Chemical provenance of pre- to post-contact period copper and copper-rich alloy artifacts from archaeological sites in Nova Scotia, Canada: a laser ablation ICP-MS study

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Copper had cultural significance to the Mi'kmaq peoples of the Maritimes, and was used in the fabrication of tools and personal, ceremonial, gift, and trade wares. In this study, LA-ICP-MS was used to characterize the trace elemental composition of artifacts from archaeological sites in Nova Scotia ranging from Early Woodland (2500-2400BP) to Protohistoric (450-350 BP) to European contact (1500+BP) periods in age, and samples of natural copper from potential sources with goals of: (i) differentiating artifacts derived from natural copper from those made from synthetic (refined) European (trade) copper and its alloys, and (ii) identifying the specific natural sources of copper that were exploited. The methodology used in this study improves on previous bulk analytical methods (e.g., INAA, XRF) that suffer from the presence of contaminating mineral phases within the copper volume analyzed and are more destructive. LA-ICP-MS analysis of 57 artifacts identified 10 compositional groupings with specific elemental enrichment/depletions/ratios, notably involving Ag, Pb, Hg, Bi, Zn and As. Most single artifacts are compositionally homogeneous with respect to the majority of elements with <20% relative variation in concentration over 8-10 ablation spots. Patinas show preferential enrichment (e.g., Fe, Sn, Zn, Au) and depletion (e.g., Ni, Co, Ge, Ag) relative to the fresh metal. However, differences in source composition are significant enough that the patina can be diagnostic of provenance. Three groups have definitive provenance determined: six artifacts from Cap d'Or, Nova Scotia (natural Cu), six from Margaretsville, Nova Scotia (natural Cu), and nine artifacts of European origin (refined Cu or Cu-Zn-Sn alloys). Seven remaining artifact groups have unknown provenance and, importantly, sources analyzed from Michigan, USA (Keweenaw Peninsula) are ruled out. Contrary to the Lake Superior model, copper deposits from the Bay of Fundy were important but many other sources of the metal are likely and require further investigation.

Acknowledgments

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1.0 Introduction

The chemical microanalysis of archaeological materials by non-destructive methods allows insight into the manufacturing and origins of objects that are of considerable cultural or archaeological value. For metallic artifacts in particular, which often present significant surface corrosion modifying primary composition, robust chemical characterization of fresh material has required invasive sampling methods and large sample volumes, primarily due to limitations in the analytical methodologies available to archaeological sciences historically. The preservation of sample integrity and appearance is a priority during collection, conservation, storage and study, and must be carefully reconciled with the desire to reduce uncertainties in provenance studies introduced when fresh metal cannot be accessed in an artifact.

In North America, there has been considerable work done to identify the origins of natural copper artifacts, ad to differentiate between natural and refined (European) copper and its alloys. In the sixteenth and seventeenth centuries, the first permanent settlers from Europe arrived in Nova Scotia to find it was inhabited by the Mi'kmaq, the indigenous group of people that had been living in Nova Scotia thousands of years before the arrival of the Europeans in the early 1600s (Morton, 1999). It has been heavily documented that the Mi'kmaq used materials such as animal hides and fur, bones, wood, and stones to make their clothing, jewelry and tools (Whitehead 1993, Leonard 1996, Whitehead et al 1998, Levine 1999, Rapp 2000, Bourque, 2001, Fenn 2001, Glascock & Neff 2003, Anselmi 2004, Lattanzi 2007, Dussubieux et al. 2008, Lattanzi 2008). Another material favoured by the Mi'kmaq, was copper. As indigenous peoples slowly spread across North America, their spiritual connections to, and practical utilization of, raw materials including metals changed continuously. In fact, creating and trading of goods amongst themselves and with other indigenous peoples led to the first commercial use of metals (Quimby, 1966; Bourqe, 2001; Lattanzi, 2007; Levine, 2007; Cooper et al., 2008; Cooper, 2011). The importance of copper to the Mi'kmaq had also been increasing as migrations, settlements and discovery of new sources of the metal took place. Copper was used for a variety of purposes and in the archaeological record, objects of definitive purpose have been identified including trade "currency," personal adornments and burial necessities for the afterlife in the form of talismans, beads (Rapp, 2000; Mulholland & Pulford 2007) and tinkling cones (Levine 2007), and after European contact, the use of copper kettles for burial practices, practical use of vessels, and reworking into other objects listed here (Turgeon et al., 1990; Fitzgerald et al., 1993; Whitehead et al., 1998). The first use of copper in what is now Canada dates back to between 6800 BP (Ehrhardt, 2009) and 5560 BP (Beukens et al. 1992; Rapp & Hill, 2006) based on controlled archaeological stratigraphy (spatial relationships to other objects from these times) and radiocarbon dating methods. Later in the archaeological record for the Protohistoric period, it was known to be obtained from Europeans during trade involving the Spanish (Basque), and later the French, Dutch and English (Hancock et al. 1991; Whitehead, 1993; Rapp 2000; Lattanzi, 2006; Levine 2007; Klein et al 2010; Michelaki et al 2013).

To date there has been no scientific analytical studies done on pre-contact artifacts found in Nova Scotia in order to identify the sites of origin of their contained copper with respect to possible sources of this metal in the region, and elsewhere. In addition, there has been no work conducted to characterize contact-era artifacts through chemical analytical means. Several studies have been undertaken to discuss where indigenous peoples in some areas of North America, (Ontario, Yukon, and the northeastern United States) procured their copper (Hancock et al., 1991; Fitzgerald et al., 1993; Levine 1996, 2007; Whitehead et al., 1998; Rapp et al., 2000; Fenn 2001; Junk, 2001; Lattanzi 2007, 2008; Mulholland & Pulford, 2007; Dussubieux et al., 2008; Hill, 2012), but no studies have been conducted in the Atlantic provinces with the exception of a single chemical analytical study of burial artifacts from three localities by INAA all found to be of European origin (Whitehead et al., 1998). The most commonly accepted theory with respect to the procurement of native copper for the creation of objects, is the Lake Superior model (Hancock et al., 1991; Levine, 1996, 2007; Rapp et al., 2000; Fenn, 2001; Lattanzi, 2007, 2008; Ehrhardt, 2009). Through this model, it has been widely accepted that any archaeological copper prior to European contact and trade, originated in the Lake Superior areas of Ontario (e.g., Mamainse Point) and Michigan (e.g., Keweenaw Peninsula). These locations were rich in large native copper deposits and were later mined commercially for over one hundred years (Rosemeyer, 2009, 2011). The deposit types in this area range from the volcanic red bed copper more typical of the Keweenaw Peninsula (Eckstrand et al., 1995), to less common stratiform sedimentary hosted copper deposits (ex. the White Pine Mine) (Brown, 1992; Eckstrand et al.,1995). Many researchers appear to simply accept or assume that copper artifacts originated from the Lake Superior region such as Holmes (1901) and Reeder (1903), both of whom “presented [this model] as if it were a proven fact” (Levine, 2007). However some archaeologists have questioned this hypothesis (see Levine, 1996, 2007; Rapp et al., 2000; Fenn, 2001; Lattanzi, 2007, 2008; Hill, 2012), and through careful chemical analysis by relative destructive means combined with statistical methods of data analysis, have shown that some artifacts found in the United States and central Canada

(Ontario, Quebec) were likely sourced from other copper mineralization throughout the northeastern United States and Nova Scotia (the Bay of Fundy Region).

This study involved the microanalyses by laser ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) of 60 copper-based artifacts collected from 6 archaeological sites representing sites of aboriginal habitation in Nova Scotia, Canada (Figure 1.1, Table 1.1), and 38 geological samples (native, naturally-occurring copper) from 15 deposits in Canada (Nova Scotia; Figure 1.2), the United States (Michigan, Pennsylvania) and some international sources (Bolivia, the United Kingdom, Kazakhstan), Tables 1.1 and 1.2 summarize the characteristics of the artifacts and natural copper source samples analyzed. Some of the artifacts studied have been dated using archaeological methods and it is considered that the collection spans a time period through the Early to Late Woodland periods (2500-500 BP) and up to the contact period. However, little is known as to the original geological provenance of the copper found at the archaeological site localities. The application of LA-ICP-MS to in-situ trace element analysis is an appropriate method for archaeometry as it is a relatively non-destructive method (i.e., generating only microscopic pits invisible to the naked eye) compared to instrumental neutron activation analysis (INAA; requiring several hundred mg of sample) or X-Ray fluorescence (XRF; requiring a flat surface on the object greater than ~14 mm in diameter or a powder of minimum volume of several grams). The LA-ICP-MS method also achieves a much wider range of, and much lower detection limits for, trace elements compared to the other methods.

The main objectives of this study were (i) identify the source of native copper contained within artifacts recovered at various aboriginal archaeological sites across Nova Scotia, and (ii) to evaluate and discuss the benefits of LA-ICP-MS as an analytical method for metallic archaeological objects. The study establishes recommendation for the analysis of archaeological materials by LA-ICP-MS, highlighting the rapid analysis of materials for a range of trace elements that is not possible by other typically used analytical means without substantial sample preparation and destruction.

In this study, whole artifacts were mounted and inserted into the ablation chamber, analyzed and removed intact with no visible damage. It is important to note that the majority of the previous work on North American copper artifacts (Levine, 1996; Rapp, 2000; Kuleff and Pernicka, 1995; Rapp Jr., 1985; Mulholland and Pulford, 2007) used INAA to study trace element concentrations in native copper artifacts. Review of the data sets produced by these studies indicate that, in addition to their relative destructive nature, these applications of the methods above have revealed relatively large variations in copper chemistry from single artifacts and sources, likely due to contamination of the analytical volumes removed from the objects by inclusions of other mineral grains. More recently, LA-ICP-MS analyses of copper artifacts were done by Fenn (2001), Lattanzi (2007 and 2008), Cooper (2008) and Hill (2012). Some concerns about the standards utilized for calibration of analyte sensitivities in these LA-ICP-MS studies were identified and a full description of the relative advantages and disadvantages of the LA-ICP-MS method follows in a discussion.

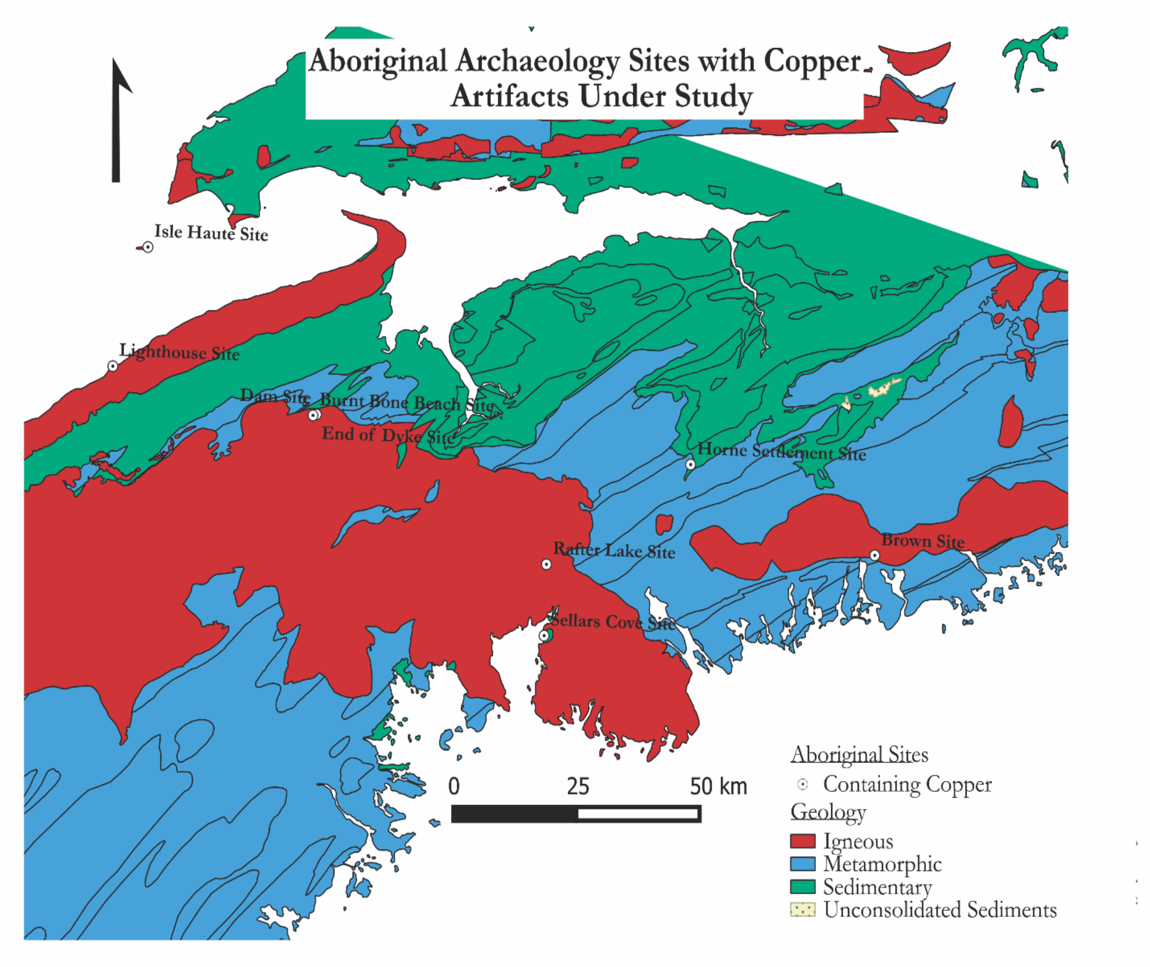

Figure 1.1 Geological map of study area (modified from Marche, 2014) depicting changes in rock type. Excavation sites shown. Software: QGIS Version 2.2 Data Sources: Nova Scotia Department of Communities, Culture and Heritage, Nova Scotia Department of Natural Resources Disclaimer: Map not to be used outside of MNH/SMU research Datum & Projection: NAD 83 UTM Zone 20. Cartographer: Jennifer Marche.

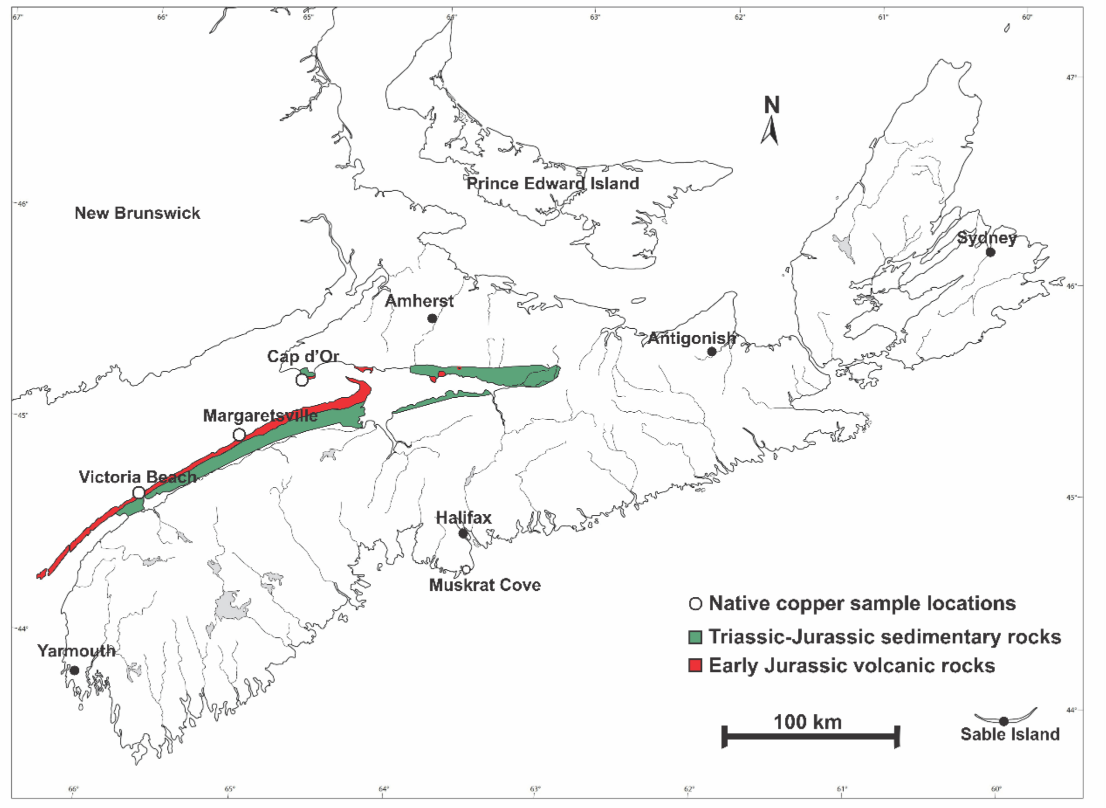

Figure 1.2 Map of Nova Scotia showing geological units in the areas where native sources were collected. Modified from NS Department of Natural Resources online GIS Database.

Table 1.1 Object descriptions of all copper artifacts in the collection belonging to the Nova Scotia Museum and CRM group.

