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Joint IAEA/NNSA International Workshop Nuclear Forensics Methodologies for Practitioners 2013 Scenario Based Exercise – Version 4.0 Instructor's Manual

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October 2013



Pacific Northwest
NATIONAL LABORATORY

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**Joint IAEA / NNSA International Workshop Nuclear Forensics Methodologies
for Practitioners 2013
Scenario Based Exercise – Version 4.0
Instructor’s Manual
28 October 2013**

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SBE 1: Radiation Portal Monitoring at Reimerland & Radiological Crime Scene Management

You are serving as a Reimerland border guard at Checkpoint (CP) 2 (see Appendix A for a country map and Dossier of Reimerland and the surrounding region). Your morning starts off with an intelligence briefing that indicates guards at the Country’s northern Checkpoints should be especially vigilant and on the lookout for any suspicious activities. You are reminded that any vehicle alarming portal monitors will require a secondary screening. If at any time during secondary screenings anything seems out of the ordinary (e.g., shipping manifests do not match cargo, inconsistencies arise during questioning of the driver), you are to immediately contact agents from Reimerland’s National Law Enforcement Agency (NLEA) to investigate further. If a vehicle sets off both gamma and neutron alarms, contact NLEA directly once these alarms are confirmed during secondary screening.

[Participants will serve as border guards for Reimerland. They will be given brief instruction on the operation of hand-held Radioisotope DetectorS (RIDS) and be provided an intelligence briefing that tells them to be on the lookout for suspicious activity at their post. Their instruction will include directing suspicious vehicles to a location for secondary screening. If, after secondary screening, suspicions of a criminal act involving nuclear and or radioactive materials remain, participants have been instructed to request assistance from the NLEA, who will then setup and manage a radiological crime scene.

Participants will watch a demonstration of two vehicles containing radioactive materials driving through and setting off a portal monitor. The first vehicle, a semi-tractor trailer, sets off only a gamma alarm.

After the driver provides a shipping manifest of fertilizer, participants, posing as border guards, are expected to waive this vehicle through inspection. The second vehicle, an SUV, set off both gamma and neutron alarms. The alarming of the neutron monitor should prompt participants to set up a secondary inspection of the vehicle immediately. The driver of the vehicle indicates he is in legal possession of an industrial instrument containing an old ¹³³Ba source that has decayed to a level no longer requiring official paperwork according to the IAEA and internationally accepted transportation regulations.

Authorities have verified that the industrial source does fit the description of one that is sold commercially. However, upon setting up a secondary screening, participants will use hand-held detectors to locate several other radioactive sources emanating from a black duffle bag in the rear of the vehicle (Figure 1). Hand held detectors detect the presence of ¹³³Ba, and Pu. Upon questioning, the driver only commits to having the ¹³³Ba industrial source and cannot account for the detection of neutrons within his vehicle. Since neutron alarms also sounded, participants should indicate that a neutron alarm would be inconsistent with a ¹³³Ba source alone and should therefore conclude further investigation is warranted. This will prompt participants to call in a response team from the NLEA to set up a radiological crime scene around the vehicle in question. The response team is able to shoot a 3-D X-ray radiograph of the duffle bag without moving it to ensure it is rendered safe and moveable without disturbing the contents in

the field (Figure 2). At this point, the duffle bag is entered into inventory as evidence and a chain of custody form is initiated. Swipes are taken from the outer bag to confirm there is no dispersible contamination. The bag and its contents are considered valuable for the investigation by the lead investigator. He determines the duffle bag is safe to transport to RRL for evidence inventory and analysis. The duffle bag and its contents are packaged and sent off to the RRL.]

SBE 2: Receipt of Evidence, Inventory, and Basic Physical Measurements

Agent Schwantes from Reimerland's National Law Enforcement Agency (NLEA) seeks assistance by your laboratory (Reimerland Radioanalytical Laboratory - RRL) for the processing and analysis of nuclear forensic and potentially radioactively contaminated evidence. A black duffle bag containing radioactive materials was seized by authorities after the search of a late model Durango-Sport Utility Vehicle that set off radiation portal alarms on October 29, 2013, at approximately 8:23 am at border CP 2. The driver of the vehicle, Amennl Yami (a Reimerland national that has been living in Chicoland for the past 16 years), indicated he was on his way to a construction site located in Reimerland with an industrial instrument containing a radioactive source of ^{133}Ba . He provided documentation to Customs representatives claiming the possession of this amount of activity/quantity of a radioactive substance is exempt from IAEA transportation regulations.

The duffle bag of evidence is received at RRL. The lead investigator indicates the outer portion of the duffle bag has been surveyed and has no detectable dispersible contamination, however, contents within the bag have not yet been surveyed. He instructs the lab staff to inventory the contents within the bag and survey each item for dispersible contamination, while maintaining or initiating chain-of-custody records for each of the pieces of evidence. Lab staff are to segregate, if possible, evidence that do not contain or are not contaminated with nuclear or radioactive materials. Evidence not contaminated with or containing nuclear or radioactive materials should be sent to the NLEA's traditional forensics laboratory. Participants will prepare individual items for gamma spectrometry screening by placing items in secondary containment. After gamma screening and segregating evidence, basic physical measurements (e.g., pictures, mass, dimensions, density) should be performed at RRL on any evidence found to contain or be contaminated with nuclear or radioactive materials.

[The duffle bag will be unpacked initially within a glove bag by participants to ensure contamination control and that evidence is safe to handle and free of dispersible radiological contamination. Items will be swiped and inventoried. All major pieces of evidence will be scanned initially by a low-background NaI(Tl) gamma spectrometer to determine the presence of radioactive materials (students will place items in secondary containment for screening, but no actual screening will be done. Instead, instructors will then identify which items are "radioactive" and which are not). Based upon those results, items will be segregated and either sent off to the NLEA forensics lab or processed further at RRL.

[Evidence contained within the duffle bag includes:

1. *Plastic bag (with apparent fingerprint on the bag).*
 - 1.1. *Lab coat*
 - 1.2. *Lab gloves*
2. *Manila envelope*
 - 2.1. *Several documents*
3. *Small zip-lock bag*
 - 3.1. *Plastic bottle*
 - 3.1.1. *Dark grey powder*
 - 3.2. *Plant seed*
 - 3.3. *One hand-written document contaminated with radioactivity*
4. *Glass vial*
 - 4.1. *Yellow liquid*

Gamma screening indicates items 1 and 2 are free of radioactive contamination and should be sent to the traditional forensics laboratory for further processing. However, staff at RRL should conduct basic physical measurements on the remaining pieces of evidence. This should include taking photos of 3.3 and sending those photos off for translation and handwriting analysis. Pictures and masses of 3.1, 3.2, and 4. Microscopy pictures of 3.1.1. and 3.2. Density measurements of 3.1.1. and 4.1. NLEA will translate the handwritten note based upon photos your lab provides. The note will be a description of the processing plan illustrated in Figure 3. Handwriting analysis will match the handwriting from the suspect to the handwriting of this note. The density of 3.1.1. will be consistent with PuO₂. The mass of 3.1.1 will be greater than 500 mg. Appendix B contains a summary of the main results expected from SBE 2.]

SBE 3: Development of an Analytical Plan

Authorities would like for you to help them determine if a law has been broken. In Reimerland it is unlawful to have in your possession greater than 500 mg of SNM (U of any ²³⁵U enrichment above that of natural abundance, or Pu) without proper documentation.

They have asked you to develop an analytical plan to analyze evidence pieces 3.1.1, 3.3. and 4.1 using capabilities you have in house (see Table A-1).

[Participants should propose the use of gamma and alpha spectrometry and the results of the basic physical measurements to confirm the identity of evidence piece 4.1. as a ¹³³Ba-containing liquid and evidence piece 3.1.1. containing greater than 500 mg of Pu. Alpha spectrometry should also be proposed for analyzing the contamination on evidence piece 3.3. The amount of contamination is too small for accurate gamma spectrometry. Additionally, alpha spectrometry will be helpful for the purpose of better quantifying minor actinide isotopes if gamma spectrometry confirms the presence of an actinide.]

SBE 4: Gamma Spectroscopy

The Lead Investigator has approved your analytical plan to use gamma spectrometry to confirm the presence of SNM within several of the evidence pieces recovered. RRL staff scientists are approved to conduct gamma ray spectrometry on evidence pieces 3.1.1 and 4.1. The small amount of contamination found on evidence piece 3.3 is not sufficient to justify approval of gamma spectrometry on this item.

[Results of analyses indicate evidence item 3.1. contains Pu. In addition, evidence item 4.1. is found to contain the isotope ¹³³Ba. From basic physical measurements previously conducted on this material, the mass of this material would require proper documentation to possess. Since no documentation covering this material could be provided by the driver, this event should become a criminal investigation and the driver should be brought up on charges of possessing SNM without a permit. Gamma spectrometry should identify the Pu as relatively low burn-up material, consistent with weapons grade Pu. Significant quantities of ²⁴¹Am will also be discovered in the gamma spectrum, suggesting that this material had aged since its last chemical separation. The ¹³³Ba detected in evidence piece 4.1 was not in a form or mass consistent with industrial applications. Participants may suggest that its presence may have been used to mask the gamma lines and identity of Pu. Appendix C contains a summary of the main results expected from SBE 4.]

