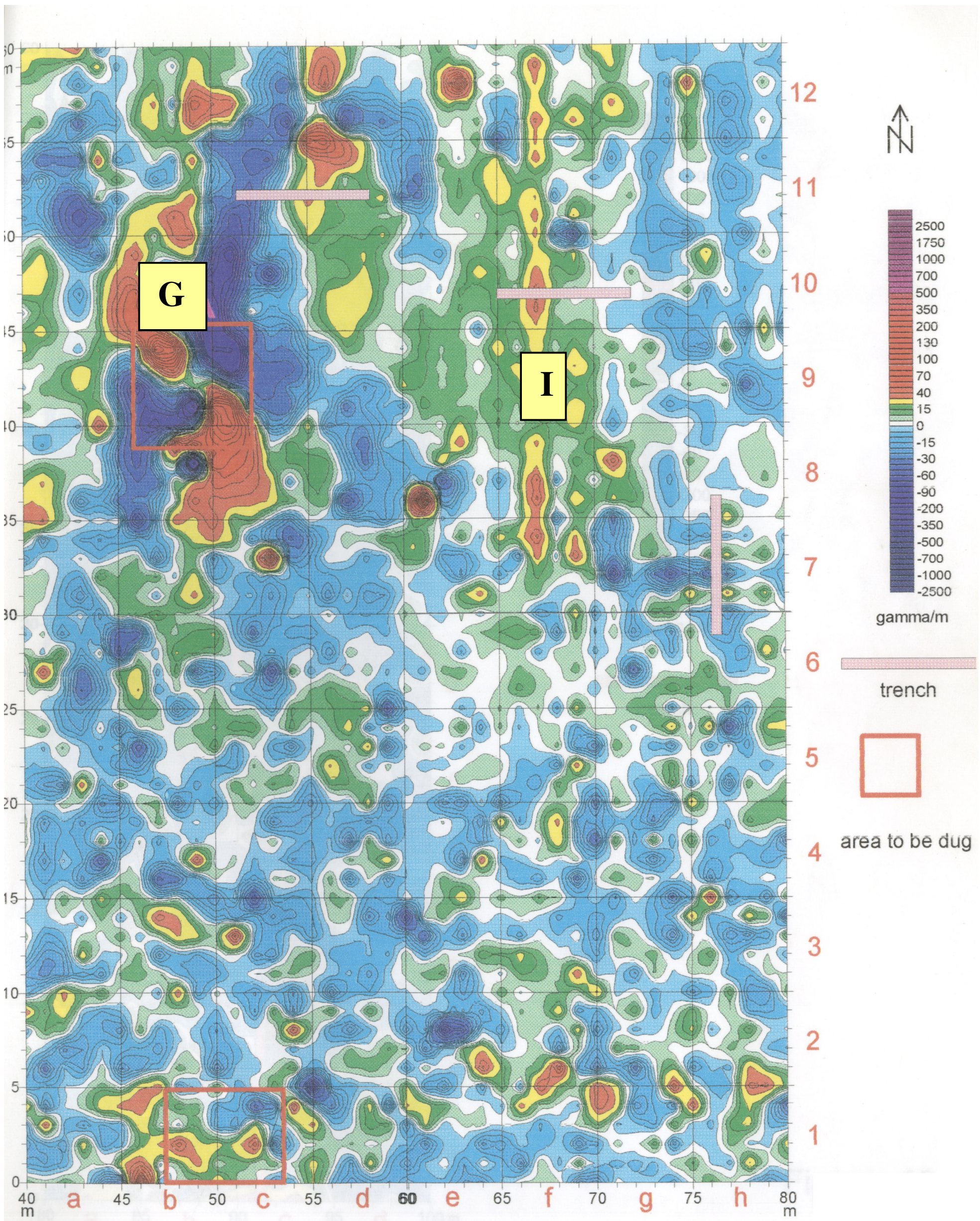
Area D



Map.13. High resolution map of vertical gradient

(Veronese, 2000)