Sample	Site	Age[3]	Description[1]	Patina[2]	Size (cm)	Source
8566	Gaspereau Lake Reservoir	Woodland period	Nodule	Low	2.4 x 0.9	CRM Group
8567	Gaspereau Lake Reservoir	Woodland period	Nodule	Low	3.0 x 1.6	CRM Group
8568	Gaspereau Lake Reservoir	Woodland period	Nodule	High	2.0 x 0.8	CRM Group
8569	Gaspereau Lake Reservoir	Woodland period	Nugget	Low with Exposure	1.3 x 1.1	CRM Group
8572	Gaspereau Lake Reservoir	Woodland period	Nodule	High	1.1 x 2.0	CRM Group
8573	Gaspereau Lake Reservoir	Woodland period	Nugget	Low with Exposure	1.8 x 1.7	CRM Group
8574	Gaspereau Lake Reservoir	Woodland period	Altered Nodule	Medium	1.2 x 1.0	CRM Group
8576	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	Low with Exposure	1.6 x 1.1	CRM Group
8577	Gaspereau Lake Reservoir	Woodland period	Nodule	High	1.3 x 1.4	CRM Group
8579	Gaspereau Lake Reservoir	Woodland period	Nodule	Low	2.0 x 1.5	CRM Group
8580	Gaspereau Lake Reservoir	Woodland period	Nodule	Low	3.1 x 2.7	CRM Group
8581	Gaspereau Lake Reservoir	Woodland period	Nugget	High	1.0 x 0.6	CRM Group
8582	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid	1.5 x 1.2	CRM Group
8584	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid with Exposure	0.9 x 0.7	CRM Group
8587	Gaspereau Lake Reservoir	Woodland period	Nugget	High	0.9 x 0.4	CRM Group
8589	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid	1.7 x 1.0	CRM Group
8590	Gaspereau Lake Reservoir	Woodland period	Nugget	High	1.8 x 1.4	CRM Group
8591	Gaspereau Lake Reservoir	Woodland period	Nugget	High	2.2 x 0.4	CRM Group
8592	Gaspereau Lake Reservoir	Woodland period	Nugget	Low	2.0 x 0.9	CRM Group
8593	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	Low	3.1 x 1.6	CRM Group
8594	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid	1.3 x 0.8	CRM Group
8595	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	Low with Exposure	1.9 x 1.3	CRM Group
8596	Gaspereau Lake Reservoir	Woodland period	Nugget	Low	1.6 x 1.0	CRM Group
8597	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	Mid	4.1 x 2.9	CRM Group
8598	Gaspereau Lake Reservoir	Woodland period	Nugget	High	1.8 x 0.4	CRM Group
8599	Gaspereau Lake Reservoir	Woodland period	Nodule	Low	2.6 x 1.9	CRM Group
8603	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	High	1.7 x 1.4	CRM Group
8604	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid	2.0 x 1.2	CRM Group
8605	Gaspereau Lake Reservoir	Contact period	Rolled Sheet	Low	3.3 x 2.6	CRM Group
8606	Gaspereau Lake Reservoir	Contact period	Rolled Sheet	Low	4.3 x 2.7	CRM Group
8607	Gaspereau Lake Reservoir	Contact period	Rolled Sheet	Low	5.1 x 3.7	CRM Group
8608	Gaspereau Lake Reservoir	Contact period	Rolled Sheet	Low	1.4 x 1.2	CRM Group
8609	Gaspereau Lake Reservoir	Woodland period	Worked Nugget	Low	1.9 x 1.4	CRM Group
8610	Gaspereau Lake Reservoir	Woodland period	Nugget	Mid with Exposure	1.6 x 1.7	CRM Group
818	Muskrat Cove	Woodland period	Preserved* Rolled sheet	Mid	1.8 x 0.7	CRM Group
819	Muskrat Cove	Woodland period	Preserved* Rolled sheet	Low	4.6 x 2.6	CRM Group
820	Muskrat Cove	Woodland period	Preserved* Nugget	Low	1.6 x 0.8	CRM Group
821	Muskrat Cove	Woodland period	Preserved* Awl	Low	1.9 x 0.3	CRM Group
822	Muskrat Cove	Woodland period	Preserved* Nugget	High	1.4 x 1.3	CRM Group
851	Sellars Cove	Woodland period	Nugget	Low	2.3 x 2.1	Steve Davis
859	Sellars Cove	Woodland period	Nugget	Low	1.9 x 0.8	Steve Davis
863a	Sellars Cove	Woodland period	Necklace beads	High	0.7 x 0.3	Steve Davis
863b	Sellars Cove	Woodland period	Necklace beads	High	0.8 x 0.3	Steve Davis
19	Burnt Bone Beach	Woodland period	Rolled Sheet	Low	6.3 x 3.2	Michael Deal
20	Burnt Bone Beach	Woodland period	Rolled Tinkling Cone	Low	6.1 x 1.5	Michael Deal
99	Isle Haute	Woodland period	Nugget	High	1.6 x 0.7	David Christianson
211	Isle Haute	Woodland period	Nugget	High	1.9 x 1.7	David Christianson
1949	Enfield	Contact period	Rolled Sheet	Mid with Exposure	2.1 x 1.0	Steve Davis
2015	Enfield	Contact period	Rolled Sheet	Mid	2.0 x 0.8	Steve Davis
2158	Enfield	Woodland period	Worked Nugget	High	2.2 x 1.4	Steve Davis
2225	Enfield	Woodland period	Nugget	Low	2.6 x 0.9	Steve Davis
5337	Enfield	Woodland period	Nugget	Low	1.3 x 1.0	Steve Davis
2	Margaretsville	Woodland period	Worked Nugget	Low	2.6 x 1.7	John Erskine
64	Clam Cove	Woodland period	Nugget	Mid	1.3 x 1.4	Michael Deal
21	Clam Cove	Woodland period	Nugget	Low	1.8 x 3.1	Michael Deal
230	Clam Cove	Woodland period	Nugget	Mid	2.4 x 1.9	Michael Deal
173	Jeddore Harbour	Woodland period	Nugget	High	1.0 x 2.1	Michael Deal
Rlake	Rafter Lake	Woodland period	Worked Awl	Mid	4.0 x 0.6	Steve Davis

*Preserved samples were treated with a solution of 5% B-72 in acetone prior to the commencement of this study

[1] Note: not all artifacts listed were used in analyses

[2] Morphological artifact descriptions follow those detailed in Leonard (1996)

[3] Patina descriptions range from low coverage (0-30% of the artifact covered in thick green patina) mid coverage (31-60%) and high coverage (61-100%) any artifacts with exposure of fresh copper have been noted

[4] Age refers to suspected age of artifact using archaeological methods as per Cottreau-Robins, pers. comm. (2013)

Table 1.2 : Descriptions of native copper sources

Mine	Host Rock	Deposit Type	County	State/Province	Country	Copper Produced (lbs)
Phoenix	basaltic extrusive rocks and sediments [2]	fissure vein [1]	Keweenaw	Michigan	USA	17 205 566*
Calumet	basaltic extrusive rocks and sediments [2]	fissure vein [1]	Keweenaw	Michigan	USA	17 205 566*
Central Mine	conglomerate [2]	fissure vein[1]	Keweenaw	Michigan	USA	17 205 566*
Copper Falls	conglomerate [2]	fissure vein[1]	Keweenaw	Wisconsin	USA	17 205 566*
Isle Royale	basaltic extrusive rocks and sediments [2]	amygdaloid ore bodies [1]	Houghton	Michigan	USA	254 632 779[1]
Osceola Mine	cambrian sediments [2]	amygdaloid ore bodies [1]	Houghton	Michigan	USA	4 782 774 32[1]
White Pine	carbonaceous shale, siltstone, sandstone [3]	stratiform sedimentary[3]	Ontonagon	Michigan	USA	4 088 269 603 [9]
Greenstone Quarry	quartz	fissure vein[1]	Adams County	Pennsylvania	USA	unknown
Corocoro	shale, sandstone, conglomerates [4]	vein [4]	N/A	Le Paz	Boliva	200 000 000 [4]
Itauz Mine	clastic redbed sequences [5]	stratiform sedimentary [5]	N/A	Dzhezkazgan	Kazakhstan	207 452 860 000 [5]
Cap d'Or	basalt, carbonate quartz veins [6]	vein [6]	Cumberland	Nova Scotia	Canada	12 320 [10]
Margaretsville	basalt [7]	amygdaloid ore bodies [7]	Annapolis	Nova Scotia	Canada	0**
Victoria Beach	basalt [7]	amygdaloid ore bodies [7]	Digby	Nova Scotia	Canada	0**
Cornwall	metasediments [8]	veins [8]	N/A	Cornwall	England	352 736 [11]

1. Broderick, 1931; 2. Butler & Burbank, 1929; 3. Brown, 1992; 4. Singewald & Berry, 1992; 5. Box et al. 2012; O'Reilly, 2007; 7. Campbell, D.A., 1966; 8. Bevins et al. 2010; 9. Rosemeyer, 2010; 10. Messervey, 1929; 11. Geological Survey of Great Britain, 1846.

*Common tonnage listed is representative of all of the copper collected from all active mines in the Keweenaw Peninsula (Rosemeyer, 2009)

**Copper occurrences never put into production (NSDNR, pers. comm. 2014)

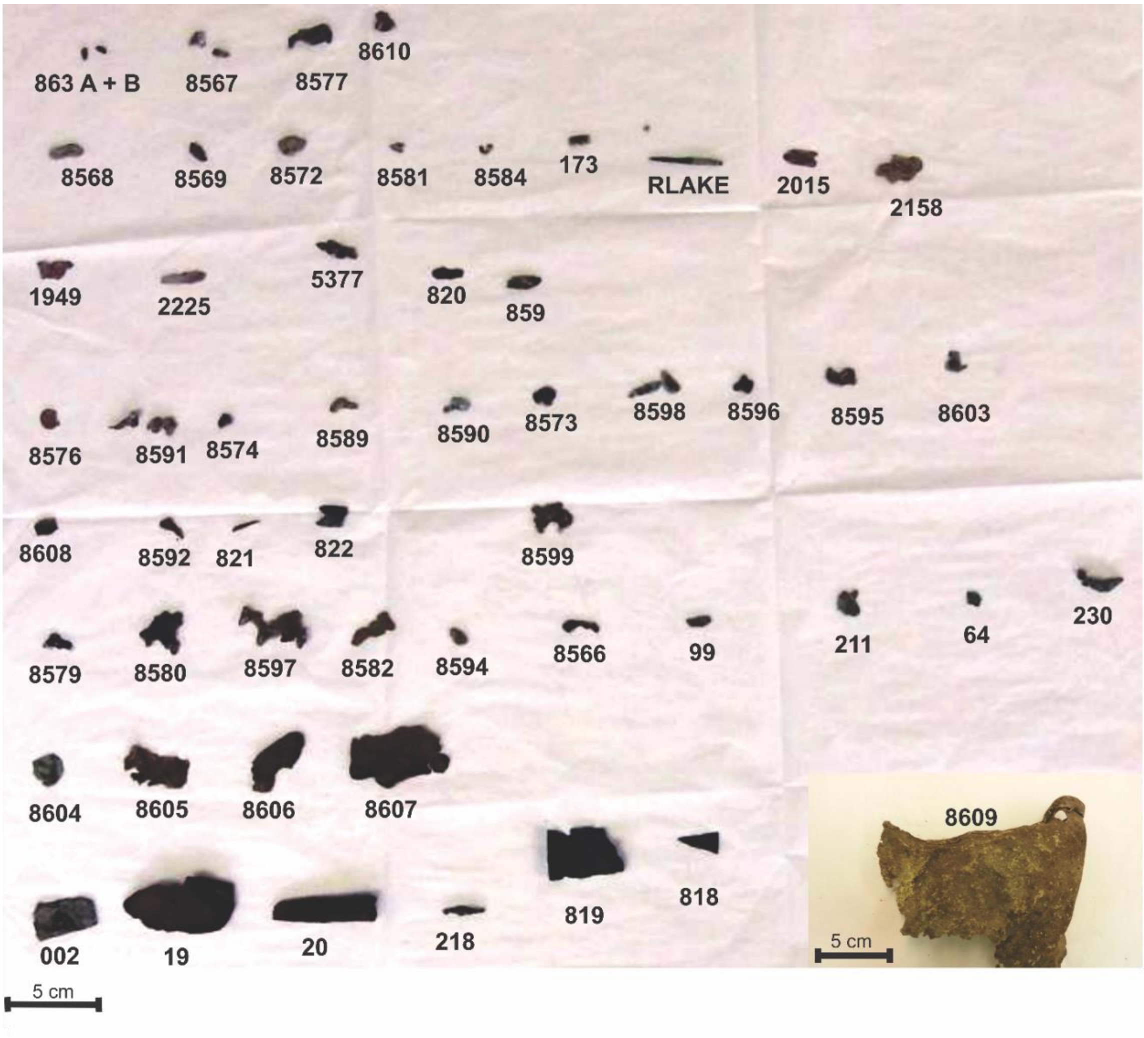

Figure 1.3 All artifacts used in this study from the Nova Scotia Museum. Inset: Artifact 8609.

2.0 Methodology

2.1 Sample selection and preparation

The samples used for this study comprised two different types: native copper samples, and archaeological copper-based samples. Native copper samples were purchased from private collections and sampled from larger specimens in the collections of the Nova Scotia Museum. Artifacts for this study were borrowed from the Nova Scotia Museum and come from collections that were discovered, assembled and characterized by provincial and private archaeologists Steve Davis, Michael Deal, Helen Sheldon, John Erskine and archaeology employees at Cultural Resources Management Inc. (Halifax) over a twenty year period (Cottreau-Robins, pers. comm., 2014). The collection includes artifacts from 6 different sites with various types of artifact morphology (e.g., shape and/or type of object, size, preservation) represented (Table 1.1, Figure 1.3). Morphological descriptions follow those detailed by Leonard (1993). Archaeological samples suspected or known to have been used for burial purposes or in burial ritual were excluded from this study.

2.1.1 Artifact copper

The archaeological samples were measured, catalogued and described prior to analysis using LA-ICP-MS. Owing to the size constraints of the laser ablation chamber, artifacts smaller than 2cm x 2cm x 2cm were selected to be analyzed with priority and larger artifacts were analyzed last with the maximum size possible being 6.1 cm x 3 cm x 0.1 cm. Samples ranged from worked nuggets to small decorative items such as tinkling cones and beads for necklaces, to fragments of rolled copper and copper-based alloy sheets of suspected European origin (Figure 1.3, Table 1.1). Artifacts larger than ~2.5 cm were carefully mounted in bricks of paraffin wax hollowed out to allow the artifacts to rest on the brick and still be stable (Figure 2.1A). Samples smaller than ~2.5 cm were mounted in paraffin wax packing on top of, or within, the cores of drilled out cylindrical epoxy pucks (Figure 2.1B). This allowed for stabilization and levelling of the artifacts to be flush with the top of the surface of the sample holder to ensure that they were as close to the sampling cone (and within laser and optical focus) as possible, while still allowing for movement of the sample stage, but without risking damage to their brittle, patina-covered surfaces. In total, 60 artifacts were analyzed and only 57 artifacts being used in provenance determination as one was modern Zn metal, and two artifacts were too corroded for accurate analyses to be obtained (i.e., no fresh metal remaining at depth in the objects).

2.1.2 Natural copper source samples

A total of 38 samples of native (natural) copper samples were analyzed including multiple samples from single localities to allow assessment of site compositional homogeneity. Some of the samples came from private collections and others were accessed from the Nova Scotia Museum at the Museum of Natural History location. From each of the native copper samples, small fragments (<0.5 cm) were taken from each sample and mounted into epoxy pucks using Buehler Transoptic Powder, and a Buehler Simplimet 1000 Automatic Mount Press at Saint Mary's University. These pucks were then polished and ground down to expose fresh native copper without patina (Figure 2.1C).