SBE 5: Alpha Spectroscopy

The Lead Investigator has approved your analytical plan to use alpha spectrometry to confirm the presence of SNM within several of the evidence pieces recovered. RRL staff are approved to conduct alpha spectrometry on evidence pieces 3.3 and 4.1.

[Alpha spectrometry of 3.3 will reveal the presence of a small amount of Pu, with a ²³⁸Pu/^{239,240}Pu ratio consistent with the Pu in item 3.1.1. The isotope ²⁴¹Am should be measureable and quantified by participants. Appendix D contains a summary of the main results expected from SBE 5.]

SBE 6: Database Query of State Holdings

Lead investigator has requested your assistance in helping them determine if evidence piece 3.1.1. could have originated from within the State of Reimerland. Reimerland authorities have developed and maintained a database of State holdings of nuclear and radioactive materials, known as the National Nuclear Database (NND). Specifically, the database includes a summary of the State's holdings of nuclear materials, including uranium ore concentrates (from its extensive mining operations), fresh and

spent nuclear fuel related to its power and research reactors. Also included in the NND are IAEA Category I and II radioactive sealed sources that include irradiators, teletherapy sources, industrial radiography sources, and neutron and gamma well loggers. They request that you assist them in querying this database in order to determine if any of these holdings are consistent with item 3.1.1. Based upon the analytical information you have currently, determine if evidence piece 3.1.1. matches any of the State's holdings by querying the database.

[Participants should be able to reduce the number of possible matches by excluding all sources that do not contain Pu. Gamma spectrometry should be able to further eliminate the possibility that this Pu came from spent nuclear fuel (SNF) caches from the OPAL research reactor based upon (1) significant differences between the ²⁴²Pu abundance in the SNF and evidence piece 3.1.1. and (2) the significant differences between the ages of the two materials. Plutonium-Beryllium (PuBe) sources Y-1 through Y-5, manufactured in Yosemland, are also inconsistent (within 2-σ uncertainty) with the unknown material based upon a comparison of ²³⁹Pu and ²⁴⁰Pu abundances.

Alpha spectrometry results provide an accurate measure of the age of the unknown material, which is calculated to be 16.3 ± 1.14 years old at 2-σ. This age determination further eliminates the possibility that this material likely came from either of the PuBe sources manufactured in Chicoland. Appendix E summarizes expected results for SBE 6.]

SBE 7: Revised Analytical Plan & Advanced Interpretation I

Authorities have realized that more precise and accurate measurements of evidence piece 3.1.1. are needed to further investigate the origin of this material, based upon your efforts to match the unknown materials up with the State's inventory summarized in the NND. The Lead investigator has requested that you propose a revised analytical plan that will task more advanced capabilities maintained and operated at the National Environmental Radiation Laboratory (NERL) at the Reimerland Institute of Technology. You are familiar with these capabilities because you have collaborated with scientists from this institution many times in the past and RRL has set up a memorandum of understanding between them and NERL for providing analytical assistance in forensic investigations. A list of the Institute's radioanalytical capabilities is provided in Table A-1.

[Participants should propose the use of both ICP-MS and possibly ICP-OES. After discussing the analytical plans, data inject (DI) #1 is provided to participants.]

DI#1: ICP-MS analytical results on evidence piece 3.1.1. provided by NERL.

Evidence Piece	²³⁹ Pu (%)	1-σ	²⁴⁰ Pu (%)	1-σ	²⁴¹ Pu (%)	1-σ	²⁴² Pu (%)	1-σ	²⁴¹ Am (%)	1-σ
3.1.1.	97.83	0.36	1.91	0.102	0.0099	0.00042	0.0027	0.00035	0.0113	0.000297

Comparing this data with the database holdings will allow participants to further limit the list of potential materials matching the unknown. Based upon a more refined Pu/Am chronometer age estimated from ICP-MS data the PuBe source Y-6 (manufactured in Yosemland) may be excluded as a potential source of the evidence piece 3.1.1. Additionally, evidence piece 3.1.1. is inconsistent with the PuBe source Y-8 based upon the ²⁴²Pu abundance. A summary of expected outcomes from SBE7 is provided in Appendix F.]

SBE 8: Revised Analytical Plan & Advanced Interpretation II

LE asks for your continued support to compare advanced analyses of the materials in question in order to confirm or deny links between the current investigation and the two remaining items in Reimerland inventory. You are your Country's Point of Contact to the Nuclear Forensics International Technical Working Group (ITWG). Through this organization, assistance is available from countries that have advanced nuclear forensics analytical capabilities. The Lead investigator has requested that you propose a

second revised analytical plan that would utilize advanced analytical capabilities represented by your colleagues within the ITWG. A list of advanced analytical capabilities available through collaboration with ITWG colleagues is listed in Table 2.

Table 2. List of possible analyses available through ITWG collaborators.

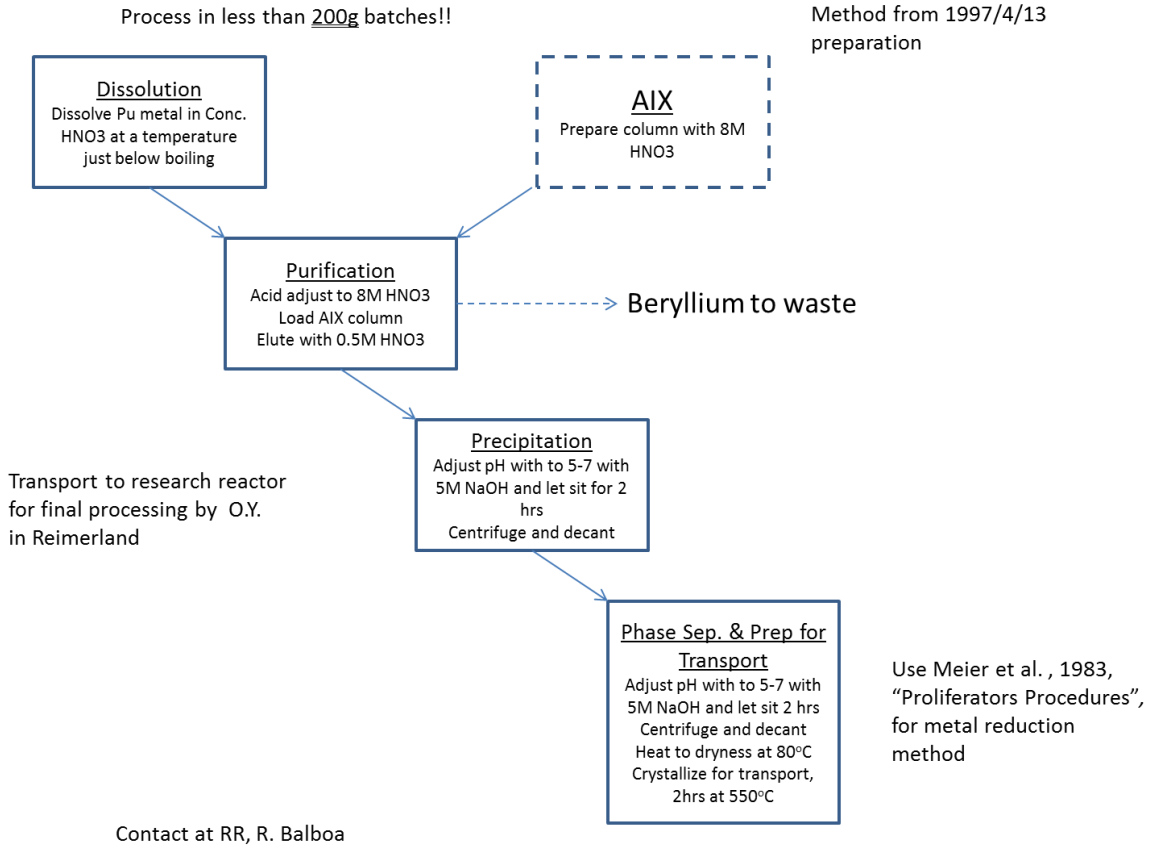
Atomic Absorption Spectrophotometer (AAS)	Inductively Coupled Plasma – Optical Emission Spectrophotometer (ICP-OES)	Multi-Collector (MC) ICP-MS
Inductively Coupled Plasma – Mass Spectrometer (ICP-MS)	X-ray Diffraction (XRD)	CHN analyzer
Scanning Electron Microscopy	Transmission Electron Microscopy	

[With RRLs assistance, the lead investigator has been able to narrow down the potential links between this most recent seizure and State holdings within the NND to just two possibilities, a single PuBe source (Y-5) manufactured 16.8 years earlier in Yosemite and a prototype PuBe source (R-1) manufactured at the research reactor in Reimerland 15.6 years ago. *List will contain MC-ICP-MS and XRD. The use of these analyses on item 3.1.1. and the two remaining materials in Reimerland holdings should be proposed in the revised analytical plan. Once analytical plans are received, results of these analyses are provided back to the participants as DI#2.*

DI#2: MC-ICP-MS analytical results on evidence piece 3.1.1. provided by NERL.