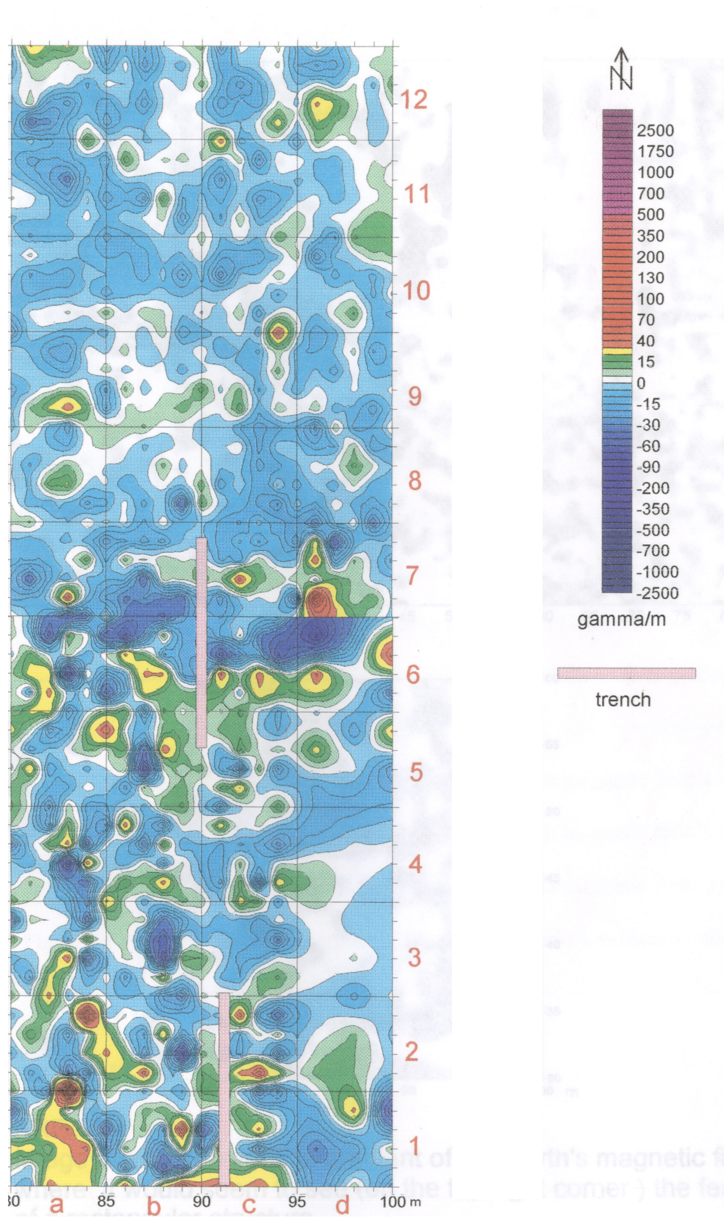
Area D



Map.14. High resolution map of vertical gradient

(Veronese, 2000)