2.1.3 Analytical standards

Five certified standards were used for data reduction (external calibration of analyte sensitivities) and quality control (e.g., inter-standard determination of analytical accuracy). Three copper standards from MBH Labs (United Kingdom; "residuals in refined copper" standard numbers 38X 27866, 39X 27869 and 39X 17872), as well as a silicate glass

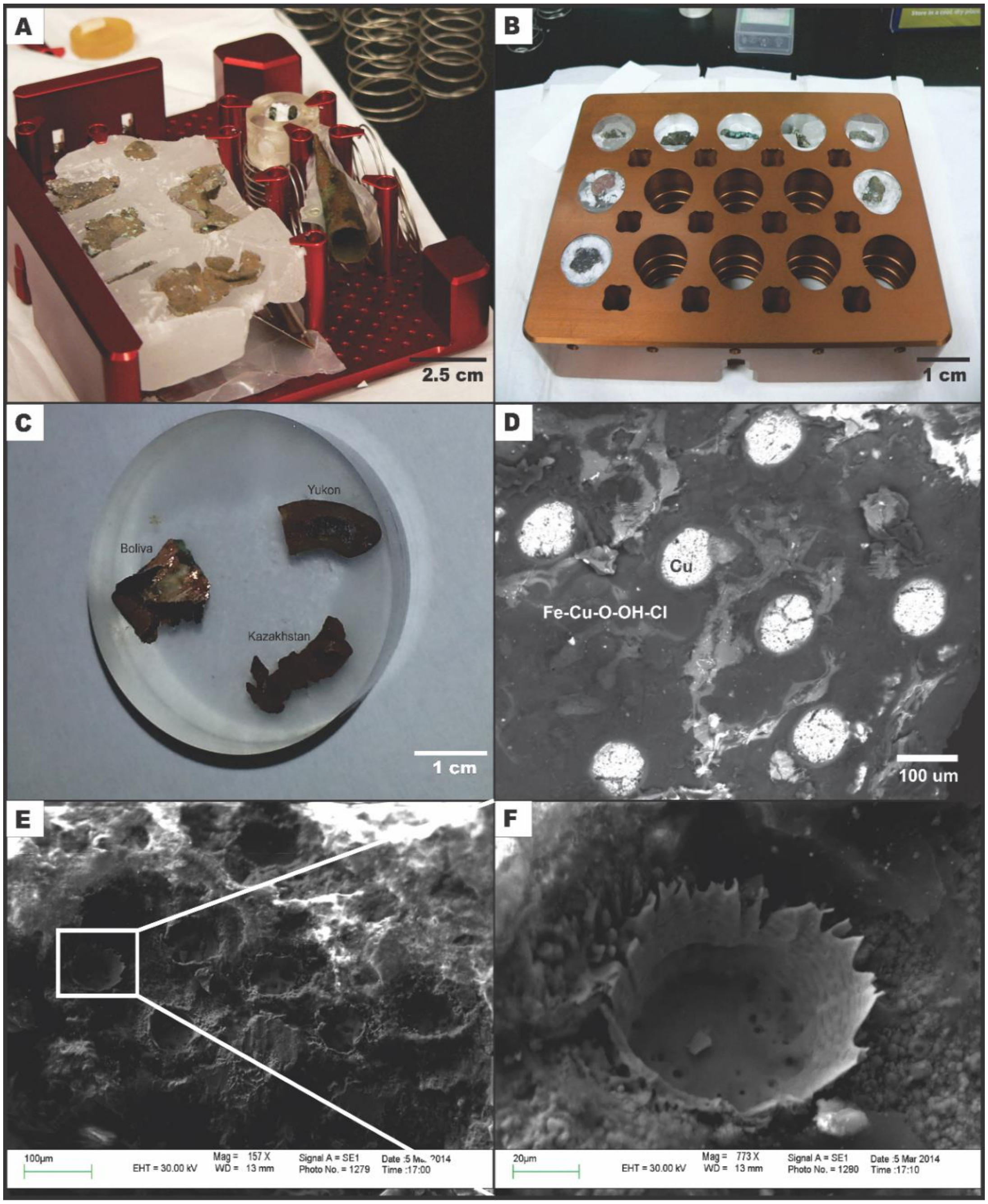

Figure 2.1 Images of sample stages, mounts and ablation pits in copper artifacts. Photos courtesy of Dr. Catherine Cottreau – Robins, Nova Scotia Museum, and Dr. Jacob Haney, Saint Mary's University. A) Larger irregular artifacts in laser ablation chamber tray, mounted in paraffin wax. B) Smaller artifacts mounted in hollow epoxy pucks with paraffin wax holding each artifact in place. C) Three natural source samples of native copper mounted into an epoxy puck. D) SEM–BSE image of laser ablation pits in an artifact after ablation, showing fresh copper at depth (bright white) and corrosion products (patina) comprised of Cu-Fe-O-OH-Cl. E) SEM - SE image of ablation pits F) Enhanced SEM image of an ablation pit with melted copper flaring around the pit and surrounding ablation ejecta.

(SRM610) and a pressed sulfide powder pellet (MASS1) standard from NIST (National Institute of Standards and Technology) were utilized. Preliminary study of the ablation quality and composition of other certified reference materials, (e.g., NIST400; unalloyed copper VII) showed that while the samples were relatively homogeneous, the ablation characteristics of the samples were unusual, showing a lack of coupling of the laser with the sample and an inverse correlation between Cu isotope count rate and fluence. The reasons for this poor ablation behavior is unclear. Table 2.1 summarizes standards used for quantification of specific elements and Table 3.1 summarizes reported vs determined element concentrations for the respective standards.

2.2 Laser ablation ICP-MS method and data reduction protocol

2.2.1 Instrumentation and operating conditions

All artifacts used in this study were analyzed by LA-ICP-MS for trace elements at the University of New Brunswick, Department of Earth Sciences. The system used comprised a Resonetics RESOlution M-50 (193 nm Ar-F Excimer) with S-155 Laurin Technic Cell coupled to an Agilent 7700x quadrupole ICP-MS. Ablation was carried out at a fluence of ~4 J/cm^2. And at a repetition rate of 2.5 Hz with 10 measurements taken in each artifact or sample as a series of 90 μm-diameter pits (Figure 2.1 D-F). Ablation aerosols were transported to the ICP-MS using a He-Ar mixture (300 mL/min He, and 930 mL/min Ar). Complete analytical and data acquisition/reduction parameters are summarized in Table 2.1.

2.2.2 Quantification and data reduction schemes

Raw laser ablation data was reduced using the Iolite data reduction software package that runs in the Igor Pro compiler (version 6). Reference standard files were prepared from

Table 2.1: Table of LA-ICPMS operating conditions

LA	
Model	**Resonetics RESOlution M-50 with S-155 Laurin Technic cell**
Wavelength	**193 nm**
Pulse duration (FWHM)	**20ns**
Repetition rate	**2.5 Hz**
Spot diameter	**90 µm**
Energy density	**~4 J/cm^2**
Primary (calibration) standards	**MBH39X27866, MBH39X27869, MBH39x17872, MASS1**
Secondary (QC) standard	**MBH39X27866, MBH39X27869, MBH39x17872, MASS1**
ICP-MS	
Model	**Agilent 7700x with dual external rotary pumps**
Forward power	**1500W**
Shield torch	
Sampling depth	**4.0 to 5.0 mm**
Gas flows	
Carrier (He)	**300 mL/min**
Make up (Ar)	**930 mL/min**
ThO^+/Th^+	**<0.1%**
Data acquisition and reduction parameters	
Dwell time per isotope	**15 ms**
Detector mode	**Dual mode**
Data reduction software	**Iolite platform on Igor Pro 6**
Internal Standard used	**Cu wt% (assumed 99 wt% for all objects or determined for alloys)**
Isotopes determined with standard 66	**^{56}Fe, ^{72}Ge, ^{197}Au, ^{208}Pb, ^{209}Bi**
Isotopes determined with standard 69	**^{31}P, ^{34}S, ^{53}Cr, ^{59}Co, ^{60}Ni, ^{65}Cu, ^{66}Zn, ^{71}Ga, ^{75}As, ^{107}Ag, ^{111}Cd, ^{115}In, ^{121}Sb, ^{125}Te**
Isotopes determined with standard 72	**^{118}Sn**
Isotopes determined with standard Mass1	**^{55}Mn, ^{71}Ga, ^{95}Mo, ^{202}Hg**
Quadrupole settling time	**5 ms**
Analysis time	**background (20s) abaltion (20s) washout (5s)**

certified element concentration data provided for each standard by MBH laboratories. Regularly during LA-ICP-MS measurements, standards (MBH copper standards SRM610 and MASS1) were analyzed to allow evaluation of analytical accuracy and precision, and the homogeneity of the standards. To do this, each standard was treated as an unknown sample and quantified using the other standards (e.g., MBH66 treated as unknown with its trace element concentrations quantified using MBH69 to calibrate analyte sensitivities). A full compilation of the inter-standard quality control exercise is summarized in Table 3.1. Raw data for blocks of 8-20 artifacts were quantified using each of the five standards. Then, a comparison of the resulting data was done in order to evaluate internal consistency. With the exception of a few elements that could only be quantified using MASS1 because they were not present in the MBH standards (e.g., Mn, Ga, Mo, Hg), all data reported were quantified using the MBH standards. No data are reported using the SRM610 standard for quantification due to matrix mismatch. Copper was used as an internal standard for quantification, and was set to 99 wt% Cu for all natural copper samples and artifacts (with the exception of some European-sourced artifacts.) For some artifacts suspected as not being ~pure Cu (European refined Cu-Sn-Zn alloys) based on their appearances on fresh surfaces, SEM-EDS spectra were obtained and quantified in order to determine the appropriate Cu concentration to use for quantification (e.g., artifacts 8606 [95.5 wt% Cu] 8607 [92.2 wt% Cu], 002 [97.03 wt% Cu] 8609 and 8605 [95 wt% Cu], 20 [95.24 wt% Cu] 19 [69.25 wt% Cu] 819 [83.60 wt% Cu] and 8604 [67.04 wt% Cu].) Since objects were variably coated in patina (Figure 2.1F) and the thickness of this patina could not be determined before analysis, signals were examined closely to identify maximum depth (in time of ablation) at which a patina of different composition occurred. This could be identified readily in transient signals (Figure 2.2, 2.3) as the time during ablation at which point specific elements preferentially depleted (e.g., Ag) and enriched (e.g., Au, Mn) in the patina showed an increase or decrease, respectively, in measured isotope count rate to a relatively constant level (see portions of signal interval labelled “patina” and “fresh metal” in Figure 2.2C). Additionally, count rates for ^{65}Cu appeared to initially be low at the start of the signal and then rise but remain variable in the patina, followed by an interval of constant ^{65}Cu count rate (e.g., Figure 2.2C). The maximum duration of ablation that the transition from apparent patina to fresh metal was observed was approximately half of duration of the total ablation (~10s). On the basis of these criteria, ablation signals were reduced into two separate groups to generate a separate quantified data set for: (i) the shallow part of the ablation profile (patina) ablation time starting one second into ablation and ending ten seconds into ablation, and (ii) the deep part of the ablation profile (fresh metal), starting eleven seconds into ablation and ending one second from the end of ablation.

2.3 Data manipulation

Once the data was quantified for each of the two signal portions (shallow and deep), it was filtered for analyses below detection limits. Additionally, examination of the transient signals showed the presence of anomalous peaks (“spikes” in signal intensity) that likely represent contaminating mineral particles, present even in the fresh metal (Figures 2.2 and 2.3). During data reduction, many of these particles contributed to anomalously high reported concentrations for the ablation intervals quantified resulting in outliers within blocks of 8-10 analyses of each sample for some elements. Outliers were excluded, the remaining analyses were averaged and a standard deviation was calculated for each element in each sample, and the results were then plotted into spider diagrams allowing a preliminary graphical determination of compositional similarities between artifacts. Artifacts with similar trace element chemistry were sorted into categories for comparison with natural source copper analyses.

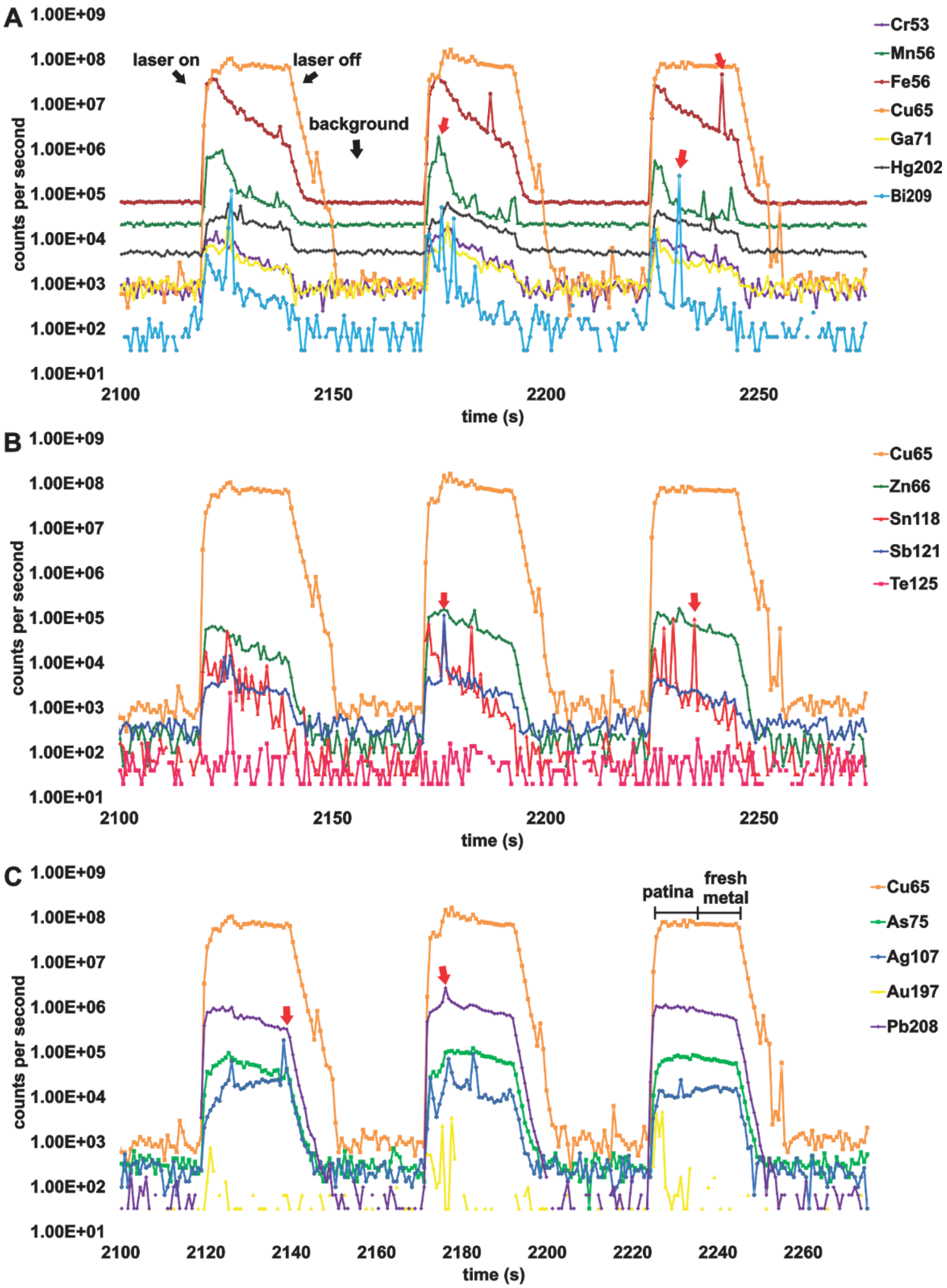

Figure 2.2 Transient LA-ICP-MS signal (cps) vs time (s) for measured isotopes from three ablations of artifact 99 (suspected natural copper). Red arrows highlighting peaks in signal intensities. A) Cu, Cr, Mn, Fe, Ga, Hg, and Bi with Bi, Mn and Fe “spikes” highlighted. B) Cu, Zn, Sn, Sb, Te with Sb and Sn “spikes” highlighted. C) Cu, As, Ag, Au, and Pb, with Pb and Ag “spikes” highlighted. Also labelled in this frame are the interpreted intervals of patina (e.g., elevated ^{197}Au and ^{56}Mn, lower ^{107}Ag and low to variable ^{65}Cu) and fresh metal (e.g., where these isotope count rates drop rise and level out respectively.

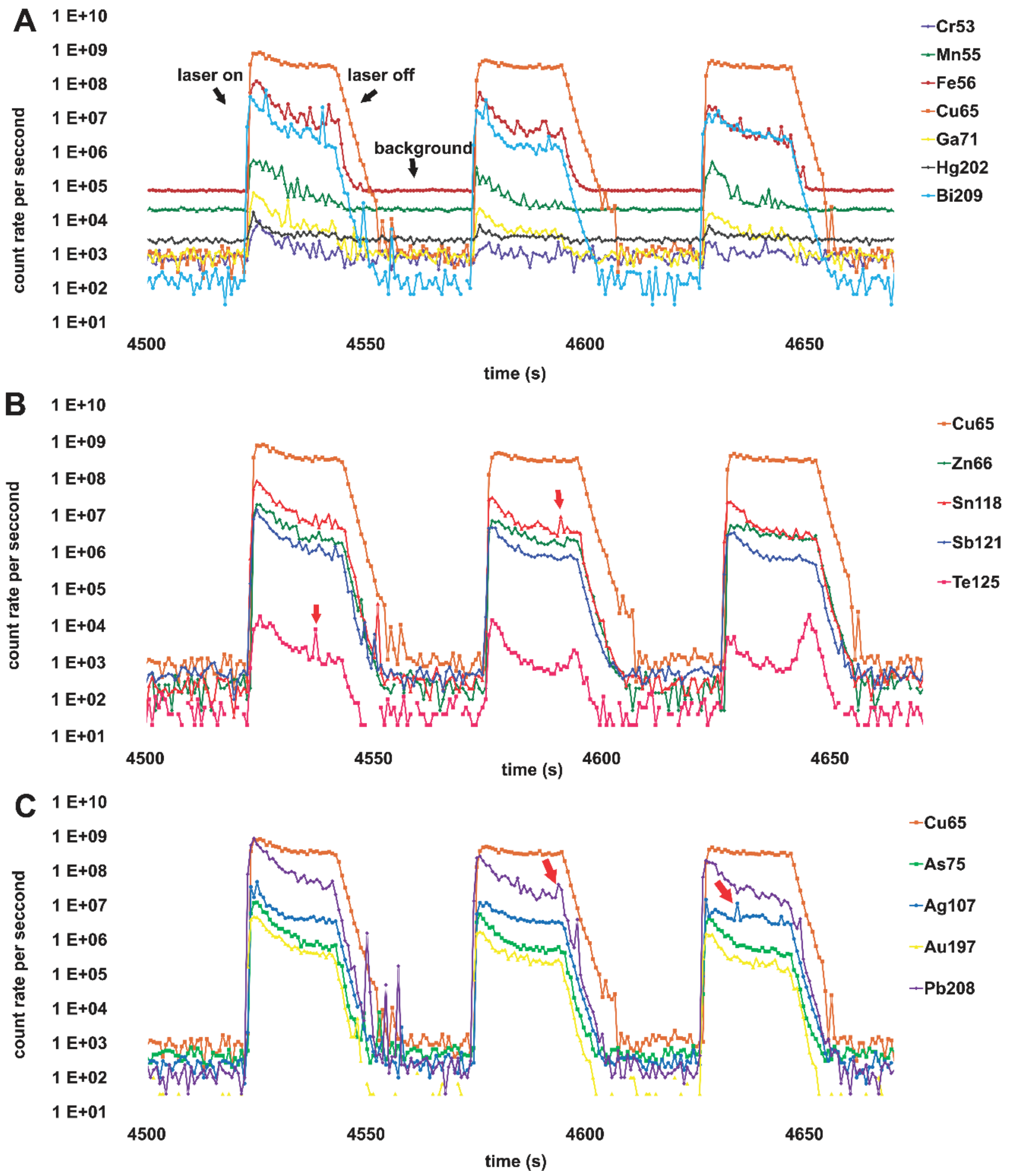

Figure 2.3 Transient LA-ICP-MS signal (cps) vs time (s) for measured isotopes from three ablations of artifact 99 (suspected natural copper). Red arrows highlighting peaks in signal intensities. A) Cu, Cr, Mn, Fe, Ga, Hg, and Bi. B) Cu, Zn, Sn, Sb, Te with Sn and Te "spikes" highlighted. C) Cu, As, Ag, Au, and Pb, with Pb and Ag "spikes" highlighted. Relative to ^{65}Cu, many elements appear elevated in the first ~10s of the signal in the refined European copper, representing the patina coating.