Evidence Piece	²³⁹Pu (%)	1-□	²⁴⁰Pu (%)	1-□	²⁴¹Pu (%)	1-□	²⁴²Pu (%)	1-□	²⁴¹Am (%)	1-□
3.1.1.	97.71	0.22	2.023	0.004555	0.0093	05	8.35E-00026	05	5.85E-00011	05

- *XRD analyses identify the powder as PuO₂.*
- *Forensic examinations of the microscope image of the plant seed by NLEA investigators conclude the seed is of the flowering plant “sanguinis elius”. This plant is native to northern territories to as far south as Chicoland.*
- *Based upon the picture of evidence piece 3.3. you provided NLEA investigators, they have been able to match the handwriting of the suspect in custody with the handwriting on the note.*
- *The note was also translated. Investigators would like to know if you believe there is any significance to the technical information provided in the translated note.*



MC-ICP-MS will conclusively exclude the possibility that the material seized came from Reimerland inventory. XRD analysis will confirm the material is PuO₂.]

SBE 9: GICNT Engagement of Holdings within Chicoland and Yosemland

The Law enforcement has asked your assistance in helping to draft a request to be sent through diplomatic channels to representatives in bordering countries Chicoland and Yosemland in order to determine if they may have holdings that match that of item 3.1.

[A request should be generated asking both countries to check their inventories of materials matching that of the materials seized by authorities in Reimerland. Yosemland officials respond with the response letters shown in Appendix H. A summary of the results of the entire SBE is provided in Appendix I.]



Figure 1. Black Duffle bag containing suspect radioactive material of interest.

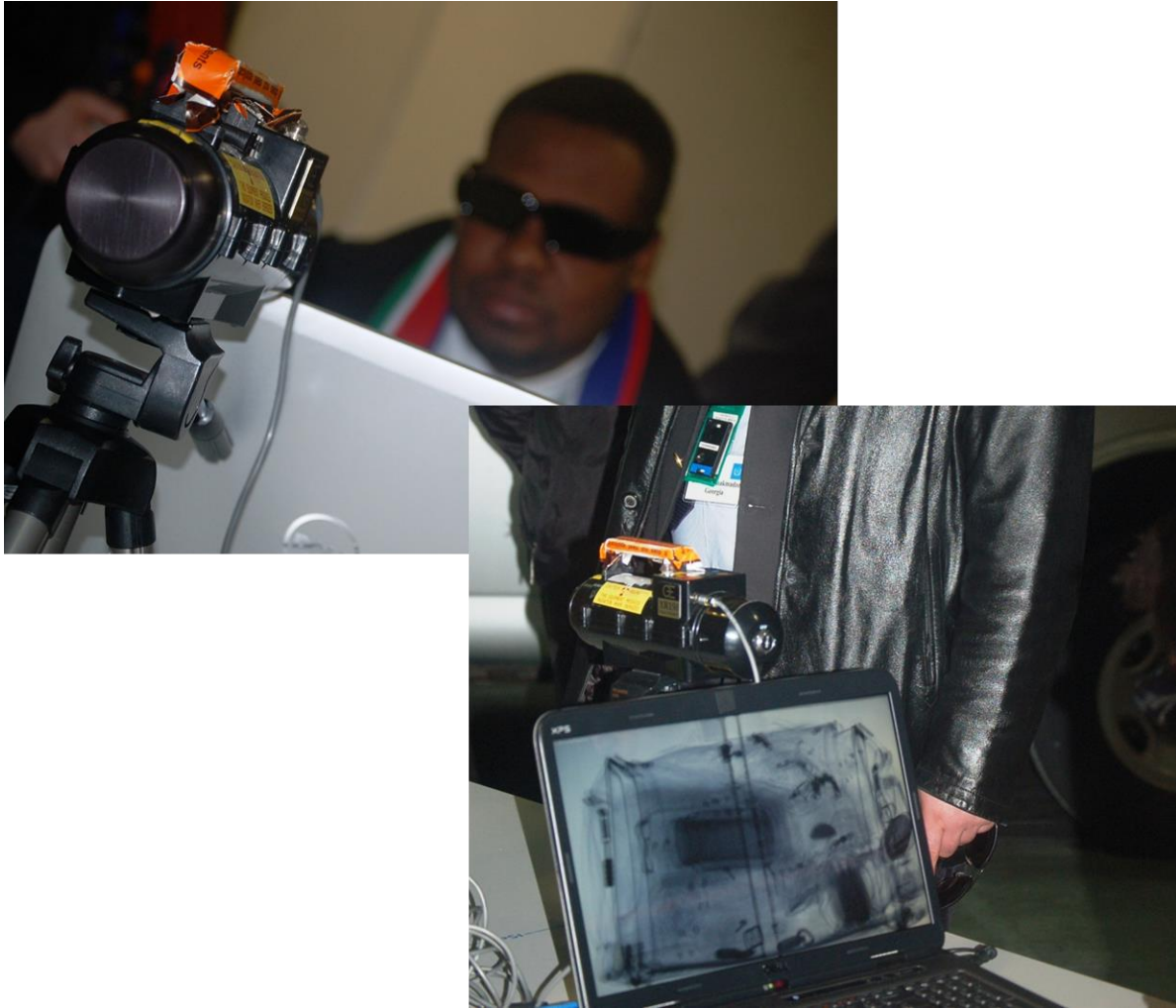


Figure 2. 3-D radiography of black duffel to enable “render safe” and movement of the entire bag and its contents to NLEA Reimerland Radiation Laboratory (RRL) for further processing.

Käsittele alle 200g kerrallaan!

Metodi 13/4/1997

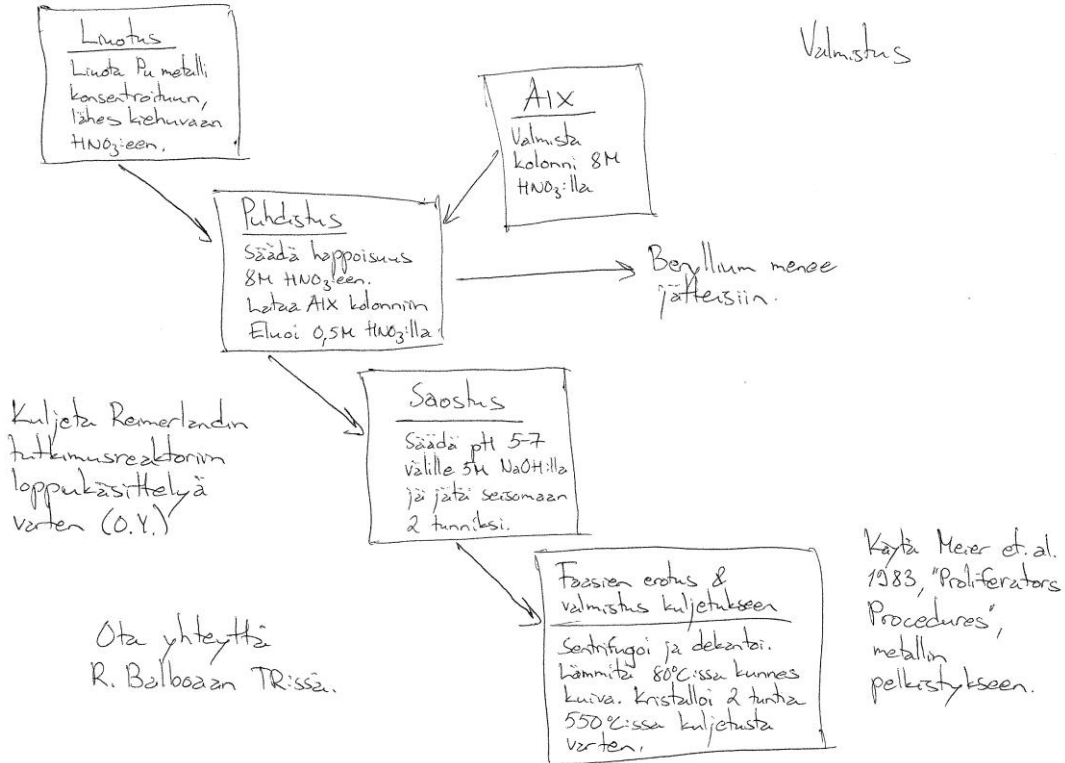
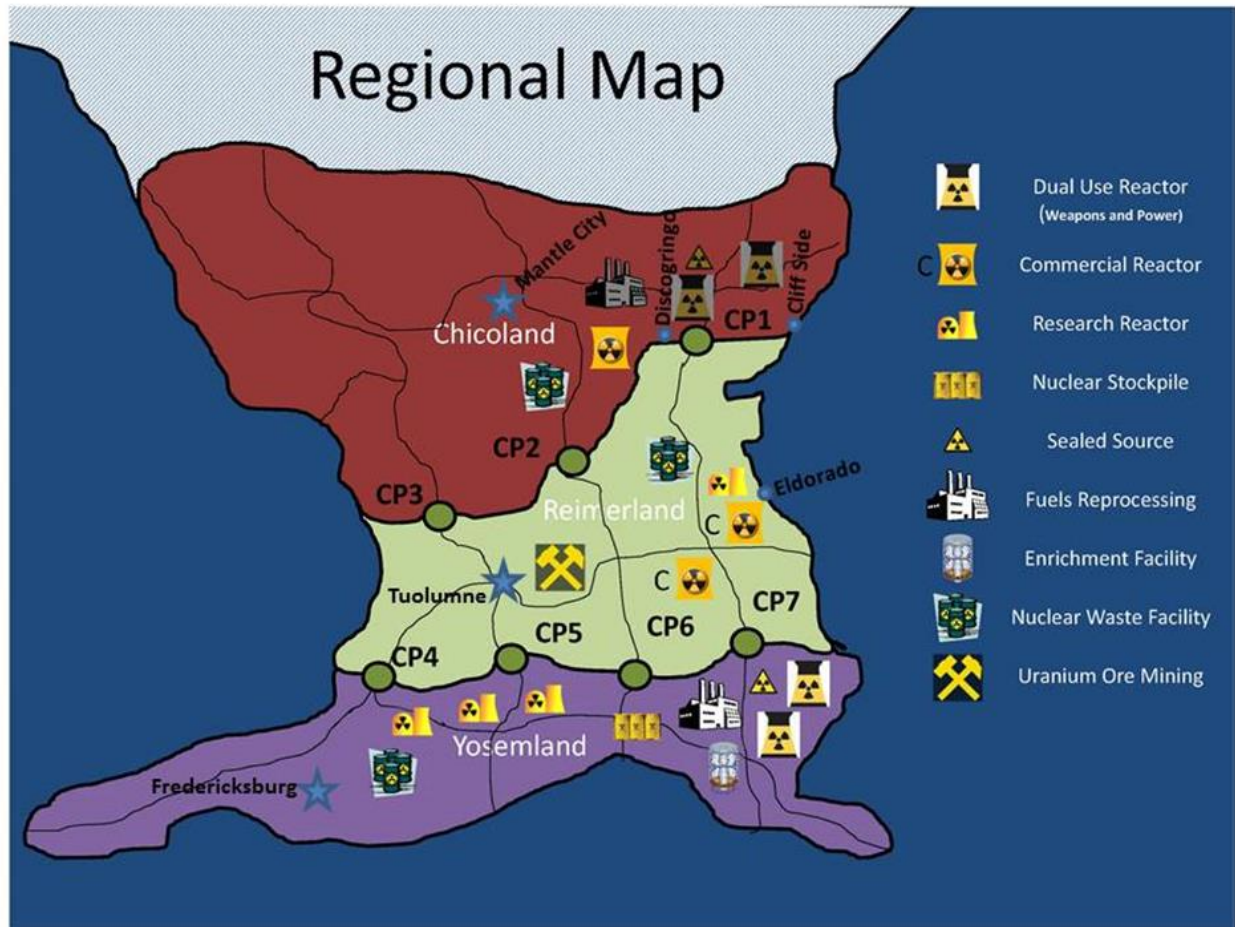