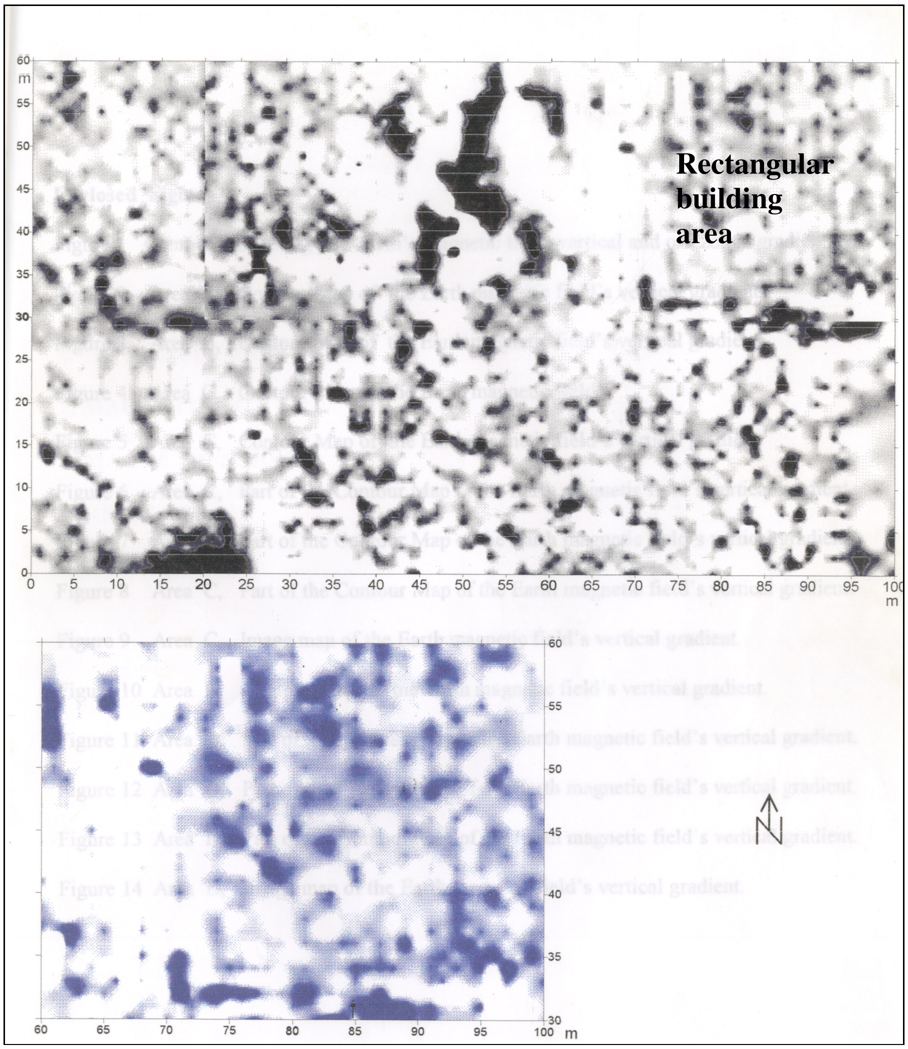
Area D



Map.15. High resolution map of vertical gradient

(Veronese, 2000)

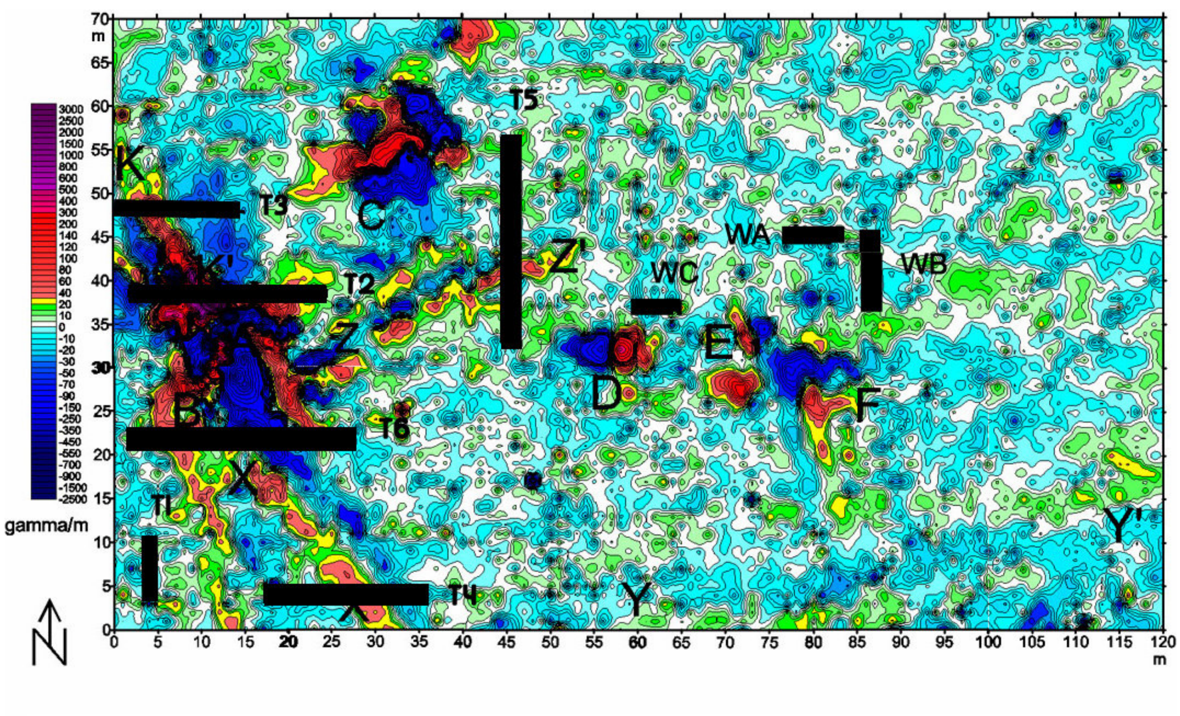
Area D



Map.16. Image map

(Veronese, 2000)