3.0 Results

3.1 Analyses and comparisons of standards

The composition of the four key standards (three MBH copper standards; MASS1 sulfide) used in this study were compared to each other by setting one standard as analyte sensitivity calibrant against another standard as an unknown. The LA-ICP-MS data for each standard quantified by each of the other standards were compared to the reference certificates provided by MBH Laboratories and NIST to estimate analytical accuracy and standard homogeneity (Table 3.1), and to deduce which standard was the most appropriate to quantify each element in the artifacts. To further evaluate the feasibility of each standard for specific elements through a check for internal consistency, analyses of artifacts quantified by each standard were compared against each other (Figure 3.1). After careful scrutiny of the results attained for each standard, compared to the certified references, it was determined that each standard would only be appropriate to quantify specific elements as outlined below and in Table 2.1. Selection of the most appropriate standard for each individual element was based on selection of the standard yielding the greatest accuracy and precision for elements reported. Figure 3.1 shows comparison of analyses of two artifacts with very different trace element concentrations, one of suspected European origin (8604) and one of suspected North American (natural copper) origin (99), based on archaeological evidence (not this study). In this figure, comparison of quantified (mean of 10 analyses ± 2 s.d.) trace element concentrations by external calibrant 72 vs. 66, 69 vs. 66, and 72 vs. 69 are shown.

Table 3.1 Evaluation of analytical accuracy (values in ppm) utilizing standards MBH 38X 27866, 39X 27869, and 39X 17872 (residuals in copper) and MASS1 (sulfide)

Element	66_{exp}	$66_{ms(69)}$	$66_{ms(72)}$	72_{exp}	$72_{ms(66)}$	$72_{ms(69)}$	69_{exp}	$69_{ms(66)}$	$69_{ms(72)}$	$MASS1_{exp}$	$MASS1_{ms(66)}$	$MASS1_{ms(69)}$	$MASS1_{ms(72)}$
P	147	345 (1398, 76)	229 (396, 66)	45	29.9 (17.7, 42)	228 (765, 75)	119	133 (138, 66)	185 (268, 70)	NC	NQ	NQ	NQ
S	469	150 (38.4, 61)	302 (163, 63)	242	373 (155, 46)	119 (63.9, 61)	112	351 (133, 56)	223 (148, 68)	276000	11861 (3671, 60)	4089 (4681, 82)	12137 (2810, 78)
Cr	12	14.4 (105, 62)	NQ	NC	NQ	NQ	20	3.69 (9.81,49)	NQ	37	30.3 (49.9, 68)	29.2 (49.1, 64)	NQ
Mn	NC	NQ	NQ	55	NQ	NQ	NC	NQ	NQ	260	NQ	NQ	727 (1337, 78)
Fe	30	28.3 (64.1, 66)	75.2 (210, 63)	450	247 (187, 43)	202 (196, 59)	30	31.9 (77.5, 71)	70.2 (231, 69)	156000	92300 (91548, 64)	99853 (71070, 58)	404123 (317886, 78)
Co	308	266 (98, 62)	371 (107, 62)	102	84.6 (8.93, 46)	70.6 (25.5, 65)	36	40 (14.5, 63)	49.9 (23.5, 58)	67	68.9 (5.91, 60)	60.4 (12.6, 57)	124 (19.6, 78)
Ni	487	512 (372, 72)	503 (42.2, 57)	537	530 (44.6, 45)	559 (1458, 72)	190	184 (12.9, 54)	190 (21.7, 68)	61	102 (6.17, 64)	106 (9.03, 58)	163 (11.7, 78)
Zn	287	352 (119, 59)	313 (235, 68)	1070	1015 (150, 42)	1289 (383, 60)	65	49.7 (15.5, 64)	55 (44.8, 69)	207383	163028 (27675, 63)	204503 (32115, 55)	305401 (119551, 78)
Ge	29	25.4 (6.03, 67)	NQ	NC	NQ	NQ	123	137 (13.8, 55)	NQ	50	85.5 (8.11, 58)	76.7 (5.57, 58)	NQ
As	383	386 (57.1, 61)	353 (105, 52)	203	223 (63.5, 15)	239 (118, 62)	98	97.5 (8.27, 60)	84.9 (24.8, 49)	65	58.8 (3.60, 59)	59.8 (3.99, 60)	89.9 (15.1, 78)
Ag	57	56.5 (11.4, 65)	48.9 (43.4, 69)	214	213 (28.5, 45)	239 (93.1, 62)	349	345 (24.7, 77)	291 (309, 70)	67	53.8 (2.49, 65)	54.4 (2.96, 58)	88.9 (45.3, 78)
Cd	139	153 (40.4, 56)	116 (64.6, 57)	13	14.4 (10.2, 59)	18.1 (23.4, 71)	28	24.7 (3.76, 63)	20.5 (11.4, 62)	70	57.9 (9.84, 53)	66.8 (11.6, 62)	80.2 (23.5, 78)
In	437	424 (144, 67)	354 (129, 59)	241	273 (101, 49)	259 (143, 59)	90	90.7 (14.9, 64)	76.5 (29.2, 51)	50	62.4 (3.31, 60)	61.4 (7.31, 58)	85.8 (16.3, 78)
Sn	448	246 (691, 75)	451 (786, 68)	1800	1844 (1323, 58)	1208 (1022, 44)	106	925 (5516, 65)	1672 (7943, 69)	55	65.6 (10.4, 80)	47.7 (29.8, 40)	127 (59.8, 78)
Sb	52	55.5 (112, 68)	49.2 (51.7, 68)	217	227 (90.7, 50)	250 (98.1, 75)	362	340 (34.1, 53)	310 (366, 70)	55	64.6 (3.78, 59)	68.9 (5.78, 60)	119 (63, 78)
Te	32	49.4 (156, 67)	52.1 (103, 63)	208	273 (1612, 60)	352 (1515, 72)	153	92 (279, 71)	129 (340, 68)	21.1	7.22 (13.5, 74)	14.6 (12.7, 63)	20.1 (17.1, 78)
Au	16	17.2 (14.9, 68)	26.2 (4.98, 54)	15	8.79 (1.17, 39)	9.63 (16.2, 70)	80	74.8 (5.86, 56)	122 (23.2, 56)	47	62.9 (5.07, 65)	67.7 (6.79, 62)	169 (20.2, 78)
Pb	54	47.2 (27, 55)	35.9 (840, 69)	2930	5365 (6765, 55)	4775 (7457, 71)	225	242 (122, 63)	200 (5014, 70)	80	63.2 (16.1, 59)	60.1 (13.7, 61)	302 (824, 78)
Bi	47	52.1 (18, 55)	37.7 (64.5, 68)	240	350 (392, 51)	389 (692, 71)	376	321 (90.3, 58)	233 (495, 69)	66	40.9 (2.93, 56)	49.5 (10.2, 59)	65.3 (54.6, 78)

[1] NC = no value reported for that standard; NQ = not quantified (not available in standard as certified value)

[2] Values outside of brackets is average value based on 'n' analyses; values in brackets represent ±1 s.d. on the average value, and 'n' analyses

[3] Subscript exp = expected values for certified reference standard

[4] Subscript ms(XX) = measured values for certified reference standard treating as an unknown and quantifying it with another certified reference standard

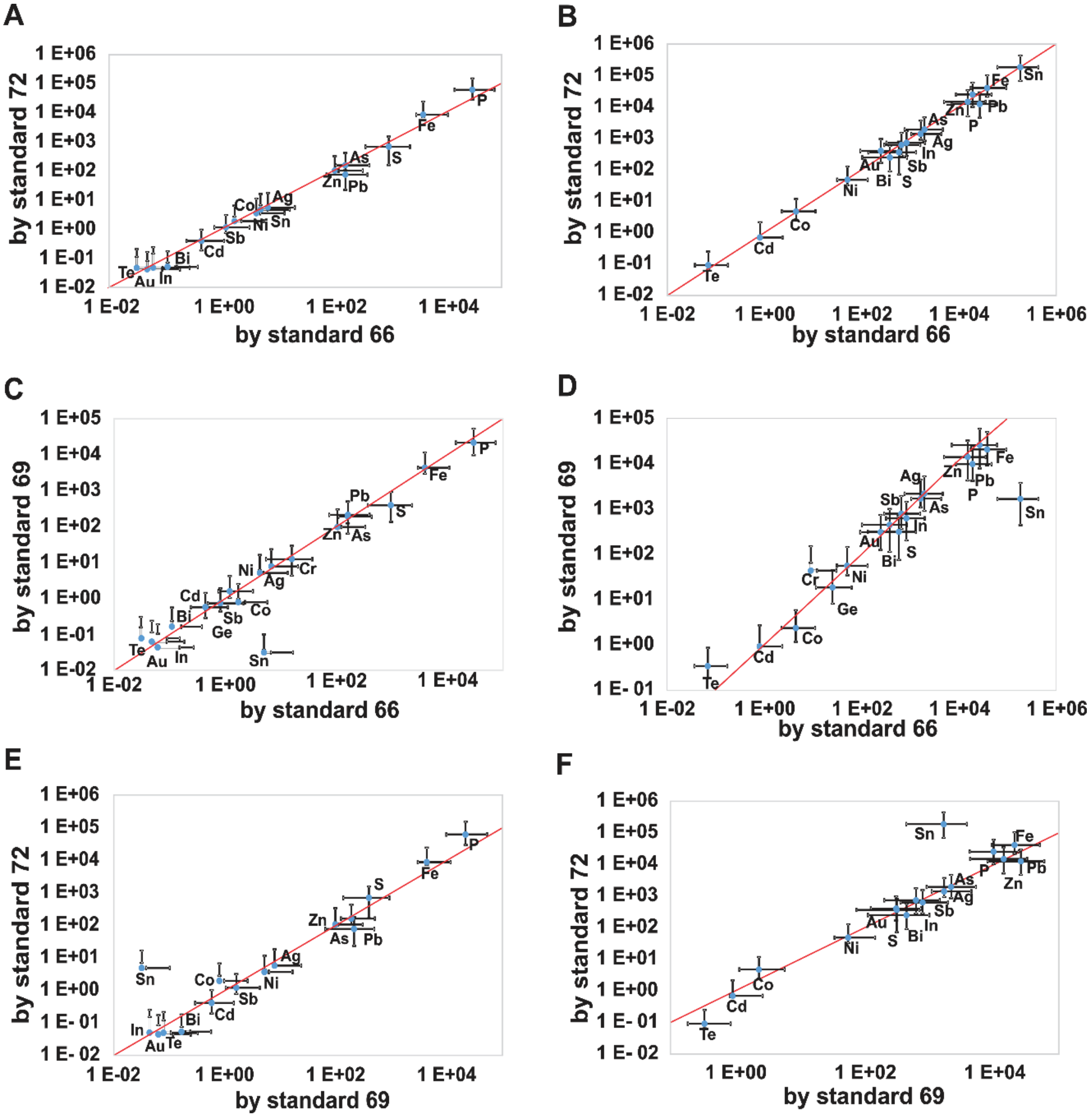

Figure 3.1 Comparisons of quantified concentrations of trace elements in copper artifacts using different standards for external calibration of analyte sensitivities. Each panel shows the concentration in ppm of trace elements quantified by the listed external standard, compared to that of the same artifact quantified by another external standard. The red line in each tile represents a linear relationship with a slope of 1. Data points show mean element concentration (10 analyses) ± 2 s.d. on the mean value. A) Artifact 99, concentration of trace elements quantified by standard 72, vs those quantified by standard 66. B) Artifact 8604, concentration of trace elements quantified by standard 72, vs those quantified by standard 66. C) Artifact 99, concentration of trace elements quantified by standard 69, vs those quantified by standard 66. D) Artifact 8604, concentration of trace elements quantified by standard 69, vs those quantified by standard 66. E) Artifact 99, concentration of trace elements quantified by standard 72, vs those quantified by standard 69. F) Artifact 8604, concentration of trace elements quantified by standard 72, vs those quantified by standard 66.

By the methods discussed above, evaluation of the standard MBH 38X27866 (henceforth referred to as 66) proved that it was the most appropriate standard to use for Fe, Ge, Au, Pb, and Bi. Evaluation of the standard MBH 39X 27869 (henceforth referred to as 69) provide that it was the most adequate standard to use for P, S, Cr, Co, Ni, Zn, As, Ag, Cd, In, Sb, and Te. Evaluation of the standard MBH 39X 17872 (henceforth referred to as 72) proved that it was the most adequate standard to use for Sn. Overall, standard 69 proved to be the best with good ablation behavior and the majority of elements reporting the closest to the certified values, and was used for the majority of elements quantified in this study. Elements not quantified using standard 69, 66, or 72 were those that were not certified or even quantified from MBH Laboratories (Mn, Ga, Mo, and Hg) thus MASS01 was used. Other elements quantified by 66 and 72, were not inaccurately quantified by standard 69. Rather, they were just more accurately quantified by the other two standards. Notably, many elements were not being reported in standard 72 accurately (Table 3.1).

3.2 Comparison of patina and fresh metal composition, and sample homogeneity

Comparison of the first and last ~10 seconds of ICP-MS transient signals (Figure 3.2) allowed for the differences in composition of the altered surface patina and the fresh metal of the artifacts to be evaluated. Repeated analyses of four artifacts – two of “European” origin (8604 and 8606), and two of “North American” origin (99 and RLAKE) – were used for comparison of the composition of patina (corrosion products) and fresh (unaltered) copper or alloy.

Figure 3.2 shows that the majority of elements are reported in higher concentrations in the patina relative to the fresh metal. What is relevant from this comparison is analyses of patina, containing a lower concentration of Cu than fresh metal (due to the presence of Fe,

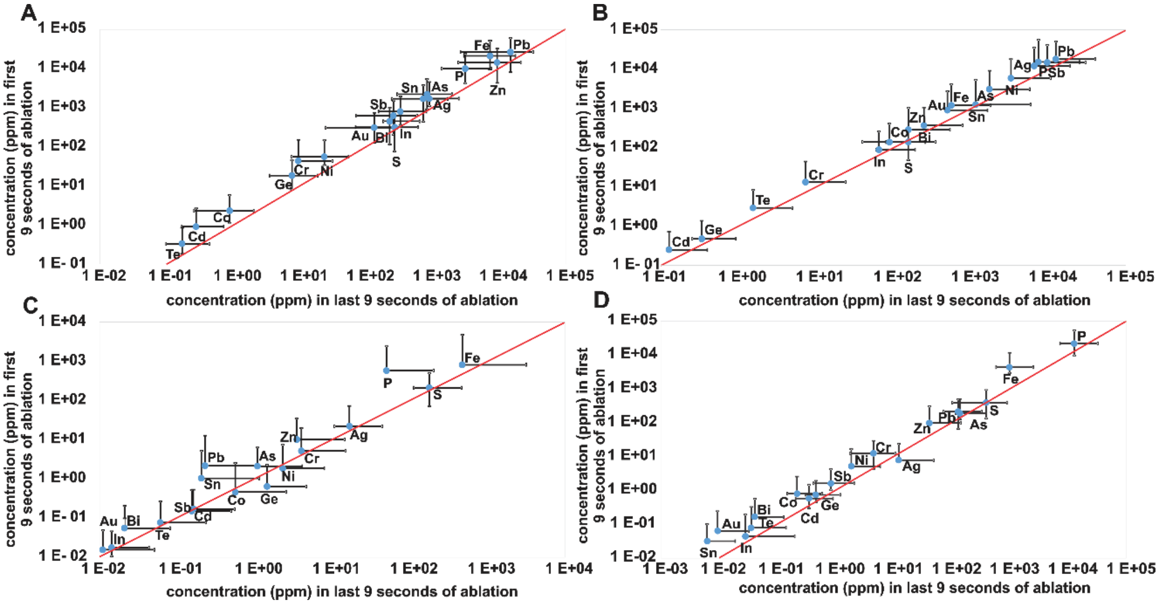

Figure 3.2 Comparison of trace element concentrations (ppm) in patina (y-axis; first 9 seconds of ablation profile) and core copper (x-axis; last 9 seconds of ablation profile). The red line represents a linear relationship with slope 1. Data points show mean element concentration (10 analyses) ± 2 s.d. on the mean value. A) Artifact 8604; B) Artifact 8606; C) Artifact 99; D) Artifact RLAKE.