Figure 3. Evidence Piece 3.3.

APPENDIX A: Regional Map and Country Dossiers



REIMERLAND DOSSIER

Government Type: Social Democracy

Geography: Reimerland is a small country of 153,085 square kilometers, located on an isthmus with land borders to the north and south. Reimerland is flat with winding brackish river systems that feed numerous coastal inlets. These river systems frequently overflow during the rainy season producing wide sweeping grasslands and lush forests. Reimerland has a well-established power grid, adequate supplies of potable water, and infrastructure to manage air and water quality. Unemployment is relatively low at approximately 7%.

Population: ~14 million

GDP (purchasing power parity): \$250 billion

Industries: Coal, hydro- electric power, timber, ferrous and nonferrous metals, machinery and transport equipment, chemicals, food processing. Reimerland operates one Pressurized Water Reactor (PWR) reactor for electricity generation and as a resource for various fields of science and education in the nuclear sciences. The reactor incorporates facilities for radioisotope production for medical, industrial and agricultural purposes.

International NF Community: In 2009 Reimerland became an active member of the International NF Community, attending the annual International Technical Working Group for NF meetings and participating in GICNT NF Working Group meetings. Reimerland has a history of close cooperation with

the International Atomic Energy Agency (IAEA) as a member of the Analytical Laboratories for the Measurement of Environmental RadioActivity (ALMERA) network since 1998 and routine reporting to the Incident and Trafficking Data Base (ITDB) of materials that are found out of regulatory control. In 2011, Reimerland hosted an IAEA regional workshop on “Radiological Crime Scene Management” and have offered to host an “Introduction to Nuclear Forensics Workshop” in the near future

Nuclear Forensics Capabilities: The National Law Enforcement Agency (NLEA) has a specialized facility (Reimerland Radioanalytical Laboratory – RRL), specialized crime scene teams trained for collecting, categorizing, packaging, and transporting radioactive materials and maintains a memorandum of understanding with the National Environmental Radiation Laboratory (NERL) part of the Reimerland Institute of Technology. The laboratory provides analytical services during forensics investigations.

Known Domestic Material: Commercial material and small amounts of academic material, including fresh and spent nuclear fuel, sealed sources and medical radioisotopes.

Law Enforcement/Legal Environment: Respect for law enforcement is common. Some violent domestic groups have migrated to Reimerland in recent years advocating anarchy and antigovernment sentiments in support of a host of issues including; animal rights, and anti- and pro-nuclear energy and nuclear weapons. The splinter group “Oppose Y” supports the agenda of developing a nuclear weapons program to balance power in the region with its pro-nuclear neighboring state Yosemland. Reimerland has a history of settling legal disputes through the court system and using case law for precedence in deciding matters of law and of accepting physical evidence if presented at trial. Local court decisions can be appealed at the national level via the Supreme Court. Reimerland is a signatory of the Nuclear Nonproliferation Treaty (NPT), the Convention on the Physical Protection of Nuclear Materials (CPPNM), and the International Convention on the Suppression of Acts of Nuclear Terrorism. Reimerland actively implements UNSCR 1540, among other treaties and international agreements. Reimerland has laws that criminalize the unauthorized possession of more than 500 milligrams of Pu or U enriched with respect to ^{235}U above natural abundance.

Political Climate: Considered somewhat stable, with moderate to high turnout for local and national elections. Nuclear power and nuclear weapons are being publicly debated; currently no new nuclear facilities have been approved.

Public Health Infrastructure: Widely available private coverage and government subsidized care for low income/unemployed residents.

The Reimerland Ministry of Health has approved the National Environmental Radiation Laboratory (NERL) to provide radioanalytical services to the government and commercial entities. Radiochemical analyses are performed for alpha, beta and gamma emitting radionuclides in a wide range of matrices such as soil, sediment, sludge, water, food, smear test, fauna and flora. The laboratory has its own Quality Assurance (QA) and Management procedures which are accredited to ISO/IEC 17025:2005 by the Reimerland Department of Standards for the analysis of gamma emitting radionuclides. For alpha and beta emitting radionuclides, the laboratory regularly participates in inter-laboratory analysis and proficiency tests organized by International Atomic Energy Agency (IAEA) and other competent international bodies.

Academic Infrastructure: High rate of literacy and strong educational tradition with post- secondary education offered at low or no cost. Reimerland has a strong university system which emphasizes engineering and the physical sciences. There is significant funding from the government for environmental research within the university system. Reimerland Institute of Technology maintains an analytical chemistry laboratory that provides analysis services to government agencies. Currently, the laboratory is equipped with various analytical instruments, including gamma spectrometers, Inductively Couple Plasma Mass Spectrometer (ICP-MS), Inductively Couple Plasma Optical Emission Spectrometer (ICP-OES), Gas Chromatography Mass Spectrometer (GC-MS), Ion Chromatograph, Luminescence

Spectrometer and CHNS elemental analyzer. The laboratory adopts good quality control and quality assurance practices in order to provide high quality output, which meets international standards.

Table A-1. Analytical capabilities available to Reimerland National Law Enforcement Agency.

RRL, Natl. Law Enforcement Agency	NERL, Reimerland Institute of Technology
Alpha Spectrometry	Gamma Spectrometry
High Res. Gamma Spectrometry	ICP-Mass Spectrometry (ICP-MS)
3-D X-Ray Radiography	ICP-Optical Em. Spectrometry (ICP-OES)
Hand Held field portable detectors	Gas Chromatography-MS (GC-MS)
Low Res. NaI Gamma Spectrometry	Ion Chromatography
	Luminescence Spectrometer
	CHNS Elemental Analyzer

CHICOLAND DOSSIER

Government Type: Democracy

Geography: Chicoland is a country of 267,332 square kilometers with few natural resources and modest agricultural lands. Chicoland is a former nuclear weapons state, having closed its weapons production reactors, its reprocessing and sealed-source manufacturing facilities, its medical isotope production, and nuclear waste facilities. However, Chicoland retains one PWR for domestic power generation. This single power reactor provides domestic power to the most populated centers of manufacturing and commerce along the border with Reimerland. Unemployment has risen to 19% in recent years. The economic downturn associated with rising unemployment has dramatically decreased the GDP of this country.