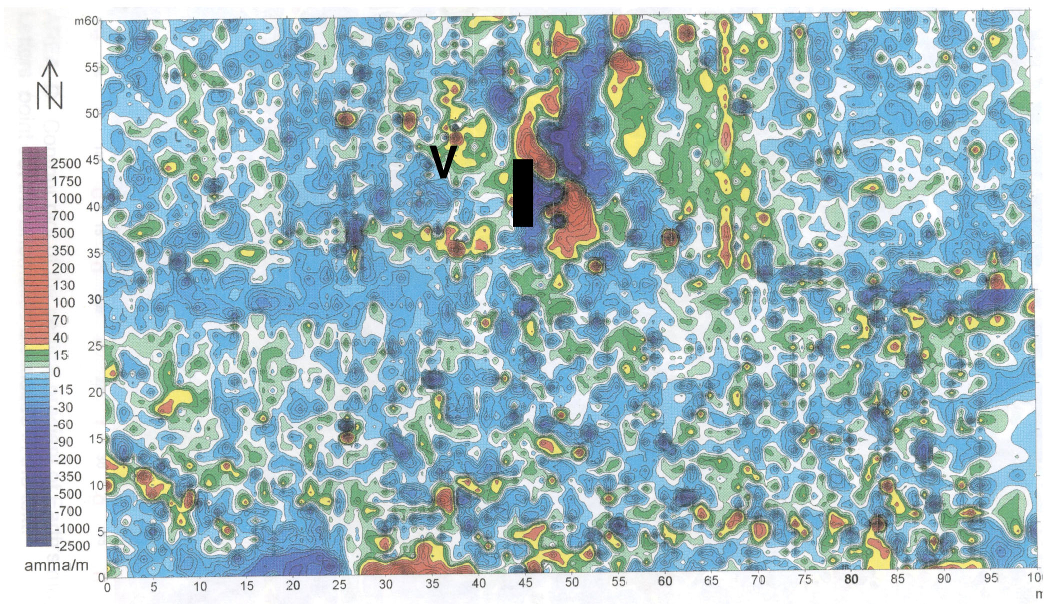
Area C



Map.17. Location of test excavations on magnetic map

(Veronese, 2000)