P, H_2O and other elements forming the patina compounds), will overestimate trace element concentrations during data reduction. The exact wt% Cu content of weathering and corrosion products is unknown. Elements that are actually enriched in the patina relative to the fresh metal would be expected to show concentrations much higher (i.e., farther away from the 1:1 line) than those elements apparently enriched in the patina solely due to the overestimation of the Cu content of the patina during internal standardization in the data reduction. For example, in artifact 99 (Figure 3.2C) enrichments in Zn, Sn, Fe, As, and Au are seen in the patina, whereas elements such as S, Sb, Co, Ni, and Ge show increased concentration in the fresh metal. By evaluating ablation intervals for patina and fresh metal, one is able to evaluate if the patina is representative of the composition of the fresh metal underneath. If the same relative concentrations of trace elements are observed in the patina and fresh metal (i.e., elements are all over-reported by the same magnitude owing to uncertainty in patina composition) then patina analysis may still be appropriate for chemical provenance studies. However, if patina and fresh metal compositions show no systematic shift from one another, the patina is not representative. For this study, the former case held true and few objects showed variable enrichment or depletion in metals in the patina, with the exception of several of the artifacts comprised of refined copper and copper-based alloys from Europe. Ideally, analysis of the actual patina to determine its Cu content is preferred but this was not done in the present study. For this study it was not a requirement to use the patina data, as fresh metal was accessed during each ablation.

Understanding that many of the concentration relationships are similar in the patina of the artifact negates the requirement to drill into the artifact to expose fresh copper to determine provenance, reinforcing the value of this methodology over previously used bulk analytical methods. European objects composed of alloys are clear exceptions to this, notably where they contain Zn. Dussubieux et al. (2008) showed a preferential depletion in Zn concentration in artifacts that were highly oxidized, weathered, and corroded, even in the fresh metal.

All of the artifacts and potential source samples were analyzed 8-10 times for statistical purposes as well to test sample homogeneity. These four artifacts had each ablation shot compared to the other nine shots of each respective artifact. Spider diagrams showing the individual (not mean) analyses of fresh metal in the same four artifacts used for the patina vs. fresh metal comparison can be found in Figures 3.3 and 3.4. Artifact 8604 shows minor variation in Sb, Mn, Cr and Te (< 20% relative variability). Artifact 8606 shows much larger variation from one shot to another (up to an order of magnitude variation) with the largest variations noted in Zn and Mn. However, the variations are systematic and the pattern of relative trace element concentrations is very similar from one shot to another across the entire variation in concentration. This may be expected for refined copper or copper-based alloy specimens that should not contain mineral inclusions but may show spatial variations in the purity of the metal or alloy. For naturally occurring copper, variations in trace element composition are expected to be less systematic from one analysis to another and can be attributed to inclusions of minerals that bear the variable trace elements in question (Figures 2.2, 2.3). Artifact RLAKE, for example, shows a much greater variability than artifact 99 and the variation in trace element concentration from shot to shot are very non-systematic in artifact RLAKE. Overall, while the analytical precision that partly reflects sample homogeneity is specific to each object, it was observed that for the majority of objects analyzed, trace element concentrations showed <30%

variation from shot to shot (and typically no more than 20%), and where variation was observed it was systematic in natural copper artifacts, allowing for confidence in the degree of certainty for provenance assignment.

Standards, and all of the shots were averaged, approximately 40 shots per standard. Using the appropriate standard for quantification, as outlined in Table 2.1, it can be seen that the concentrations of elements for each standard reported in Table 3.1, are very close to the certified references, and that standards themselves, show good homogeneity using statistical means.

3.3 Source chemistry

Samples used for provenance evaluation came from six general locations: Nova Scotia, Canada; Michigan, USA; Pennsylvania, USA; Cornwall, UK; Bolivia and Kazakhstan. (Table 3.2, Figure 3.5). Elements that prove to be diagnostic of source locations are Fe, Ni, Zn, As, Mo, Ag, Pb, Cd, In, Sn, Sb, Te, Au, Hg, and Bi, with emphasis on the relationships between the concentrations of Ag and Pb; Hg and Bi; Zn and As; and in some cases the relationship between Sn, Sb and Te. Table 3.2 lists average concentration of all elements for each source location used in this study.

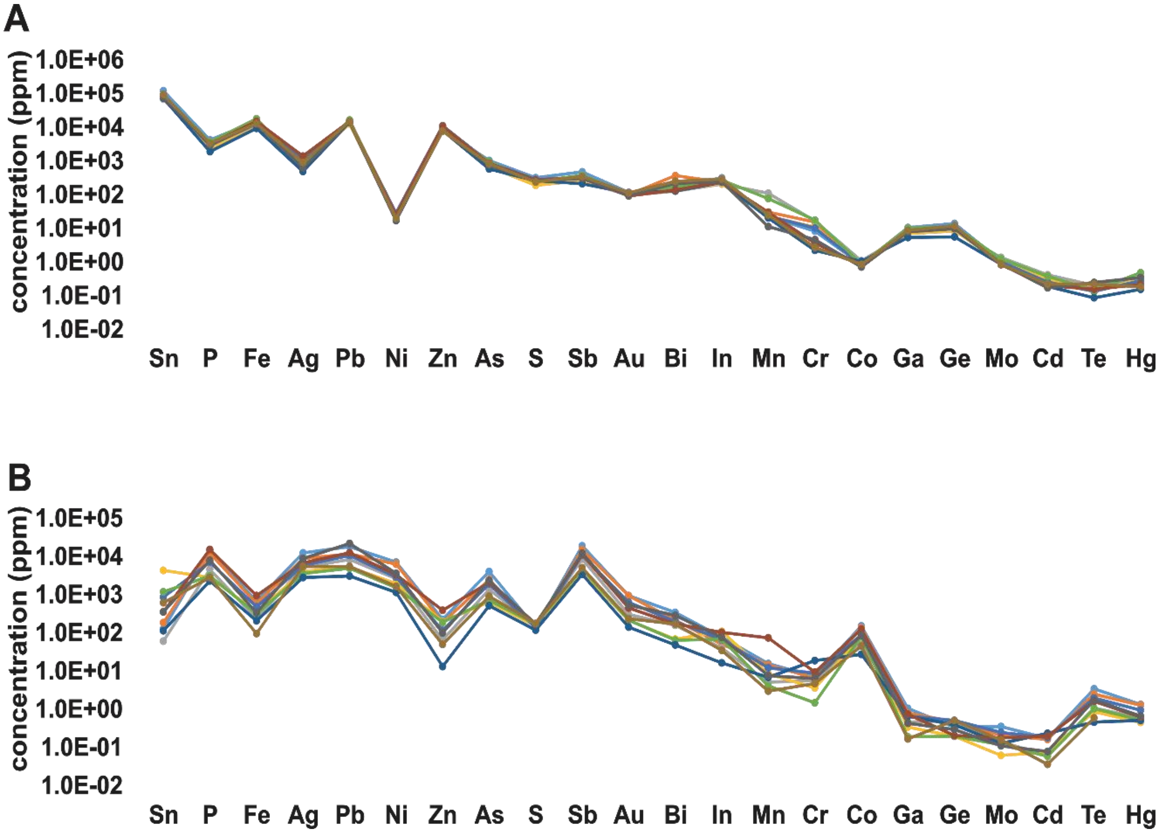

Figure 3.3 Comparison of the concentration of trace elements (ppm) determined for each individual laser ablation shot. A) Artifact 8604, good homogeneity. B) Artifact 8606 low homogeneity, variation between each shot.

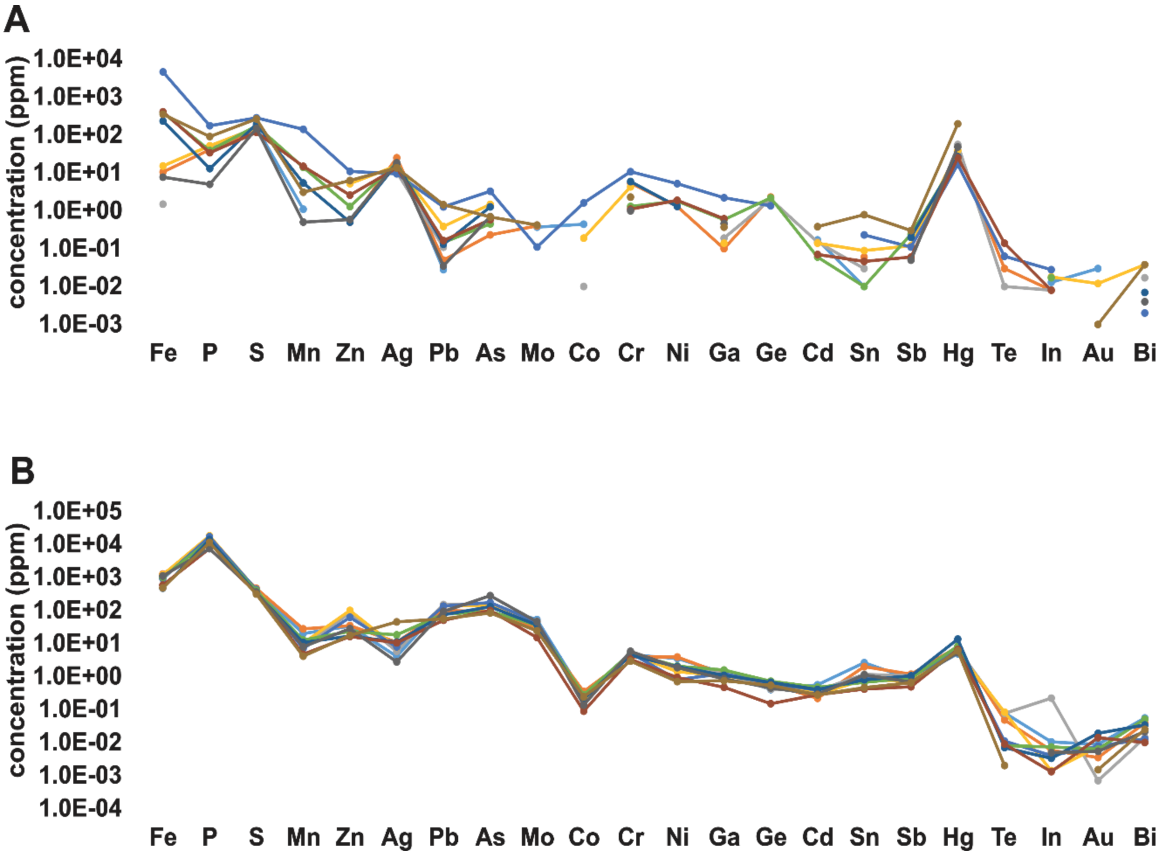

Figure 3.4 Comparison of the concentration of trace elements (ppm) determined for each individual laser ablation shot. A) Artifact RLAKE, low homogeneity B) Artifact 99, moderate - high homogeneity.

3.3.1 Nova Scotia, Canada

Samples of Nova Scotian copper (figure 3.5A) were sampled from private collections and the Nova Scotia Museum collection. The private collection yielded sixteen samples of copper from Cap d'Or, and the samples from the Nova Scotia Museum yielded four samples from Margaretsville. Margaretsville copper samples contain on average higher Ag concentration (81.9 ppm) than Pb concentrations (0.059 ppm), moderately higher Hg (2.05 ppm) concentrations than Bi concentrations (0.516 ppm), and low Zn concentrations (0.534 ppm) compared to As concentrations (0.581 ppm). Cap d'Or samples contain moderate Zn vs As relationships (136 and 0.998 ppm respectively) (Table 3.1) lower Ag vs Pb (16.3 ppm vs 15.8 ppm respectively) and Hg (2.16 ppm) vs Bi (0.114) relationships.

3.3.2 Cornwall, UK

Source samples from Cornwall, UK (Figure 3.5 B) have high As vs Mo relationships (46.9 ppm vs 0.035 ppm) as well as a significantly higher Ag: Pb relationships (209 vs 0.067 ppm). It has the highest Ag concentration of the non- North American copper sources (Figure 3.5B). Copper from Cornwall also has been slightly enriched with Hg (4.74 ppm) in comparison to Hg found in coper from Bolivia (1.79 ppm) and Kazakhstan (2.36 ppm).

3.3.3 Michigan, USA

Samples from Michigan were collected from six different copper producing areas within the Great Lakes Region of North America (Figure 3.5C). Three from the Keweenaw

Table 3.2 Average concentration (ppm) of all sources used in this study

Element	Standard Used	Adams Co, PA.	Cap d'Or, NS.	Cornwall,	Dzezkazgan,	Houghton Co, MI.	Keweenaw Co, MI.	Le Paz,	Margaretsville, NS.	Ontonagon Co, MI.
		United States	Canada	England	Kazakhstan	United States	United States	Bolivia	Canada	United States
S	MBH 69	139 (19.9, 16)	146 (41.9, 128)	151 (27.2, 16)	129 (22.6, 8)	149 (25.0, 16)	117 (17.9, 16)	153 (14.2, 8)	142 (17, 32)	151 (23.4, 8)
Cr	MBH 69	0.953 (0.649, 8)	4.52 (24.5, 76)	0.375 (0.195, 4)	1.75 (0.58, 4)	0.213 (0.134, 8)	0.234 (0.12, 7)	0.325 (0.287, 4)	0.845 (0.323, 11)	0.12 (0.066, 3)
Mn	MASS1	0.722 (0.531, 6)	1.19 (2.01, 86)	0.547 (0.561, 6)	0.735 (0.388, 6)	0.654 (0.323, 5)	0.588 (0.469, 10)	0.984 (0.609, 7)	0.417 (0.374, 19)	0.65 (0.495, 2)
Fe	MBH 66	2.26 (1.36, 12)	3.61 (17.5, 124)	1.39 (0.879, 9)	0.2 (0.141, 2)	2.43 (1.74, 7)	0.504 (0.421, 8)	8.32 (11.6, 8)	0.746 (0.607, 19)	3.53 (3.45, 3)
Co	MBH 69	0.006 (0.007, 7)	0.106 (0.089, 67)	0.016 (0.009, 5)	0.028 (0.024, 6)	0.08375 (0.075, 8)	0.084 (0.069, 10)	0.011 (0.006, 6)	0.014 (0.015, 21)	0.05 (0.036, 3)
Ni	MBH 70	0.239 (0.160, 10)	6.92 (5.46, 128)	0.212 (0.195, 12)	0.168 (0.089, 4)	0.535 (0.625, 4)	0.645 (0.275, 6)	0.345 (0.172, 4)	0.58 (0.712. 25)	0.445 (0.078, 2)
Zn	MBH 71	1.32 (2.04, 8)	136 (47.9, 128)	0.709 (0.532, 8)	0.445 (0.601, 2)	0.257 (0.183, 13)	0.197 (0.149, 10)	0.456 (0.601, 5)	0.534 (0.407, 24)	0.288 (0.309, 5)
Ga	MASS1	0.009 (0.014, 10)	0.153 (0.108, 69)	0.024 (0.016, 6)	0.043 (0.034, 5)	0.099 (0.063, 7)	0.122 (0.087, 10)	0.018 (0.015, 5)	0.009 (0.013, 20)	0.05 (0.036, 3)
Ge	MBH 66	0.524 (0.308, 7)	0.555 (0.381, 57)	0.379 (0.266, 10)	0.61 (0.274, 4)	0.501 (0.431, 10)	0.511 (0.198, 9)	0.495 (0.373, 4)	0.443 (0.379, 15)	0.52 (0.337, 3)
As	MBH 69	392 (51.8, 16)	0.998 (0.592, 109)	46.9 (15.2, (16)	0.55 (0.212, 7)	26.1 (14.9, 16)	10.5 (1.75, 16)	0.528 (0.219, 6)	0.581 (0.566, 28)	8.51 (1.88, 8)
Mo	MASS1	0.007 (0.012, 12)	0.169 (0.159, 73)	0.035 (0.021, 6)	0.094 (0.009, 2)	0.126 (0.113, 11)	0.117 (0.066, 10)	0.015 (0.011, 4)	0.004 (0.011, 23)	0.22 (0.142, 4)
Ag	MBH 69	209 (18.1, 16)	16.3 (10.6, 128)	310 (74.7, 16)	79.6 (40.4, 8)	205 (39.8, 16)	56.9 (39.9, 16)	1.85 (0.968, 8)	81.9 (31.1, 32)	104 (20.6, 8)
Cd	MBH 70	0.006 (0.011, 11)	0.116 (0.079, 72)	0.035 (0.038, 6)	0.033 (0.029, 4)	0.068 (0.062, 10)	0.051 (0.033, 11)	0.048 (0.033, 5)	0.014 (0.027, 21)	0.051 (0.054, 4)
In	MBH 71	0.001 (0.001, 10)	0.011 (0.009, 94)	0.005 (0.005, 7)	0.015 (0.006, 4)	0.005 (0.003, 8)	0.006 (0.005, 9)	0.011 (0.007, 4)	0.008 (0.009, 31)	0.003 (0.001, 3)
Sn	MBH 72	0.018 (0.009, 8)	1.74 (0.587, 128)	0.038 (0.027, 12)	0.065 (0.038, 6)	0.04 (0.031, 9)	0.036 (0.033, 9)	0.059 (0.045, 7)	0.063 (0.052, 30)	0.018 (0.013, 5)
Sb	MBH 69	0.037 (0.032, 10)	0.237 (0.113, 127)	0.067 (0.037, 9)	0.069 (0.073, 2)	0.052 (0.034, 11)	0.068 (0.034, 10)	0.155 (0.083, 4)	0.05 (0.039, 19)	0.298 (0.108, 8)
Te	MBH 70	0.153 (0.062, 6)	0.419 (0.299, 98)	0.014 (0.012, 5)	0.033 (0.026, 4)	0.23 (0.38, 8)	0.087 (0.075, 12)	0.07 (0.014, 2)	0.11 (.094, 22)	0.04 (0.00, 2)
Au	MBH66	0.000 (0.001, 16)	0.021 (0.014, 99)	0.00 (0.00, 16)	0.00 (0.00, 3)	0.012 (0.012, 6)	0.005 (0.004, 6)	0.00 (0.00, 5)	0.001 (0.001, 32)	0.004 (0.002, 4)
Hg	MASS1	4.74 (0.644, 16)	2.16 (0.546, 128)	4.59 (0.578, 16)	2.36 (0.543, 8)	3.62 (6.68, 16)	2.26 (1.27, 16)	1.79 (0.352, 8)	2.05 (0.413, 32)	1.35 (0.243, 8)
Pb	MBH 66	0.067 (0.128, 11)	15.8 (4.54, 128)	0.021 (0.012, 8)	0.036 (0.023, 5)	0.007 (0.005, 8)	0.008 (0.006, 13)	0.156 (0.227, 7)	0.059 (0.039, 26)	0.016 (0.008, 7)
Bi	MBH 67	0.005 (0.004, 8)	0.114 (0.042, 128)	0.006 (0.005, 9)	0.017 (0.01, 8)	0.005 (0.003, 9)	0.005 (0.005, 7)	0.041 (0.038, 5)	0.516 (0.978, 29)	0.028 (0.028, 8)