Population: ~ 28 million

GDP (purchasing power parity): \$113.2 billion

Industries: Agriculture provides a modest living for growers and fruit producers in the central region of Chicoland. Manufacturing industries includes textile mills, electronic parts assembly, well-pump manufacture and repair. Chicoland also has a large fishing industry.

International NF Community: Chicoland became a former nuclear weapons state in 1989 and has actively participated in the International NF Community in recent years (ITWG and GICNT). Chicoland has stood up a basic NF capability but it lags in its technical capabilities, relative to its neighbors to the South. Chicoland and Reimerland have formed a regional alliance for investigating nuclear smuggling cases. Chicoland attends the annual International Technical Working Group meetings and has joined the International Atomic Energy Agency (IAEA) as a member state. Chicoland continues to build its NF technical expertise and analytical capabilities.

Nuclear Forensics Capabilities: The Federal Law Enforcement Agency (FLEA) of Chicoland has limited capabilities for crime scene management and collecting, categorizing, packaging, and transporting radioactive materials. The agency does, however, maintain a memorandum of understanding with Reimerlands NLEA that enables them to utilize forensic capabilities represented by their partner.

Known Domestic Material: Chicoland was a nuclear weapons state with reprocessing capabilities until 1989, when it transferred its weapons materials to Yosemland. As part of the weapons program they manufactured medical isotopes and sealed-sources including Pu/Be sources. Many activities connected to the weapons programs languished when the decision was made to terminate its nuclear weapons program.

One PWR remains for domestic power production. Nuclear fuel is sourced from Yosemland and spent nuclear fuel is shipped to Yosemland for reprocessing and disposal.

Law Enforcement/Legal Environment:

Chicoland is a signatory of the Nuclear Nonproliferation Treaty (NPT), the Convention on the Physical Protection of Nuclear Materials (CPPNM), and the International Convention on the Suppression of Acts of Nuclear Terrorism. Chicoland actively implements UNSCR 1540, among other treaties and international agreements. Chicoland has laws that criminalize the unauthorized possession of more than 500 milligrams of weapons useable nuclear material (>20% ²³⁵U, ²³³U, Pu). In recent years, Chicoland authorities have seen an increase in nuclear smuggling cases thought to be associated with the lack of security surrounding its historic weapons production facilities.

Political Climate: Adoption of the nuclear disarmament accord (NDA) was widely supported and ratified by federal legislators in 1989. Public support for the NDA was heralded in local and national elections with the exception of a small terrorist group known as the “Oppose Y”, referencing their disdain for Yosemland. This group pushed to maintain a strong nuclear weapons program to balance power in the region with Yosemland. Chicoland reached an agreement with Yosemland for reprocessing of future SNF from its civilian power reactor. Disarmament and dismantling of nuclear weapons began in 1992 but dismantling has been slowed due to lack of resources. All materials slated for the weapons stockpile within Chicoland were transferred to Yosemland by 1992. However, significant amounts of SNM contained within the now defunct commercial industries associated with the weapons program remain safeguarded in country. Nuclear power is publically supported but no new nuclear facilities have been licensed.

YOSEMLAND DOSSIER

Government Type: Republic

Geography: Yosemite shares its northern border with Reimerland and is also a small country of 172,381 square kilometers. Yosemite's well-established nuclear power infrastructure is located in this region, as is most of the commercial and manufacturing base. The Western region of Yosemite is steeply mountainous with several rivers fed by abundant rainfall. The rivers provide irrigation for agricultural lands in southern Yosemite. Agriculture, although sustainable, employs only a small percentage of the citizens in this populous industrial and manufacturing society. Unemployment averages nearly 10% outside of the growing season.

Population: ~ 26 million

GDP (purchasing power parity): \$373.4 billion

Industries: Industrial manufacturing includes integrated circuit production, software development, metal-fabrication for automotive and aerospace components, medical isotope production, and some food processing. Agricultural exports include potatoes, corn, sheep, olives, olive oil, and fish. Two state-owned dual-purpose graphite moderated reactors provide commercial power and Pu material for its weapons stockpile. A small portion of this material is diverted for producing commercial grade neutron sources. Three other research reactors produce various medical isotopes. With the exception of sourcing its U ore from Reimerland, Yosemite maintains full U and Pu fuel cycles. Spent nuclear fuel generated in country and accepted from Chicoland and Reimerland is reprocessed and wastes isolated at dedicated facilities. Yosemite supplies all of the LEU fuel used by Reimerland and Chicoland.

International NF Community: Yosemite does not actively participate in meetings and exercises of the nuclear forensics community. The state ownership of the three research reactors and the weapons development programs leaves the nuclear expertise of Yosemite somewhat isolated from the international community.

Nuclear Forensics Capabilities: Representatives from the National Justice Branch (NJB) have attended GICNT and ITWG meetings sporadically but have never participated in table-top or materials exercises.

Known Domestic Material: With the exception of having an indigenous supply of uranium ore, Yosemite maintains full uranium and plutonium fuel cycles for nuclear weapons production. Medical isotopes are manufactured at the three research reactors. A portion of the weapons product from its dual-use reactors is also diverted to produce commercial grade neutron sources. Nuclear wastes are stored at dedicated facilities.

Law Enforcement/Legal Environment:

Yosemite laws do not specifically criminalize the unauthorized possession of weapons usable (>20% ²³⁵U, Pu) nuclear material.

Political Climate: Yosemite reached an agreement with Reimerland in 1992 for uranium ore to supply their research reactors in exchange for purchasing and recycling agreement for its fresh and spent nuclear fuel for 30 years. Yosemite was instrumental in convincing Chicoland to give up its weapons program in 1989 by offering to accept the transfer of Chicoland's remaining weapons stockpile. Nuclear power is publically supported but no new nuclear facilities have been licensed in the last 10 years.

Public Health Infrastructure: Although the state operated health care system provides medical coverage for its citizens the level of care is often very basic. Private medical insurance is too expensive for the vast majority of citizens.

The Yosemite Health Department provides oversight of medical isotope production and sealed source production and management.

APPENDIX B: RESULTS EXPECTED FROM SBE 2.

Participants should send evidence pieces 1 and 2 that were not contaminated with radioactivity off to the NLEA forensics crime lab for further processing.

- **Pictures of all items of evidence contained in zip-lock bag #3 and #4.**
- **Microscopy pictures of 3.1.1. and 3.2.**
- **Send pictures to law enforcement for further processing.**
- **Mass measurements of 3.1.1, 3.2 and 4.1.**
- **Density measurements of 3.1.1., and 4.1.**

Evidence Item	Mass	Density
3.1.1.		
3.2.		N/A
4.1.		

APPENDIX C: EXPECTED RESULTS FROM SBE 4.

- Evidence piece 3.1.1. contains low burnup plutonium.
- Evidence piece 4.1 contains the radioactive isotope ¹³³Ba. Concentration and form inconsistent with a sealed industrial source. May have been used to “mask” Pu signature.
- Summary of expected gamma results generated from FRAM:

Evidence Piece	²³⁸Pu (%)	1-σ	²³⁹Pu (%)	1-σ	²⁴⁰Pu (%)	1-σ	²⁴¹Pu (%)	1-σ	²⁴²Pu (%)	1-σ	²⁴¹Am (%)	1-σ
3.1.1.	0.0019	0.0013	98.12	0.21	1.86	0.21	0.0093	0.0002	0.0019	0.0007	0.0098	0.0034

APPENDIX D: EXPECTED RESULTS FROM SBE 5.

- **3.3. contains Pu that is consistent with that of 3.1.1.**
- **Summary of expected alpha spectrometry results for 3.1.1.:**

Evidence Piece	²³⁸Pu (Bq)	1-σ	^{239,240}Pu (Bq)	1-σ	²⁴¹Am (%)	1-σ	²³⁸Pu/ ^{239,240}Pu (mass ratio)	1-σ
3.1.1.	1.01E-2	3.12E-4	1.51	4.65E-2	9.4E-3	5E-4	2.57E-5	9.3E-7

APPENDIX E: EXPECTED RESULTS FROM SBE 6.

- Elimination of all sources not containing Pu
- Elimination of SNF
- Elimination of Y-1 thru Y-5 and C-1 and C-2 based upon gamma and alpha analyses. A complete breakdown of comparisons of PuBe sources in the Reimerland inventory based upon alpha and gamma analyses is shown below.

Gamma Results

Sample	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu	²⁴¹ Pu (+ ²⁴¹ Am)	²⁴² Pu	Pu/Am Age	Am/Np Age
C1	✓	✓	✓	✓	✓	✓	-
C2	✓	✓	✓	✓	✓	✓	-
R1	✓	✓	✓	✓	✓	✓	-
Y1	✓	✗	✗	✓	✓	✓	-
Y2	✓	✗	✗	✓	✓	✓	-
Y3	✓	✗	✗	✓	✓	✓	-
Y4	✓	✗	✗	✓	✓	✓	-
Y5	✓	✗	✗	✓	✓	✓	-
Y6	✓	✓	✓	✓	✓	✓	-
Y7	✓	✓	✓	✓	✓	✓	-
Y8	✓	✓	✓	✓	✓	✓	-

APPENDIX F: EXPECTED RESULTS FROM SBE 7.