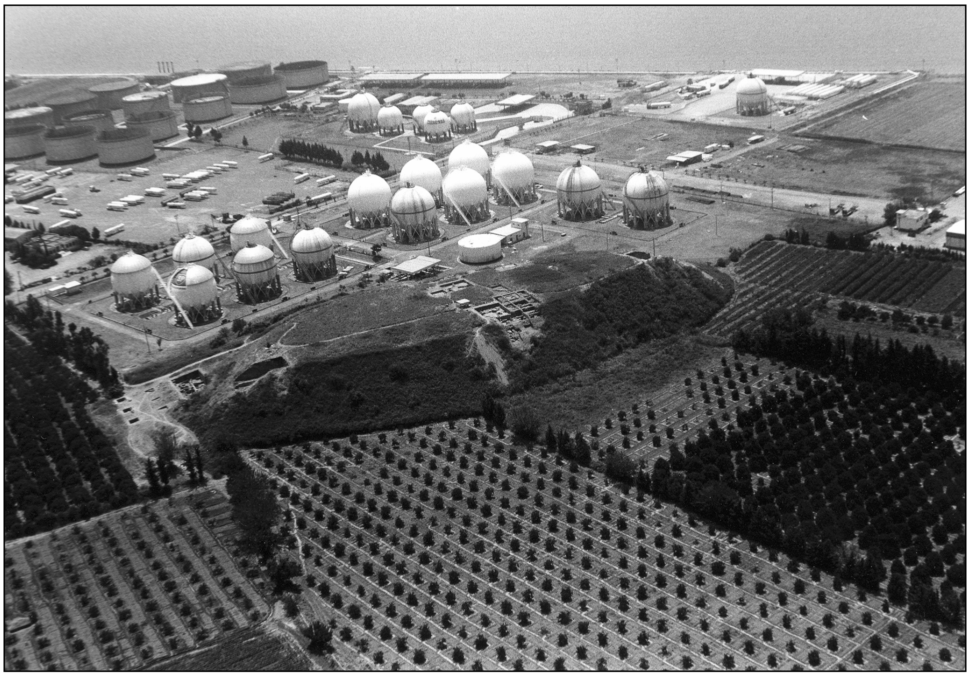
Area D



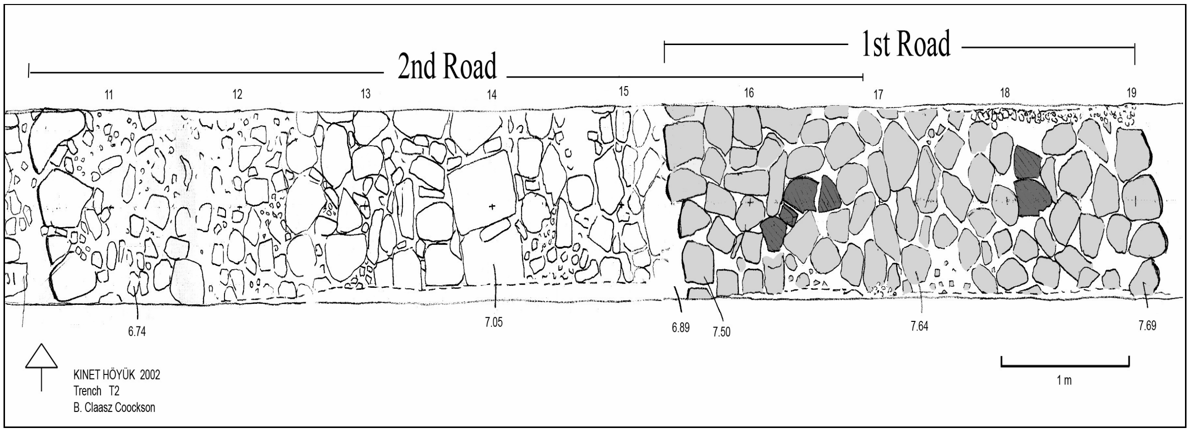
Map.18. Location of test excavation VB on the magnetic map

(Veronese, 2000)

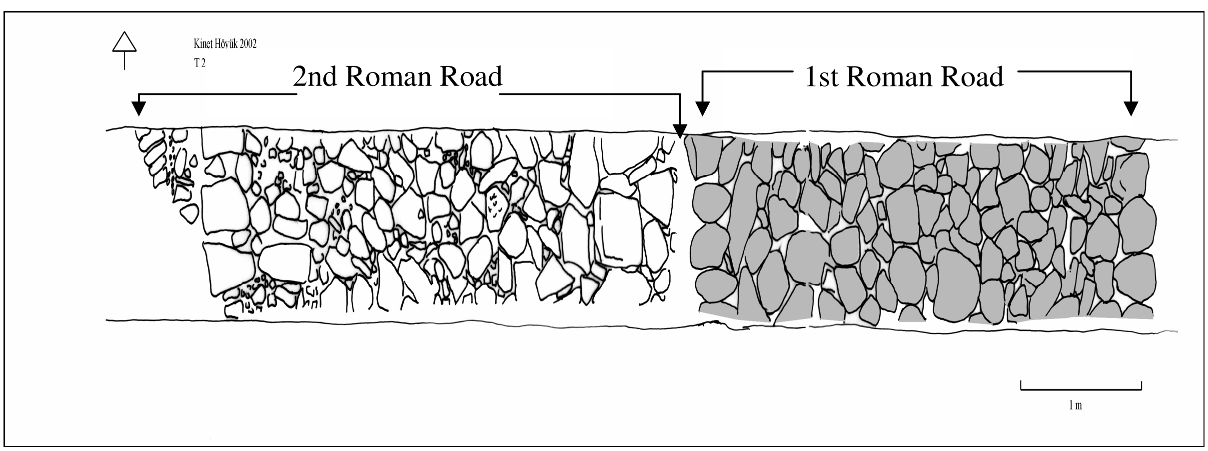
Appendix B



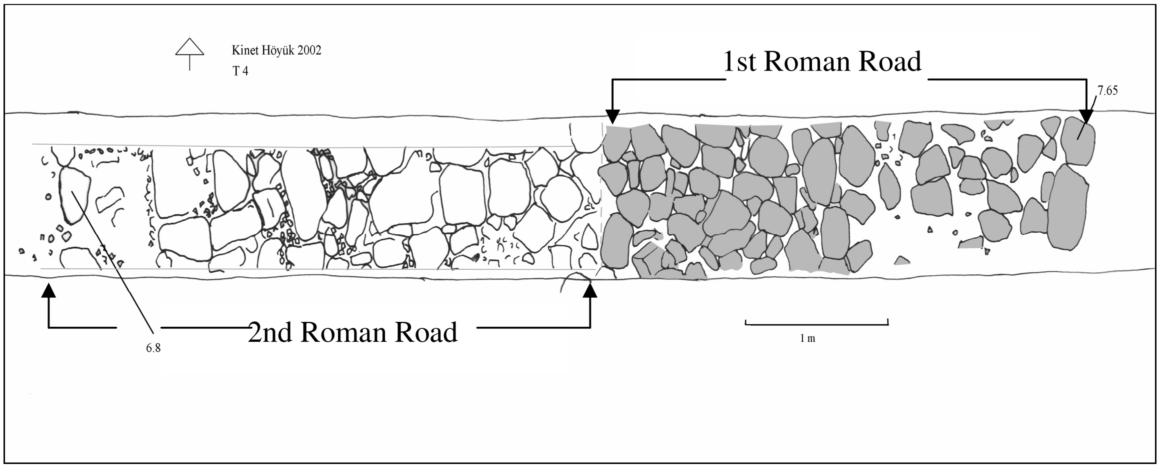
Pl.1. Aerial View of Kinet Höyük with the Delta Petroleum Company Facilities