[1] Values outside of brackets are average values based on 'n' analyses

[2] Values inside of brackets represent ±1 s.d and 'n' analyses

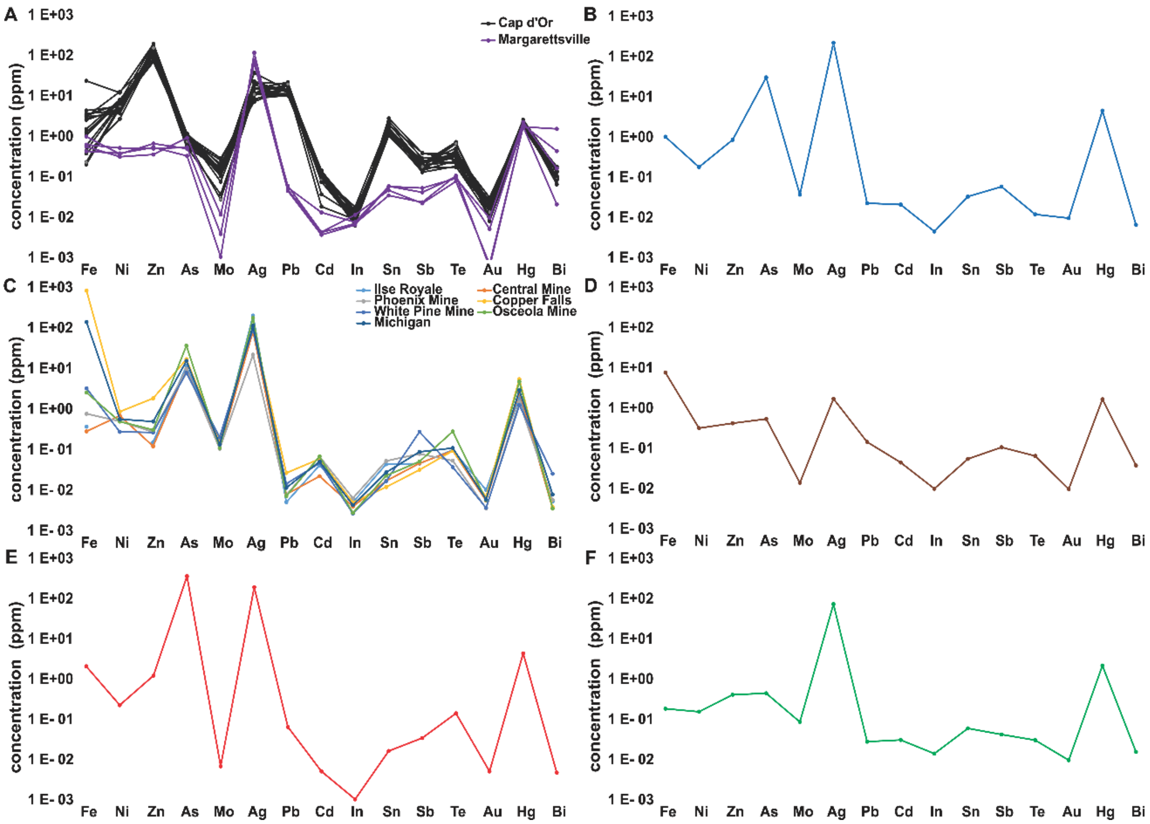

Figure 3.5 Trace element discrimination diagrams showing elemental concentrations (ppm) for all source samples of native copper. These samples were not reduced by their respective concentrations of copper as we knew they were natural native copper that had not been smelted. A) Nova Scotian copper from Cap d'Or and Margaretsville locations. B) Copper from Cornwall, UK. C) Michigan copper showing six samples taken from six different copper producing mines located in three different copper counties. D) Bolivian Copper. E) Pennsylvanian copper from Adam's County F) Copper from Kazakhstan.

County (Phoenix Mine, Central Mine and Copper Falls), two from Houghton County (Isle Royale, and Osceola Mine), and one from the Ontonagon County (White Pine Mine). Many of the trace element signatures for all of the Michigan samples were consistent amongst the other samples, with notably high Ag (56.9 – 205 ppm) low Pb (0.007 – 0.016 ppm), moderate (1.35 – 3.62 ppm) and low Bi (0.005 – 0.028 ppm). Significantly different from the Nova Scotian samples, the Michigan copper shows an enrichment in As (8.51 – 26.1 ppm) with respect to Zn (0.197 – 0.288 ppm) whereas Cap d'Or samples have slightly higher concentration of Zn compared to As, and Margaretsville samples have a moderately lower concentrations of Zn than As. Michigan samples show homogeneity and consistency between each of the samples (Figure 3.5C) however some variation exists in the concentration of Zn, Sn, Sb, and Te, between all of the different mines, which given enough analyses of artifacts from that location, could give us knowledge on exactly which mine or deposit the aboriginal peoples were procuring their copper.

3.3.4 Bolivia

Bolivian copper from Le Paz, has a very limited concentration of trace elements. Relative to the other sources used in this study, Bolivian copper is nearly pure (Figure 3.5 D). The greatest enrichments are found in Ag and Hg, however they are not enriched to the same scale as compared with the North American samples. Hg and Ag on average are only present in concentrations of 2.36 and 79.6 ppm respectively in Bolivian copper, whereas in the North American samples, Ag, Hg and Pb can get into the hundreds of ppm level, showing more impurities in the sources from North America.

3.3.5 Pennsylvania, USA

Copper from Adam’s County, Pennsylvania (Figure 3.5E), had trace element chemistry similar to those of Michigan in terms of overall trace element signatures, with the exception of select elements, for example As and Mo. Pennsylvanian copper has As concentrations in the range of hundreds of ppm with the average concentration being 392 ppm, and Mo concentrations so low that the average concentration is 0.007 ppm. In the copper samples from Michigan, As concentrations only range between 8.51 and 26.1 ppm and Mo concentrations in Michigan range between 0.117 and 0.220 ppm. Another exception is the Pb to Cd relationships. In Michigan samples, the concentration of Pb is lower than that of Cd (0.007 – 0.016 ppm Pb vs 0.051 – 0.068 ppm Cd). Pennsylvanian samples show a higher Pb concentration than that of Cd, 0.067 and 0.006 ppm respectively.

3.3.6 Kazakhstan

Copper from Kazakhstan (Figure 3.5F) is similar to that of Bolivia, as both samples do not contain high concentrations of impurities via trace elements. The copper samples from Kazakhstan also contain enrichments of Ag and Hg, however they are more concentrated than the impurities in Bolivia with the average concentration of Ag being 79.6 ppm and Hg being 2.36 ppm.

3.4 Artifact chemistry

A total of fifty seven artifacts, (Figures 3.6, 3.7, 3.8; Table 3.3) of the collection of sixty, were analyzed for this study. Artifacts 218, 818 and 82, were excluded from further comparisons with copper sources, as it was determined that these sources were modern metal alloys containing abundant Zn, Fe and Sn and originating with gun metals and Cu-Zn-Sn alloys from the 1900s. Each of the artifacts were sorted into a specific provenance group based on their trace element signatures. For this study, provenance determination was based on the concentration of Fe, Ni, Zn, As, Mo, Ag, Pb, Cd, In, Sn, Sb, Te, Au, Hg and Bi, relative to each other in a given artifact. Emphasis was placed on the relationships between Ag and Pb, Hg and Bi, and Zn and As. To further sub-divide, some artifacts were separated based on the concentration of Sn vs the concentration of Sb, however that separation is not required. Using these element concentration relationships, ten artifact groupings are created.

3.4.1 Group I

Group one is the collection of artifacts that are not pure native copper and in fact are either alloys or smelted copper with high Fe impurities. When reduced by Fe, these artifacts show enrichments in Zn, Ag, Pb, In, Sb, Au, and Bi. Significant differences that set the group one artifacts (2, 19, 20, 819, 8604, 8605, 8606, 8607, and 8609) apart from the others is the presence of an enrichment (relative to other elements) of Au in these artifacts. Au is present in these artifacts between 0.91 ppm to 470.9 ppm which is a much wider range and higher concentrations than the other provenance groups. Notable differences in elements exist in As (range between 177 and 10140 ppm), Te (0.05 and 64.12 ppm), and Hg (0.032 and 1366 ppm) (Figure 3.6A & B) which means that while we can safely assume that these artifacts are very similar in origin, there is some variation among the exact provenance of each copper artifact, or the smelting techniques that went into making them. For further details see Hodge et al. (in prep.)

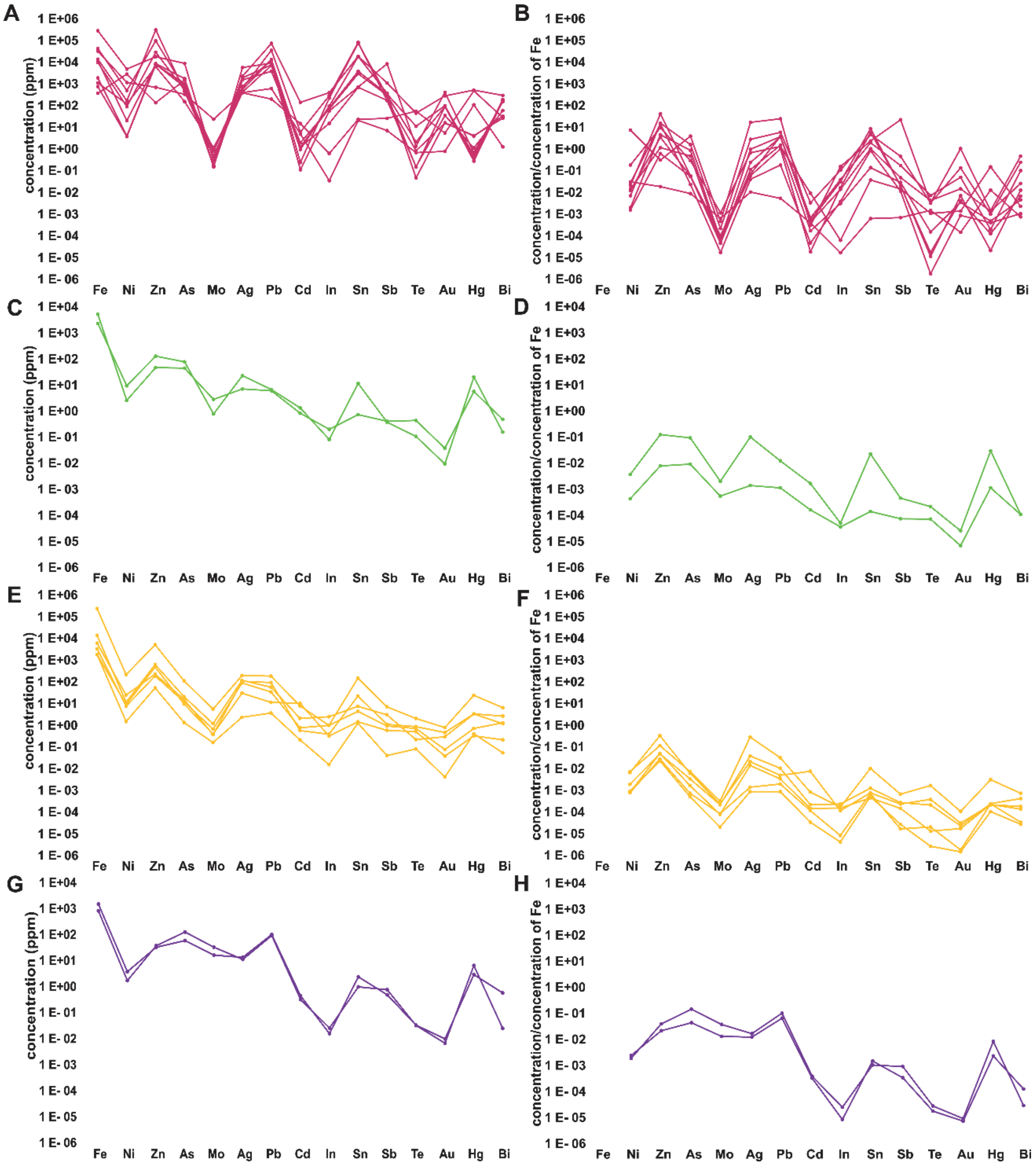

Figure 3.6 Discrimination diagrams for the first four provenance groupings. A) Group I – not reduced by iron B) Group I – reduced by iron C) Group II – not reduced by iron D) Group II – reduced by iron E) Group III – not reduced by iron F) Group III – reduced by iron G) Group IV – not reduced by iron H) Group IV – reduced by iron.

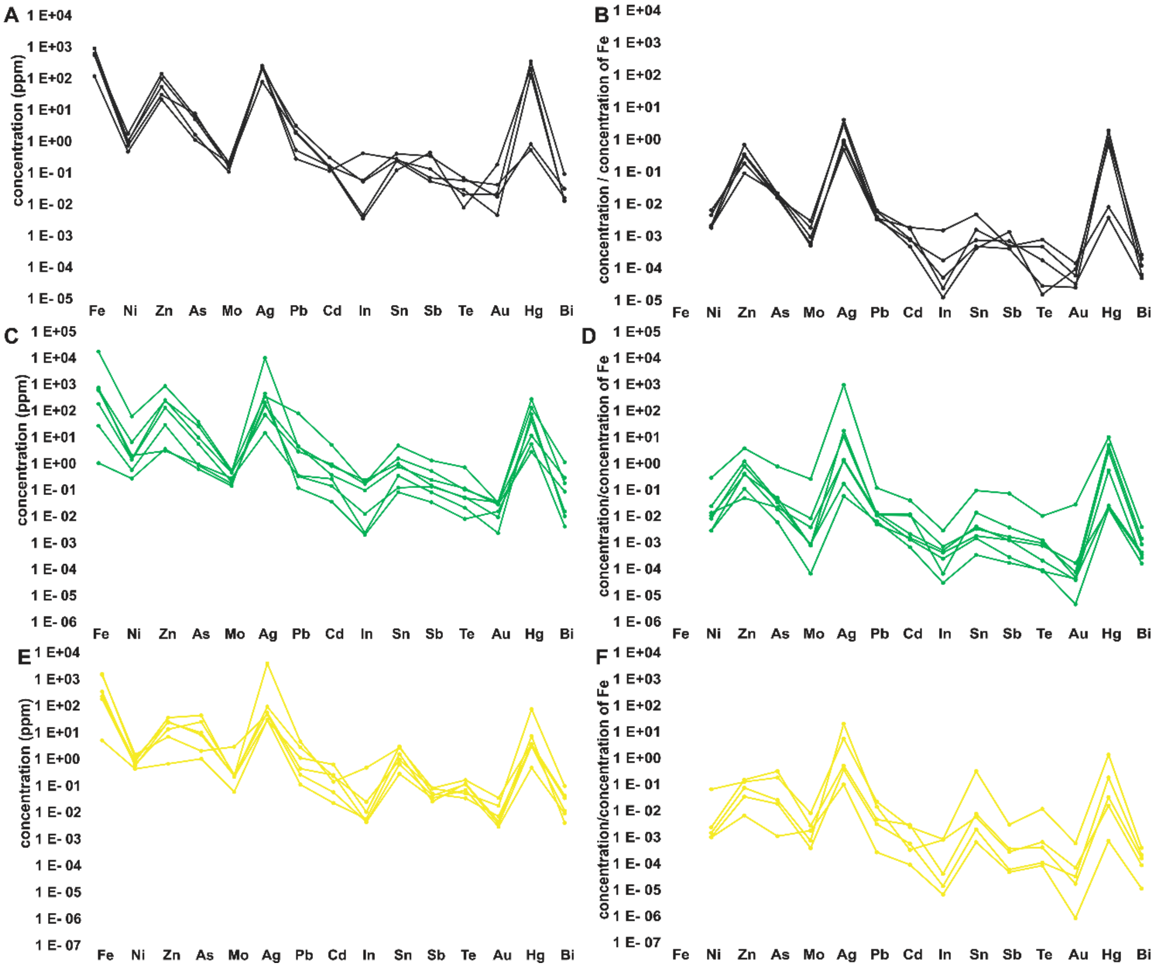

Figure 3.7 Discrimination diagrams of groups V, VI and VII A) Group V – not reduced by iron B) Group V – reduced by iron C) Group VI – not reduced by iron D) Group VI – reduced by iron E) Group VII – not reduced by iron F) Group VII – reduced by iron.