- Elimination of Y-6 and Y-8 based upon ICP-MS analyses. A complete breakdown of comparisons of PuBe sources in the Reimerland inventory based upon ICP-MS analyses is shown below.

Alpha Results

Sample	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu	²⁴¹ Pu (+ ²⁴¹ Am)	²⁴² Pu	Pu/Am Age	Am/Np Age
C1	-	-	-	-	-	✗	-
C2	-	-	-	-	-	✗	-
R1	-	-	-	-	-	✓	-
Y1	-	-	-	-	-	✓	-
Y2	-	-	-	-	-	✗	-
Y3	-	-	-	-	-	✗	-
Y4	-	-	-	-	-	✗	-
Y5	-	-	-	-	-	✓	-
Y6	-	-	-	-	-	✓	-
Y7	-	-	-	-	-	✓	-
Y8	-	-	-	-	-	✓	-

APPENDIX G: EXPECTED RESULTS FROM SBE 8.

- Elimination of all remaining PuBe sources in Reimerland inventory based upon MC-ICP-MS analyses. A complete breakdown of comparisons of PuBe sources in the Reimerland inventory based upon MC-ICP-MS analyses is shown below.
- XRD confirms Pu powder is in the form of PuO₂.

ICP-MS Results

Sample	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu	²⁴¹ Pu (+ ²⁴¹ Am)	²⁴² Pu	Pu/Am Age	Am/Np Age
C1	√	√	√	√	√	√	-
C2	√	√	√	√	√	√	-
R1	√	√	√	√	√	√	-
Y1	√	✗	✗	√	√	✗	-
Y2	√	✗	✗	√	√	✗	-
Y3	√	✗	✗	√	√	✗	-
Y4	√	✗	✗	√	✗	✗	-
Y5	√	✗	✗	√	√	√	-
Y6	√	√	√	√	√	✗	-
Y7	√	√	√	√	√	√	-
Y8	√	√	√	√	✗	√	-

MC-ICP-MS Results

Sample	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu	²⁴¹ Pu (+ ²⁴¹ Am)	²⁴² Pu	Pu/Am Age	Am/Np Age
C1	√	√	√	√	√	✗	-
C2	√	√	√	√	√	✗	-
R1	√	√	√	√	√	✗	-
Y1	√	✗	✗	√	√	✗	-
Y2	√	✗	✗	√	√	✗	-
Y3	√	✗	✗	√	√	✗	-
Y4	√	✗	✗	√	✗	✗	-
Y5	√	✗	✗	√	√	√	-
Y6	√	√	√	√	√	✗	-
Y7	√	✗	√	√	√	√	-
Y8	√	√	✗	√	✗	√	-

APPENDIX H: DATA INJECT #3 - RESPONSE LETTERS FROM CHICOLAND AND YOSEMLAND OFFICIALS

Logan Leigh
Foreign Minister
Federation of Yosemite
Salisbury, Yosemite
November 7th, 2013

Adam Nicole
Ambassador of International Relations
Republic of Reimerland
Beta City, Bowline Province, Reimerland

Dear Ambassador Nicole:

Thank you for notifying Yosemite of your recent security issues related to the seizure of plutonium in your country. As you know, Yosemite maintains a robust security of its nuclear holdings, the content of which is held as a national secret. Therefore it was no surprise to us, after a cursory review of the analytical data you sent us, that we concluded with the utmost confidence that this material did not originate from our inventory. We wish you luck in your investigation and would appreciate being apprised of any future developments in this case.

Sincerely,

Logan Leigh

Evanni Michealson
Secretary of Foreign Affairs
Chicoland Federation
Mantle City, Mountain Home Region, Chicoland
November 7th, 2013

Adam Nicole
Ambassador of International Relations
Republic of Reimerland
Beta City, Bowline Province, Reimerland

Dear Ambassador Nicole:

I wish to thank you for informing Chicoland officials of the recent seizure event in Reimerland involving the attempted smuggling of plutonium across the northern border with Chicoland and want to convey the full support of my office in your endeavor to bring those responsible for this act to justice. As you may know, Chicoland has experienced a rise in similar events within our borders in recent years and I am concerned this latest event in Reimerland may be related to some of those events. For full disclosure I provide a summary of seizures over the past two decades in Chicoland that involved plutonium.

December 12th, 1995: A man was stopped during a routine traffic stop for an unrelated traffic violation. Upon a search of his vehicle, authorities uncovered 2.3 kg of plutonium metal.

Based upon information we obtained through questioning of the suspect, ensuing undercover investigations were able to recover another 3.5 kg of plutonium metal on February 2nd, 1996, from an abandoned warehouse in the southern city of Discogringo. We believe that material came from the same source as that material recovered on December 12th, 1995.

June 1st, 1999: Chicoland authorities seized 1.1 kg of plutonium powder after they were contacted by a concerned citizen. This individual runs a fishing charter and became suspicious when he was hired to transit five individuals with a large amount of equipment by boat to the Reimerland port of Cliffside. We believe this seizure is unrelated to those that occurred in 1995 and 1996 since the form of this material (powder) and the isotopic composition were significantly different.

August 14th, 2005: Chicoland authorities seized 1.3 kg of Pu powder at an airport just outside the Country capital of Mantle City from an individual attempting to board an international flight to the tourist city of Eldorado, Reimerland. A subsequent search of his residence uncovered another 1 kg of similar powder.

March 30th, 2009: Intelligence sting operations focused on the terror group "Oppose Y" resulted in the seizure of 1.4 kg of Pu powder (similar to the 1999 and 2005 seizures).

May 22nd, 2010: Intelligence sting operations focused on the terror group "Oppose Y" resulted in the seizure of 903 g of Pu powder (similar to the 1999, 2005 and 2009 seizures).

The material recently seized in Reimerland looks strikingly similar to some of the materials seized in our Country starting in 1999, which are all oxide powders with similar isotopic composition to your materials. This material, however, appears to be significantly different than the Pu metal seized within our country in 1995 and 1996. We believe we know where the Pu metal originated from. We suspect this material was historically in Chicoland's nuclear inventory up to 1994. In that year, 27 kg of special nuclear material (nominally 98% Pu metal alloyed with Beryllium) was stolen from a facility that used to make commercial neutron sources by diverting a small portion of the country's product materials destined for its weapons stockpile. That facility closed down in 1992 after the country decided to abandon its weapons program in 1989. Since 1992, all 112 kg of the remaining Pu-Be neutron source inventory was stored and safeguarded in place until the 1994 incident. However, we still do not know the origin of the Pu oxide powders that have been the focus of more recent seizures within our country. Please let us know if you concur with our assessment.

The trafficking of special nuclear material is of the highest interest to Chicoland authorities. As such we would appreciate the opportunity to work with Reimerland authorities to bring those responsible to justice.

Sincerely,

Evanni Michealson

Chicoland
Seizures

	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Am-241	Form	Total Recovered (Kg)
1995	0.0194	97.3	2.05	0.00600	0.00202	0.0134	Metal	2.3
1996	0.0184	97.5	2.01	0.00620	0.00194	0.0138	Metal	3.5
1999	0.0200	97.9	1.93	0.00910	0.00198	0.0112	Oxide	1.1
2005	0.0192	97.5	2.05	0.00840	0.00204	0.0110	Oxide	2.3
2009	0.0182	97.8	1.91	0.00900	0.00198	0.0110	Oxide	1.4
2010	0.0190	97.6	1.99	0.00902	0.00199	0.0108	Oxide	0.903