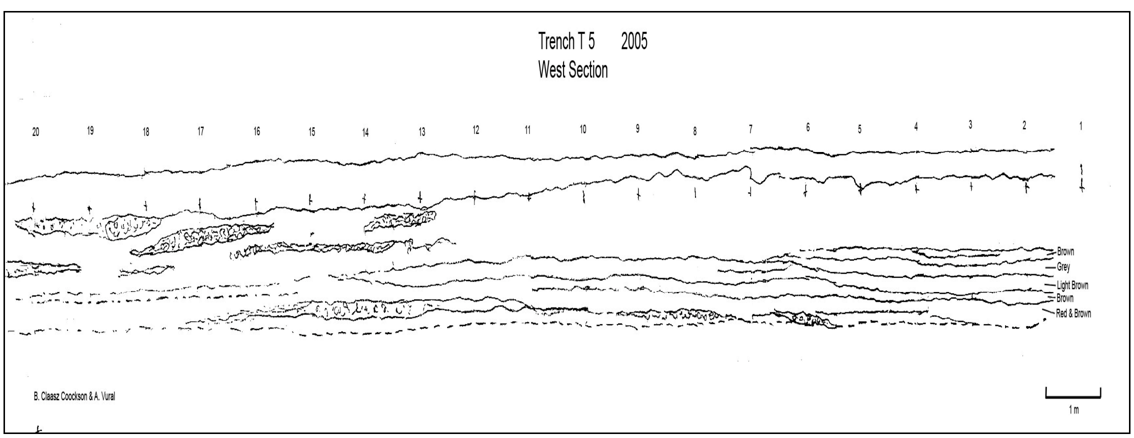
Pl.2. T2-Roman Roads
(B. Claasz Coockson)



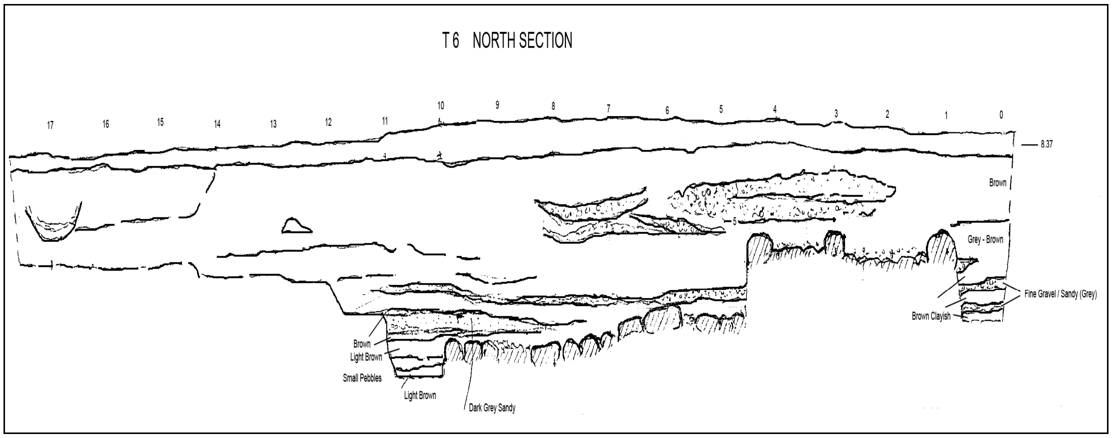
Pl.3. T3-Roman Road
(B. Claasz Coockson)



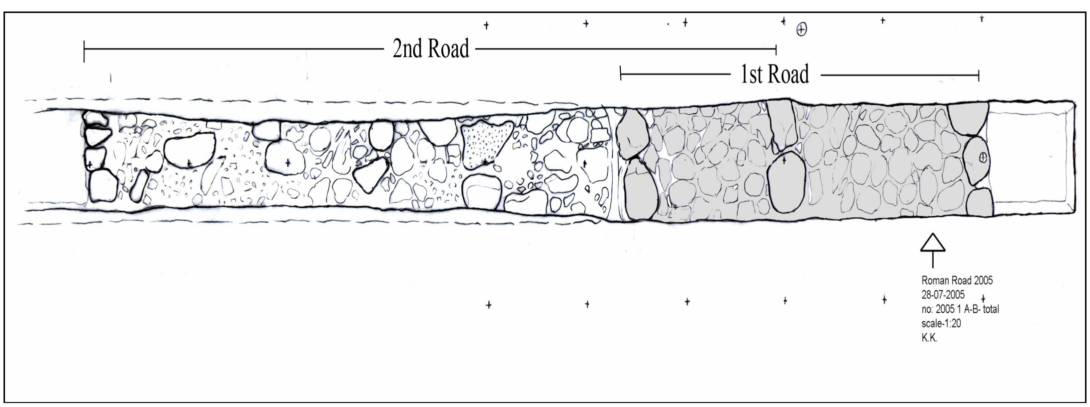
Pl.4. T4-Roman Roads
(B. Claasz Coockson)