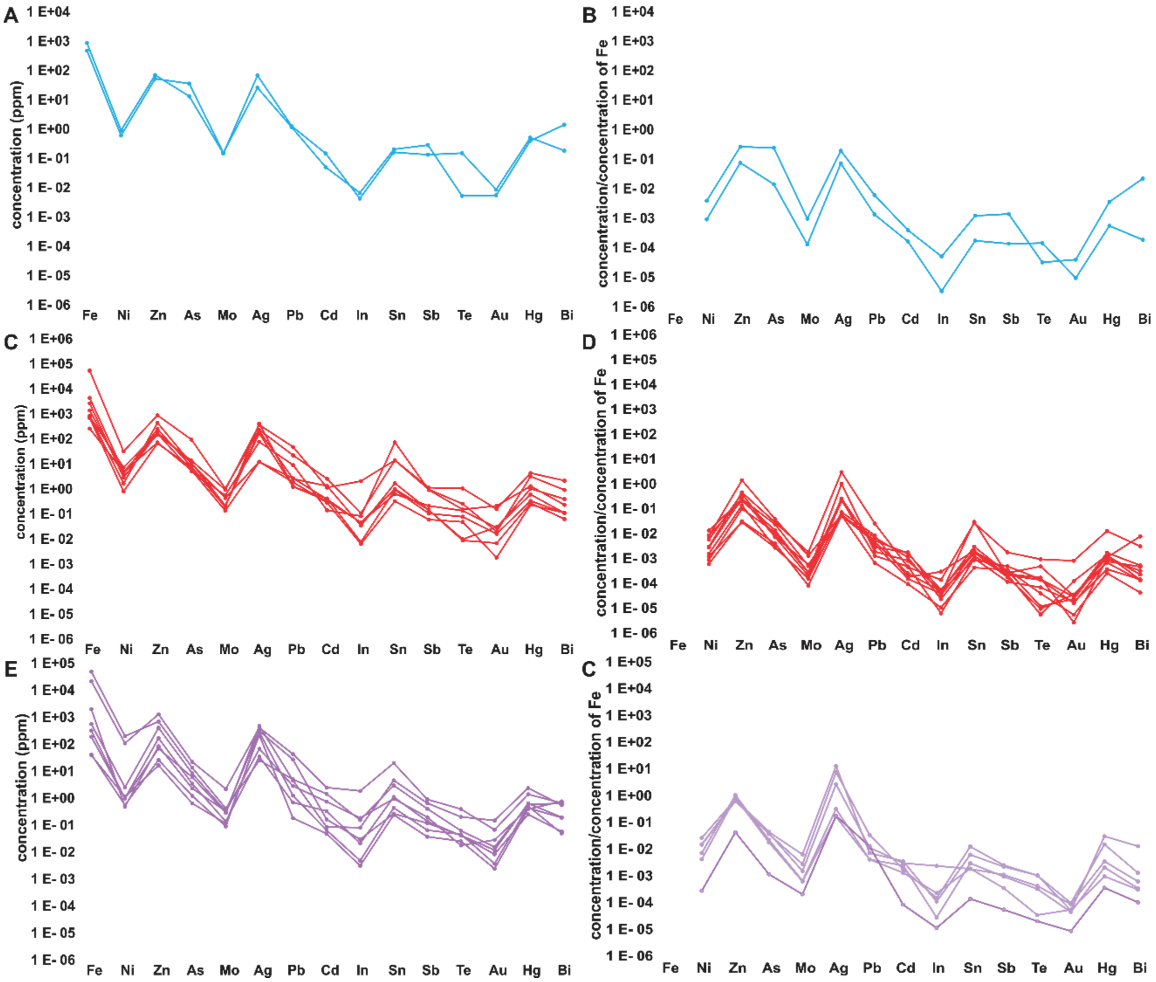

Figure 3.8 Discrimination diagrams of the last three provenance groupings. A) Group VIII – not reduced by iron B) Group VIII – Reduced by iron C) Group IX – not reduced by iron D) Group IX – reduced by iron E) Group X – not reduced by iron F) Group X – reduced by iron.

Table 3.3 Avergage concentration (ppm) of all artifacts used in this study

Element	19	20	21	64	230	1949	2015	2158	2225	5377	8566	8567	8568	8569	8572	8573	8574	8576	8577	8579	8580	8581	8582	8584	8587
	Burnt Bone Beach	*Burnt Bone Beach*	*Clam Cove*	*Clam Cove*	*Clam Cove*	*Enfield*	*Enfield*	*Enfield*	*Enfield*	*Enfield*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*
S	238	382	31101	483	206	227	199	176	211	163	849.70	295	169	214.00	485	201	1203	131	261	9440.00	260	89.9	261	588.00	245
	(65.7, 8)	(131, 10)	(97643, 10)	(340, 9)	(31.9, 10)	(24.5, 10)	(46.6, 10)	(11.6, 10)	(31.8, 10)	(15.1, 10)	(346, 10)	(53.8, 10)	(30.5, 10)	(33.3, 10)	(727, 10)	(73.4, 10)	(1217, 10)	(15.5, 10)	(62.1, 10)	(3647, 10)	(25.3, 10)	(24.8, 10)	(75.9, 10)	(233, 10)	(49.8, 10)
Cr	145	667	1249	894	140	22	97.3	9.50	270	137	2065.40	1714.00	23.1	2.47	144	250	6436	12.9	21.3	37060	105	4.96	1597.00	612.00	37.6
	(103, 8)	(507, 10)	(3222, 8)	(906, 9)	(98.8, 10)	(24.8, 10)	(285, 10)	(6.31, 10)	(164, 10)	(118, 10)	(1325, 10)	(1122, 10)	(16.6, 10)	(2.59, 10)	(194, 10)	(242, 10)	(6555, 10)	(16.4, 10)	(18.2, 10)	(11588, 10)	(29, 10)	(2.62, 10)	(794, 10)	(296, 10)	(31.4, 10)
Mn	1.32	0.81	56	3.51	66.8	37.3	0.74	0.205	0.73	0.732	20.10	1.47	1.21	1.63	2.36	9.56	20.3	0.73	0.91	1016	BDL	1.12	67.6	6.88	6.64
	(1.03, 8)	(0.461, 10)	(155, 8)	(7.49, 9)	(61.9, 10)	(21.2, 3)	(1.62, 10)	(0.104, 9)	(0.535, 10)	(0.987, 10)	(11.2, 10)	(0.649, 10)	(0.772, 10)	(1.79, 7)	(0.786, 10)	(7.11, 10)	(15.7, 10)	(0.599, 10)	(0.774, 10)	(319, 10)	BDL	(0.476, 10)	(35.8, 10)	(2.25, 10)	(4.1, 10)
Fe	15866	49011.00	37468	2617	5929.00	680	1000	30.9	853	612	15861.00	924.00	614	131.00	209	1628	63652	45.8	1640.00	271000	2077.00	390.00	2113	734	808.00
	(13579, 8)	(27717, 10)	(115462, 10)	(4622, 9)	(2569, 10)	(1134, 10)	(2951, 10)	(18.4, 10)	(534, 10)	(715, 10)	(11018, 10)	(439, 10)	(567, 10)	(147, 10)	(130, 10)	(1289, 10)	(60375, 10)	(46.2, 10)	(1667, 10)	(117643, 10)	(925, 10)	(332, 10)	(1593, 10)	(382, 10)	(443, 10)
Co	15.9	17.9	168	3.52	1.63	0.23	0.649	0.059	0.37	0.261	3.80	0.82	0.154	0.06	0.325	0.286	6.24	0.06	1.09	62.3	0.311	0.305	1.67	2.30	0.345
	(7.75, 8)	(10.8, 10)	(473, 8)	(6.62, 9)	(0.836, 10)	(0.369, 7)	(1.40, 5)	(0.076, 8)	(0.223, 10)	(0.289, 9)	(3.26, 10)	(0.444, 10)	(0.149, 9)	(0.062, 7)	(0.347, 10)	(0.365, 10)	(6.09, 10)	(0.037, 9)	(0.979, 10)	(28.6, 10)	(0.082, 10)	(0.32, 9)	(0.649, 10)	(6.26, 9)	(0.502, 10)
Ni	195	570	1332	10.6	2.92	1.07	1.16	0.652	1.67	1.96	13.31	8.60	0.816	0.52	1.62	4.7	37.7	1.31	1.68	246	1.73	0.639	10.4	7.42	0.946
	(99.1, 8)	(203, 10)	(3514, 7)	(20.9, 9)	(1.67, 10)	(1.07, 8)	(2.73, 8)	(0.419, 8)	(0.758, 10)	(2.85, 10)	(7.2, 10)	(3.54, 10)	(0.572, 9)	(0.695, 9)	(1.29, 10)	(5.15, 10)	(36.5, 10)	(1.15, 8)	(1.19, 9)	(80.2, 10)	(0.641, 10)	(0.556, 9)	(4.19, 10)	(13, 10)	(0.577, 9)
Zn	355562	112450.00	807	144	53.1	109	60.5	33.1	288	157	717.80	205	33.7	24.1	150	296	1042	19.2	7.9	5921.00	60.9	28.9	558	273	78.8
	(174809, 8)	(121070, 10)	(2492, 10)	(159, 9)	(44.4, 10)	(62.4, 10)	(41.4, 10)	(11.9, 10)	(92.3, 10)	(113, 10)	(307, 10)	(54.6, 10)	(19.7, 10)	(49.2, 10)	(77.3, 10)	(151, 10)	(1003, 10)	(18.9, 10)	(5.43, 10)	(1852, 10)	(20.4, 10)	(21.4, 10)	(206, 10)	(136, 10)	(32.1, 10)
Ga	3.03	1.95	52	2.91	1.95	0.423	0.32	0.157	2	0.88	9.65	3.56	1.14	0.204	1.24	1.01	27.9	0.149	0.697	175	1.41	0.856	3.25	5.44	1.81
	(2.02, 8)	(0.581, 10)	(145, 8)	(4.93, 9)	(0.609, 10)	(0.333, 10)	(0.542, 10)	(0.024, 10)	(0.653, 10)	(0.751, 10)	(6.61, 10)	(1.95, 10)	(0.693, 10)	(0.127, 9)	(0.609, 10)	(0.716, 10)	(26.7, 10)	(0.104, 8)	(0.589, 10)	(82.4, 10)	(0.46, 10)	(0.446, 10)	(1.42, 10)	(2.85, 10)	(0.963, 10)
Ge	1.29	1.81	35	0.742	1.16	0.162	0.30	0.158	0.55	0.275	2.58	0.87	0.301	0.514	0.46	0.38	6.62	0.309	0.45	34.3	0.167	0.257	1.45	1.66	0.373
	(0.544, 7)	(0.516, 10)	(103, 9)	(0.889, 9)	(0.503, 10)	(0.155, 9)	(0.145, 5)	(0.108, 8)	(0.346, 10)	(0.085, 9)	(2.12, 10)	(0.465, 10)	(0.193, 9)	(0.422, 7)	(0.303, 10)	(0.206, 10)	(6.26, 10)	(0.131, 8)	(0.207, 10)	(6.31, 10)	(0.115, 9)	(0.158, 8)	(1.69, 10)	(3.35, 10)	(0.337, 9)
As	512	719	358	8708	50.4	5.6	1.82	0.972	11.1	6.96	23.75	13	8.52	1.24	6.35	9.09	112	0.75	2.3	128	1.54	9.26	10.9	29.7	8.6
	(226, 8)	(210, 10)	(1145, 9)	(62.9, 9)	(17.9, 10)	(3.88, 10)	(1.40, 10)	(0.342, 10)	(3.47, 10)	(4.33, 10)	(14.4, 10)	(5.03, 10)	(5.48, 10)	(1.16, 10)	(3.42, 10)	(5.78, 10)	(232, 10)	(0.161, 10)	(3.46, 10)	(22.3, 10)	(0.48, 10)	(5.11, 10)	(4.75, 10)	(5.93, 10)	(3.61, 10)
Mo	0.513	0.58	27.5	0.881	3.17	0.183	0.121	0.201	0.52	0.245	1.37	0.26	0.17	0.24	0.23	0.242	1.24	0.14	3.31	6.40	0.185	0.268	0.45	0.54	0.227
	(0.234, 7)	(0.26, 10)	(71.6, 7)	(0.432, 9)	(1.13, 10)	(0.188, 10)	(0.063, 10)	(0.129, 10)	(0.484, 10)	(0.304, 10)	(1.86, 10)	(0.197, 10)	(0.079, 10)	(0.192, 10)	(0.222, 7)	(0.12, 9)	(0.972, 10)	(0.062, 10)	(5.12, 10)	(2.45, 9)	(0.096, 10)	(0.106, 9)	(0.328, 10)	(0.674, 10)	0.123, 10)
Ag	629.00	485	450	26.1	8.02	282	248	232	80.6	220	134.70	246	86.9	254.00	179	201	273	256	54.7	226	2.7	4494.00	34.9	11457	488
	(113, 8)	(298, 10)	(884, 10)	(21.0, 9)	(1.69, 10)	(351, 10)	(88.7, 10)	(121, 10)	(33, 10)	(75.5, 10)	(33.2, 10)	(224, 10)	(37.7, 10)	(278, 10)	(73.7, 10)	(86.8, 10)	(139, 10)	(178, 10)	(27.6, 10)	(67.1, 10)	(0.623, 10)	(2692, 10)	(11.8, 10)	(21447, 10)	(247, 10)
Cd	1.42	1.1	17.1	1.49	0.93	0.166	0.182	0.302	1.09	0.344	2.41	1.56	0.183	0.128	0.42	0.497	3.03	0.057	0.065	9.04	0.246	0.162	11.8	0.92	0.394
	(0.663, 8)	(0.452, 10)	(53.7, 10)	(0.996, 9)	(0.483, 10)	(0.111, 10)	(0.184, 10)	(0.282, 10)	(0.547, 10)	(0.217, 10)	(1.34, 10)	(0.481, 10)	(0.068, 10)	(0.121, 9)	(0.225, 10)	(0.293, 10)	(2.37, 10)	(0.061, 7)	(0.042, 10)	(3.86, 10)	(0.086, 10)	(0.185, 9)	(7.39, 10)	(0.436, 10)	(0.442, 10)
In	17.5	109	0.722	0.091	0.228	0.004	0.005	0.003	0.196	0.059	2.86	0.041	0.07	0.466	0.112	0.009	0.126	0.004	0.005	1.15	0.018	0.541	0.372	0.273	0.055
	(4.09, 8)	(39.5, 10)	(1.88, 7)	(0.095, 8)	(0.173, 10)	(0.002, 7)	(0.004, 7)	(0.002, 8)	(0.268, 10)	(0.131, 10)	(6.49, 10)	(0.047, 10)	(0.117, 9)	(1.03, 5)	(0.164, 9)	(0.006, 10)	(0.114, 10)	(0.002, 7)	(0.001, 8)	(0.559, 10)	(0.011, 10)	(1.12, 8)	(0.994, 10)	(0.699, 8)	(0.078, 9)
Sn	801	21155.00	27	13.1	0.83	0.134	0.264	0.397	1.79	0.277	8.58	2	0.45	0.311	0.875	1.09	16.6	0.281	0.317	170	1.45	3.05	1.66	1.12	0.752
	(213, 8)	(9669, 10)	(83.3, 10)	(9.59, 9)	(0.404, 10)	(0.106, 10)	(0.331, 9)	(0.536, 10)	(3.1, 10)	(0.321, 10)	(8.88, 10)	(1.7, 10)	(0.564, 10)	(0.536, 10)	(0.713, 10)	(0.47, 10)	(19.3, 10)	(0.504, 10)	(0.448, 10)	(222, 10)	(1.13, 10)	(5.64, 10)	(1.49, 10)	(2.12, 10)	(0.709, 10)
Sb	201	433	30.1	0.426	0.495	0.488	0.06	0.09	0.602	0.149	3.50	0.169	0.381	0.078	0.277	0.124	1.12	0.043	0.039	8.16	0.047	0.093	0.676	0.169	0.251
	(50.2, 8)	(232, 10)	(84.8, 8)	(0.578, 9)	(0.462, 10)	(1.06, 10)	(0.067, 9)	(0.075, 10)	(1.07, 10)	(0.144, 10)	(4.73, 10)	(0.067, 10)	(0.409, 10)	(0.086, 5)	(0.37, 10)	(0.048, 10)	(0.729, 10)	(0.024, 10)	(0.023, 10)	(14.1, 10)	(0.022, 8)	(0.088, 10)	(1.13, 10)	(0.128, 10)	(0.519, 10)
Te	0.959	0.055	64.1	0.121	0.496	0.009	0.032	0.025	0.117	0.023	0.25	0.011	0.076	0.064	0.132	0.09	0.301	0.03	0.078	2.37	0.09	0.187	0.59	0.06	0.16
	(0.503, 8)	(0.024, 9)	(180, 8)	(0.088, 8)	(0.319, 9)	(0.01, 5)	(0.017, 8)	(0.021, 10)	(0.113, 10)	(0.022, 9)	(0.282, 9)	(0.014, 8)	(0.057, 10)	(0.083, 8)	(0.075, 10)	(0.064, 8)	(0.191, 10)	(0.017, 4)	(0.042, 9)	(3.07, 4)	(0.099, 5)	(0.088, 10)	(0.789, 9)	0.093, 9)	(0.131, 8)
Au	18.2	18.8	6.29	0.011	0.043	0.205	0.005	0.003	0.041	0.024	0.34	0.036	0.019	0.046	0.032	0.019	0.023	0.003	0.003	0.91	0.005	0.04	0.044	0.039	0.033
	(4.09, 8)	(10.1, 10)	(16.6, 7)	(0.007, 9)	(0.038, 10)	(0.524, 8)	(0.003, 6)	(0.002, 6)	(0.059, 10)	(0.046, 10)	(0.469, 10)	(0.024, 10)	(0.022, 9)	(0.069, 4)	(0.043, 9)	(0.016, 9)	(0.022, 9)	(0.003, 6)	(0.003, 4)	(1.04, 5)	(0.006, 9)	(0.042, 9)	(0.048, 10)	(0.079, 9)	(0.067, 9)
Hg	4.833	4.57	554	22.9	6.42	231	146	85.1	315	387	3.83	0.72	0.909	0.596	3.2	0.393	3.76	0.46	0.544	27.6	0.47	4.21	0.376	13.2	1.22
	(4.12, 8)	(3.13, 10)	(1738, 10)	(13.6, 9)	(0.917, 10)	(116, 10)	(72.5, 10)	(53.7, 10)	(210, 10)	(230, 10)	(3.19, 10)	(0.504, 10)	(0.402, 10)	(0.241, 10)	(2.61, 10)	(0.132, 10)	(3.34, 10)	(0.114, 10)	(0.454, 10)	(9.51, 10)	(0.125, 10)	(1.5, 10)	(0.184, 10)	(6.67, 10)	(0.624, 10)
Pb	15261	8106.00	232	7.59	6.83	2.05	0.589	0.40	3.29	3.47	65.98	3	2.22	0.312	5.16	1.44	26.3	0.213	0.289	212	4.23	5.22	13.1	4.92	1.48
	(5292, 8)	(3942, 10)	(730, 10)	(4.99, 9)	(3.95, 10)	(2.23, 10)	(0.396, 10)	(0.425, 10)	(1.81, 10)	(4.21, 10)	(118, 10)	(1.78, 10)	(4.53, 10)	(0.271, 10)	(11.7, 1)	(0.755, 10)	(21.2, 10)	(0.178, 10)	(0.335, 10)	(39.2, 10)	(1.57, 10)	(7.17, 10)	(23.6, 10)	(7.22, 10)	(0.842, 10)
Bi	30.2	38.5	32.5	0.177	0.549	0.014	0.015	0.012	0.207	0.103	1.37	0.128	0.035	0.018	0.099	0.129	1.08	0.891	0.01	7.51	0.062	0.049	0.248	0.330	0.47
	(17.9, 8)	(14.3, 10)	(96.6, 9)	(0.283, 9)	(0.886, 10)	(0.011, 10)	(0.021, 10)	(0.019, 10)	(0.123, 10)	(0.095, 10)	(1.06, 10)	(0.04, 10)	(0.066, 10)	(0.015, 9)	(1.55, 10)	(0.081, 10)	(0.89, 10)	(2.52, 9)	(0.006, 10)	(2.38, 10)	(0.044, 10)	(0.08, 10)	(0.214, 10)	(0.719, 10)	(0.385, 10)