APPENDIX I: SUMMARY OF THE SCENARIO BASED EXERCISE

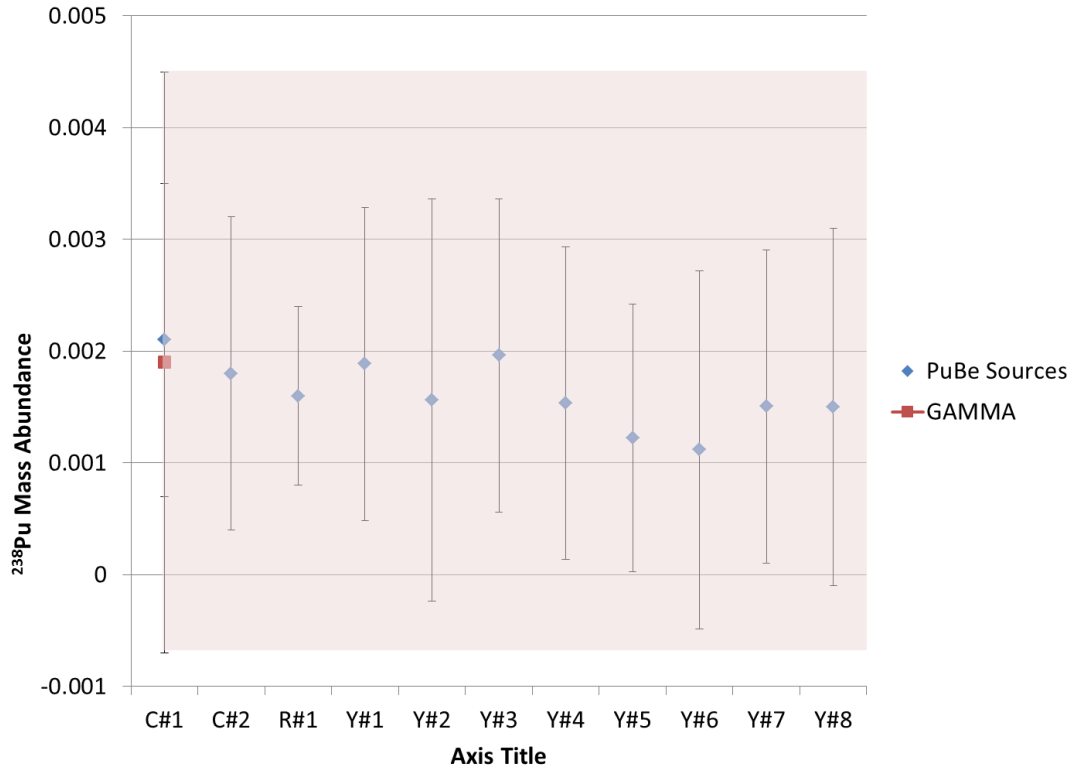


Figure I-1: Comparison of ^{238}Pu mass abundance with PuBe sources in Reimerland inventory. Light red shaded area represents the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry.

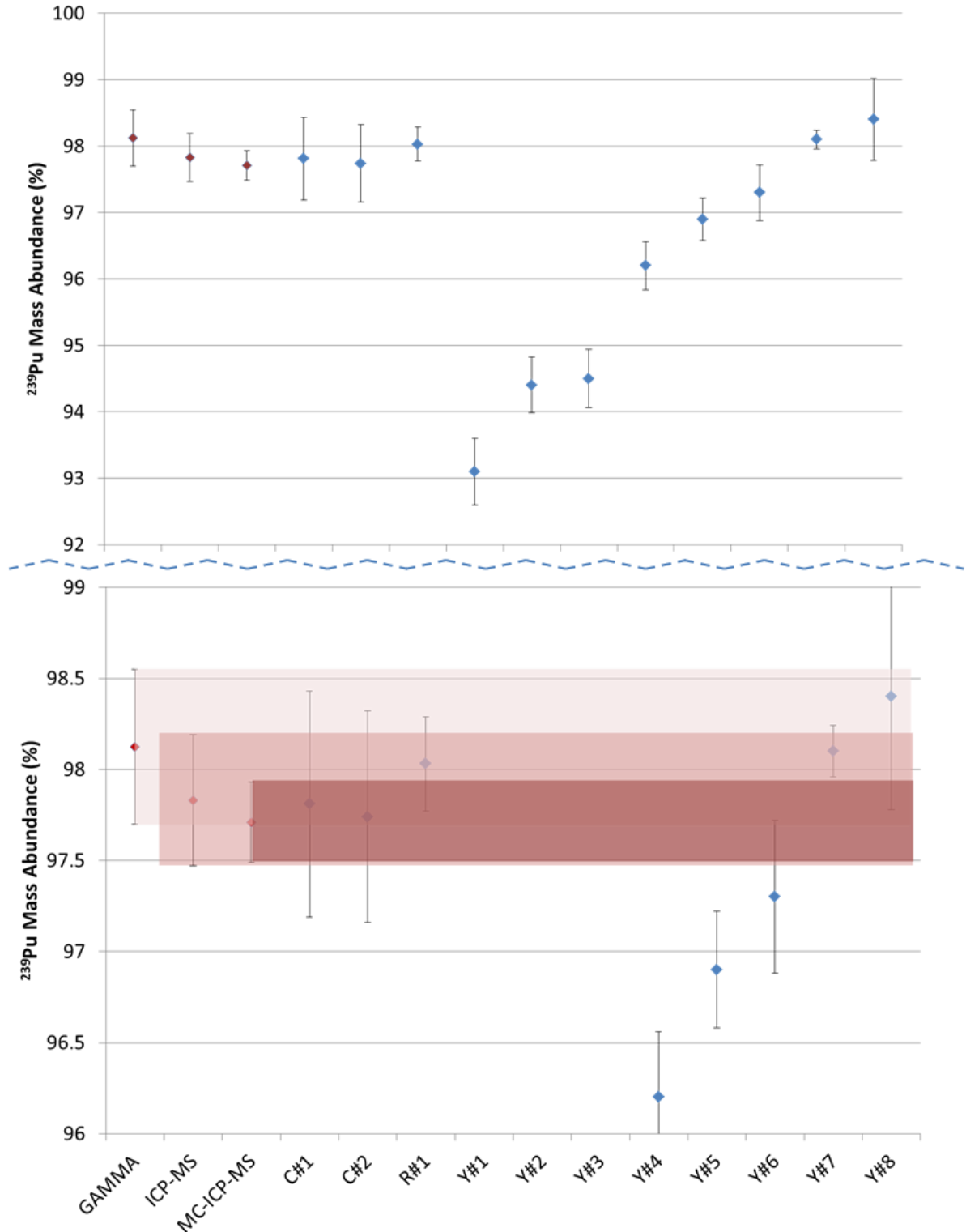


Figure I-2: Comparison of ^{239}Pu mass abundance with PuBe sources in Reimerland inventory. Light, medium, and dark red shaded area represent the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry, ICP-MS, and MC-ICP-MS, respectively.

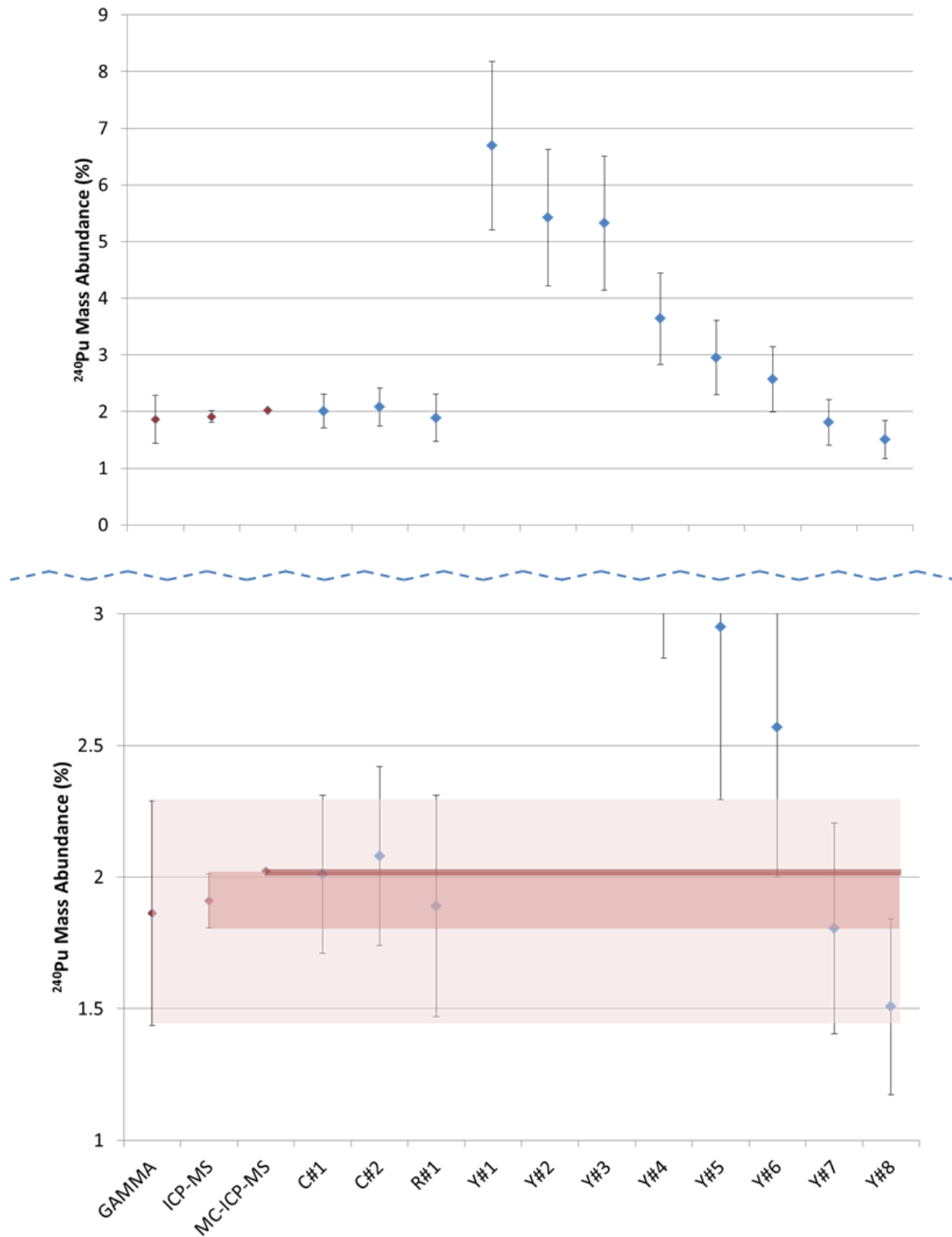


Figure I-3: Comparison of ^{240}Pu mass abundance with PuBe sources in Reimerland inventory. Light, medium, and dark red shaded area represent the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry, ICP-MS, and MC-ICP-MS, respectively.