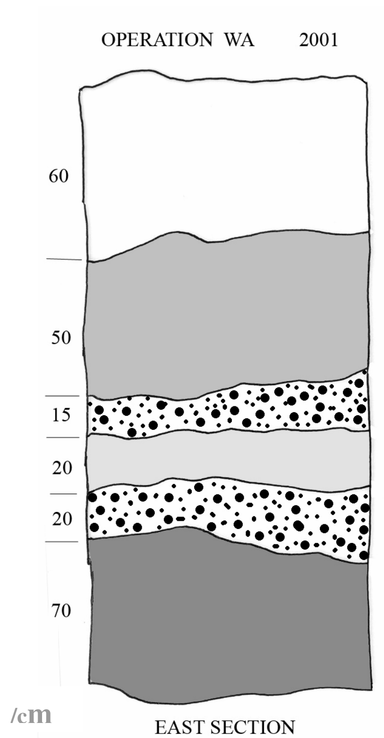
Pl.5. T5-West Section
(B. Claasz Coockson)



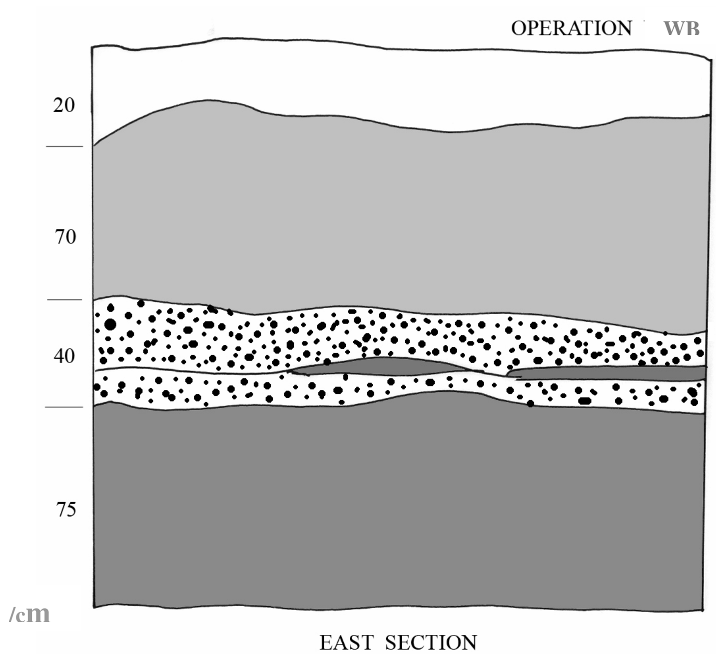
Pl.6a. T6 –North Section
(B. Claasz Coockson)



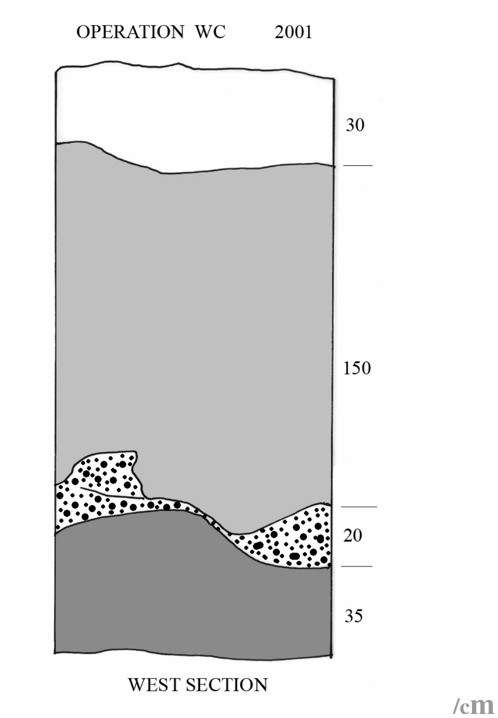
Pl.6b. T6-Roman Roads
(B. Claasz Coockson)