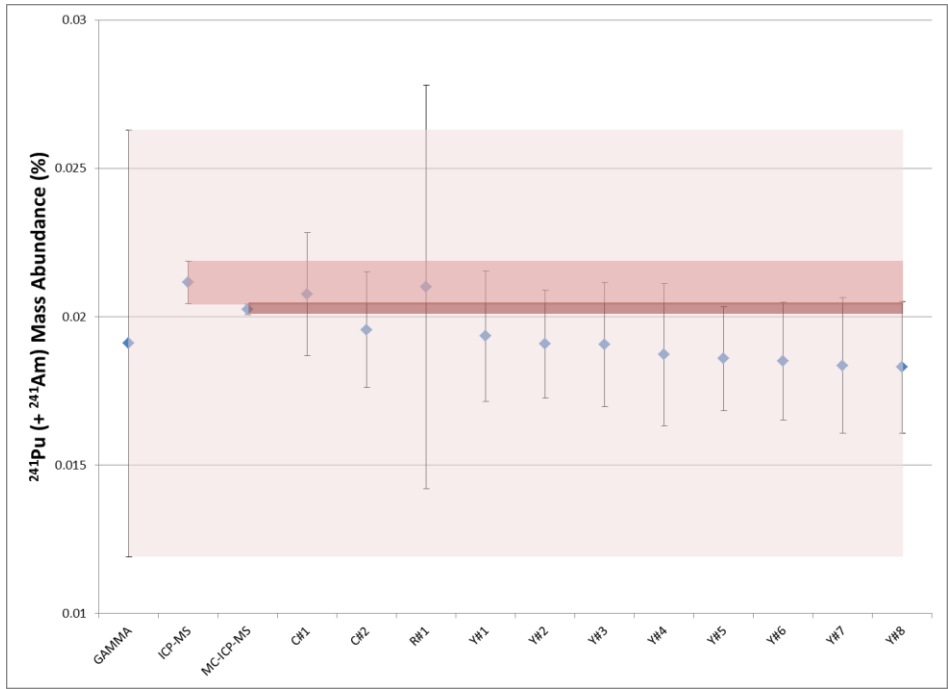


Figure I-4: Comparison of $^{241}\text{Pu} + ^{241}\text{Am}$ mass abundance with PuBe sources in Reimerland inventory. Light, medium, and dark red shaded area represent the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry, ICP-MS, and MC-ICP-MS, respectively.

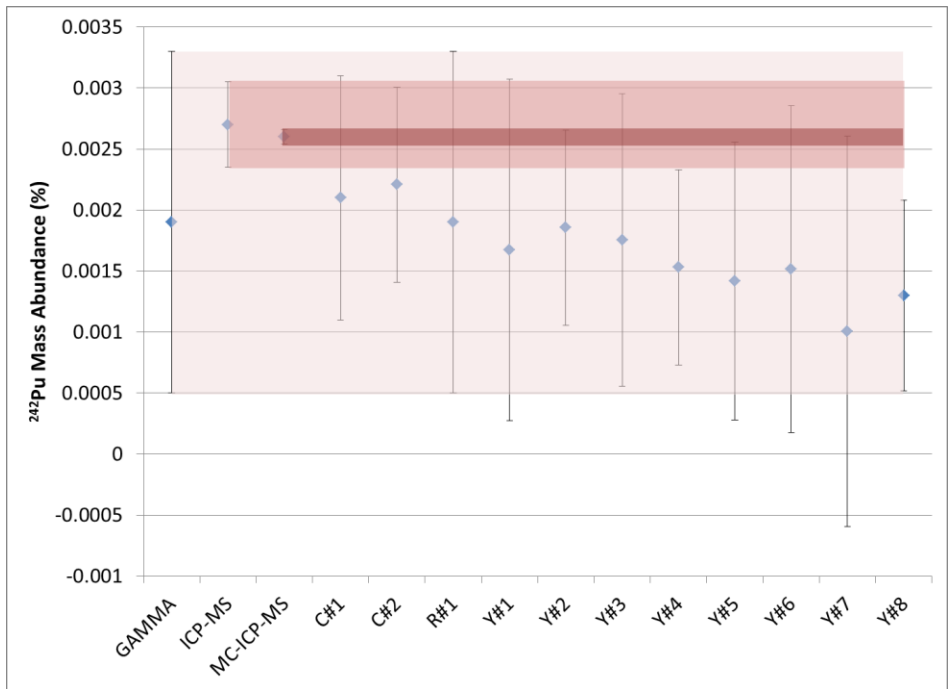


Figure I-5: Comparison of ^{242}Pu mass abundance with PuBe sources in Reimerland inventory. Light, medium, and dark red shaded area represent the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry, ICP-MS, and MC-ICP-MS, respectively.

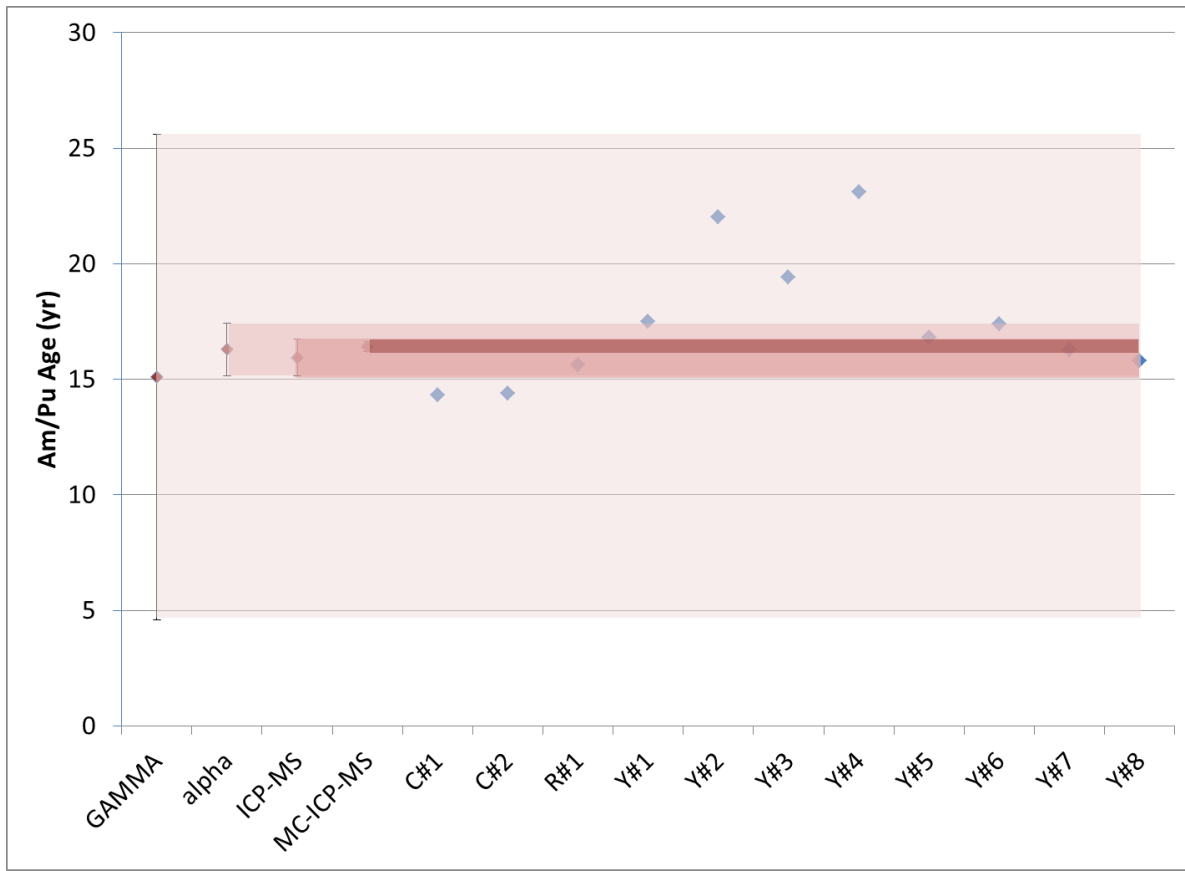


Figure I-6: Comparison of radiochronometer age based upon the $^{241}\text{Am}/^{241}\text{Pu}$ parent / daughter relationship. Light, medium, medium dark and dark red shaded area represent the 95% confidence interval around the datapoint for the unknown measured by gamma ray spectrometry, alpha spectrometry, ICP-MS, and MC-ICP-MS, respectively.



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