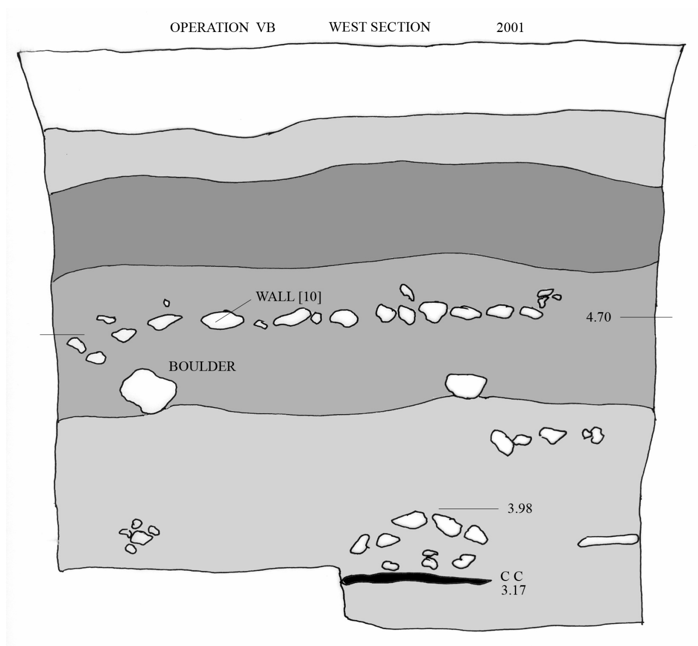
Pl.7a. Wa- East Section
(After the field drawing by B. Claasz Coockson-2007)



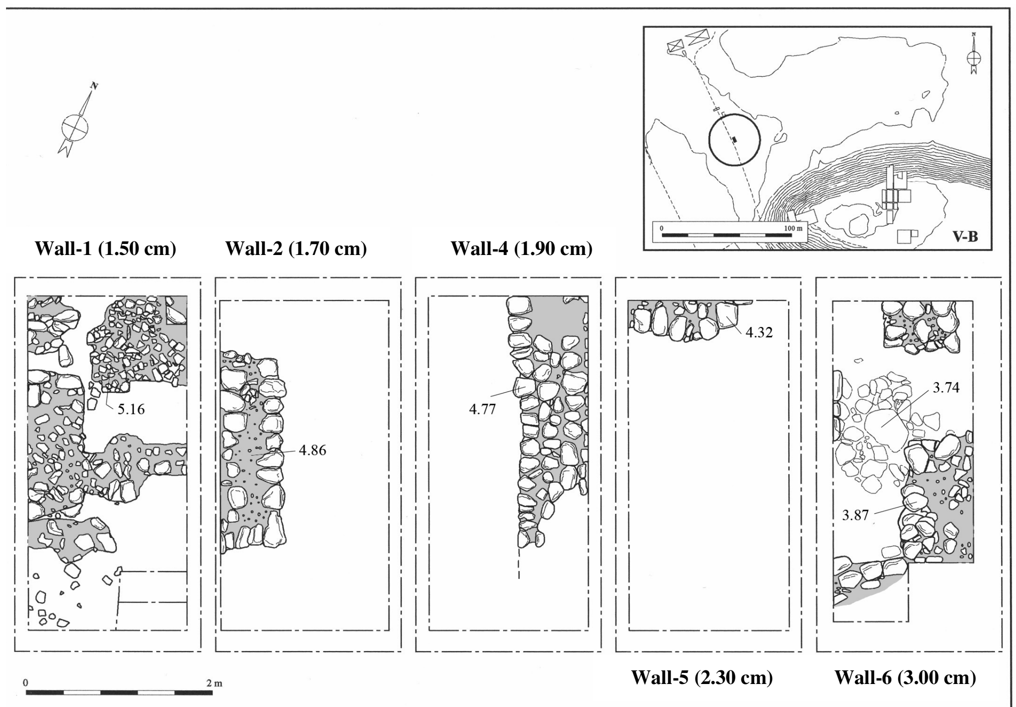
Pl.7b. Wb- East Section
(After the field drawing by B. Claasz Coockson-2007)



Pl.7c. Wc- West Section
(After the field drawing by B. Claasz Coockson-2007)



Pl. 8a. Vb- West Section
(After the field drawing by B. Claasz Coockson-2007)



Pl. 8b. Vb- Walls (Kinet Illustrations of 2002)