[1] Values outside of brackets are average values based on 'n' analyses

[2] Values inside of brackets represent ±1 s.d and 'n' analyses

[3] Respective archeological sites are listed below each artifact number

[4] GLR = Gaspereau Lake Reservoir

Table 3.3 continued

Element	8589	8590	8591	8592	8594	8595	8596	8597	8598	8599	8604	8605	8606	8607	8608	8609	8610	8630	99	211	173	2
	GLR	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*GLR*	*Isle Haute*	*Isle Haute*	*Jeddore Harbour*	*Margaretsville*
S	150	122	141	1128	183	132	362	242	165	1112	268	117	156	85947	615	73	152	107	395	256	1418	236.92
	(18.4, 10)	(25.9, 10)	(9.59, 10)	(2343, 10)	(38.5, 10)	(20.9, 10)	(54.5, 10)	(172, 9)	(47, 10)	(1891, 10)	(34.7, 10)	(10.6, 10)	(20, 10)	(226676, 7)	(352, 10)	(12.3, 10)	(13.5, 10)	(25.1, 10)	(51.3, 10)	(25.3, 10)	(1404, 9)	(20.5, 10)
Cr	50.6	33.9	9.74	7290	391	80.2	364	155	165	3326	38.3	9.8	15.5	5487	165	18.4	64.3	52.8	11.3	52.2	2372	35.62
	(39.9, 10)	(21.8, 10)	(5.04, 10)	(18226, 10)	(368, 10)	(61.4, 10)	(339, 10)	(241, 10)	(108, 10)	(6862, 10)	(32.1, 10)	(4.64, 10)	(21.7, 10)	(15665, 10)	(135, 10)	(19.7, 10)	(64.1, 10)	(54.8, 10)	(7.34, 10)	(36.9, 10)	(1773, 9)	(33.3, 10)
Mn	BDL	BDL	0.475	40.3	BDL	1.59	7.49	25.8	20.4	1353	9.53	6.5	7.41	6262	14.8	1.16	0.45	1.94	4.55	52.8	BDL	1.751
	BDL	BDL	(0.295, 10)	(103, 10)	BDL	(0.828, 10)	(5.79, 10)	(56.2, 9)	(9.88, 10)	(3955, 9)	(6.07, 10)	(6.7, 7)	(4.78, 10)	(13818, 10)	(9.54, 10)	(0.79, 10)	(0.339, 9)	(1.10, 10)	(0.909, 10)	(49.7, 10)	BDL	(1.14, 10)
Fe	2328	1005	48.7	25438	3828	220	309.00	6924	657	57689	13401	866	432	322730	5175	2173	551	983	911	1663	19821	1287.8
	(1184, 10)	(268, 10)	(34.2, 10)	(65448, 10)	(3249, 10)	(211, 10)	(196, 10)	(15088, 10)	(590, 10)	(117671, 10)	(2695, 10)	(729, 10)	(260, 10)	(824549, 10)	(3114, 10)	(774, 10)	(666, 10)	(1423, 10)	(297, 10)	(1410, 10)	(14773, 9)	(1303, 10)
Co	0.195	0.171	0.025	6804	2.74	0.273	0.554	4.05	0.989	83	0.888	0.466	89.5	516	1.07	0.539	0.104	1.13	0.222	1.15	24.9	1.2143
	(0.125, 10)	(0.075, 9)	(0.017, 7)	(141, 10)	(2.15, 10)	(0.244, 8)	(0.38, 10)	(9.85, 8)	(0.932, 10)	(154, 9)	(0.129, 10)	(0.12, 10)	(40.4, 10)	(1459, 9)	(0.74, 10)	(0.162, 10)	(0.055, 9)	(2.40, 8)	(0.074, 10)	(1.19, 10)	(22.1, 9)	(0.874, 10)
Ni	0.568	1.04	0.65	127	8.74	1.15	5.57	28.4	2.93	234	23.5	4.36	3291	5592	5.65	4.6	0.699	1.97	1.89	4.19	69.9	138.32
	(0.332, 9)	(0.539, 10)	(0.27, 8)	(258, 10)	(8.17, 10)	(0.747, 10)	(7.09, 10)	(55.9, 9)	(2.29, 10)	(580, 10)	(3.78, 10)	(0.943, 10)	(2064, 10)	(14741, 8)	(2.42, 10)	(1.33, 10)	(0.911, 9)	(0.995, 10)	(1.07, 10)	(3.21, 10)	(59.3, 9)	(53.3, 10)
Zn	98.3	80.6	30.2	1151	215	195	85.66	263	474	808	9310	8759	157	20496	179	9883	60.1	522	41.7	36.2	993	7213
	(71.3, 10)	(21.8, 10)	(11.5, 10)	(3225, 10)	(199, 10)	(119, 10)	(54.4, 10)	(222, 10)	(185, 10)	(868, 10)	(1206, 10)	(2699, 10)	(112, 10)	(18631, 10)	(155, 10)	(2998, 10)	(41.4, 10)	(349, 10)	(30.1, 10)	(25.4, 10)	(425, 9)	(2594, 10)
Ga	0.813	2.24	0.157	73.3	13.8	0.768	1.70	3.31	2.32	17.6	8.31	2.19	0.516	41.3	9.55	2.59	0.403	1.43	1.07	1.45	29.3	0.8253
	(0.583, 10)	(0.774, 10)	(0.074, 9)	(188, 10)	(10.1, 10)	(0.453, 10)	(1.09, 10)	(3.4, 9)	(0.915, 10)	(23.9, 10)	(1.54, 10)	(0.892, 10)	(0.287, 10)	(74.2, 8)	(7.75, 10)	(0.783, 10)	(0.386, 10)	(0.778, 10)	(0.311, 10)	(0.878, 10)	(18.7, 9)	(0.907, 10)
Ge	0.609	0.299	0.326	11	3.22	0.361	0.634	1.52	0.452	8.54	10.5	0.801	0.37	85	1.81	0.913	0.403	0.545	0.521	0.527	5.39	0.49
	(0.532, 8)	(0.181, 9)	(0.287, 8)	(26.8, 10)	(2.72, 10)	(0.196, 7)	(0.37, 8)	(1.31, 5)	(0.186, 10)	(18.5, 8)	(2.42, 10)	(0.292, 10)	(0.137, 10)	(223, 7)	(2.01, 8)	(0.439, 10)	(0.298, 6)	(0.598, 8)	(0.172, 10)	(0.232, 10)	(3.33, 9)	(0.579, 8)
As	2.69	15.2	1.44	25.9	13.8	4.05	6.71	17.7	9.67	15.9	824	1200	1735	10140	16.1	2018	41.4	12.1	140	65.4	43.8	177.2
	(1.47, 10)	(4.72, 10)	(0.372, 10)	(44.2, 10)	(10.2, 10)	(2.01, 10)	(3.96, 10)	(12.9, 10)	(3.57, 10)	(23.6, 10)	(145, 10)	(440, 10)	(1124, 10)	(10398, 10)	(10.5, 10)	(569, 10)	(19.5, 10)	(5.70, 10)	(58.4, 10)	(23.8, 10)	(11.4, 9)	(75.8, 10)
Mo	0.385	0.169	0.105	2.56	0.769	0.16	0.161	0.424	0.38	0.487	1.05	0.186	0.173	0.342	1.11	0.206	0.179	0.518	36.3	18	0.631	1.325
	(0.142, 10)	(0.085, 9)	(0.058, 8)	(4.77, 10)	(0.518, 10)	(0.092, 10)	(0.07, 9)	(0.398, 8)	(0.367, 10)	(0.872, 10)	(0.184, 10)	(0.128, 8)	(0.084, 10)	(0.201, 6)	(1.13, 10)	(0.156, 9)	(0.072, 8)	(0.395, 10)	(11.6, 10)	(3.25, 10)	(0.752, 8)	(1.22, 10)
Ag	359	78.1	326	479	103	40.6	14.4	123	78.4	29.6	890	1772	6548	2601	432	2212	29.7	14.4	12.4	14.9	401	461.4
	(141, 10)	(53.2, 10)	(171, 10)	(345, 10)	(34.1, 10)	(6.96, 10)	(6.06, 10)	(53.5, 10)	(25.7, 10)	(44.3, 10)	(344, 10)	(212, 10)	(2997, 10)	(1403, 10)	(297, 10)	(494, 10)	(14.5, 10)	(3.46, 10)	(12.3, 10)	(7.87, 10)	(135, 9)	(167, 10)
Cd	0.191	0.170	0.076	2.89	0.885	0.388	0.335	0.657	0.871	1.69	0.277	2.24	0.129	163	1.35	1.45	0.058	0.462	0.355	0.49	5.87	5.708
	(0.137, 10)	(0.054, 10)	(0.051, 9)	(4.63, 10)	(0.913, 10)	(0.233, 10)	(0.31, 10)	(0.508, 9)	(0.724, 10)	(2.31, 9)	(0.085, 10)	(3.32, 10)	(0.072, 10)	(354, 8)	(2.15, 10)	(1.47, 10)	(0.043, 9)	(0.209, 10)	(0.104, 10)	(0.181, 10)	(2.33, 9)	(2.14, 10)
In	0.034	0.005	0.006	2.16	1.15	0.024	0.007	0.445	0.214	0.181	256	82.1	65.5	455	2.46	89.9	0.008	0.053	0.029	0.017	0.209	0.04026
	(0.075, 9)	(0.002, 8)	(0.004, 9)	(3.72, 9)	(1.26, 10)	(0.047, 6)	(0.005, 9)	(0.493, 10)	(0.321, 10)	(0.339, 8)	(34.9, 10)	(28.1, 10)	(30.1, 10)	(763, 10)	(3.64, 10)	(17, 10)	(0.005, 9)	(0.095, 10)	(0.072, 9)	(0.014, 9)	(0.138, 9)	(0.008, 10)
Sn	0.312	0.187	0.513	23.2	5.1	1.29	0.39	25.5	1.11	3.47	86870	3407	839	21613	16.6	4416	0.262	1.18	1.09	2.64	5.53	24.112
	(0.265, 10)	(0.107, 10)	(0.233, 10)	(67.5, 10)	(3.94, 10)	(3.07, 10)	(0.251, 10)	(27.3, 10)	(0.981, 10)	(5.07, 10)	(15974, 10)	(1023, 10)	(1319, 10)	(23952, 10)	(27.8, 10)	(911, 10)	(0.125, 10)	(1.35, 10)	(0.697, 10)	(2.49, 10)	(3.78, 9)	(4.29, 10)
Sb	0.138	0.155	0.076	1.05	1.07	0.161	0.071	1.28	0.232	0.472	326	347	9646	1269	1.33	396	0.328	0.169	0.847	0.538	1.50	8.238
	(0.108, 10)	(0.082, 10)	(0.033, 9)	(1.77, 10)	(1.09, 10)	(0.156, 10)	(0.02, 9)	(1.05, 10)	(0.266, 10)	(1.04, 10)	(76.3, 10)	(105, 10)	(5327, 10)	(1879, 10)	(1.49, 10)	(54.3, 10)	(0.203, 10)	(0.191, 8)	(0.213, 10)	(0.293, 10)	(1.01, 9)	(3.80, 10)
Te	0.049	0.175	0.054	0.461	0.827	0.048	0.057	1	0.021	0.072	0.17	2.47	1.56	51.9	1.25	12.9	0.006	0.01	0.036	0.037	0.824	0.788
	(0.026, 8)	(0.188, 8)	(0.057, 8)	(1.03, 8)	(1.01, 9)	(0.04, 10)	(0.05, 8)	(1.12, 10)	(0.016, 9)	(0.084, 9)	(0.049, 10)	(1.69, 10)	(0.943, 10)	(58.1, 8)	(1.1, 8)	(14.6, 10)	(0.004, 6)	(0.014, 8)	(0.035, 9)	(0.024, 7)	(0.764, 8)	(0.281, 10)
Au	0.014	0.009	0.004	0.078	0.089	0.009	0.002	0.537	0.033	0.018	106	103	471	325	0.186	114	0.006	0.008	0.007	0.011	0.038	0.9081
	(0.013, 9)	(0.004, 10)	(0.003, 9)	(0.095, 9)	(0.07, 9)	(0.009, 8)	(0.001, 4)	(0.43, 8)	(0.03, 10)	(0.016, 8)	(9.39, 10)	(36.3, 10)	(305, 10)	(384, 10)	(0.457, 9)	(23.9, 10)	(0.005, 7)	(0.006, 8)	(0.005, 10)	(0.008, 10)	(0.036, 9)	(0.215, 10)
Hg	0.749	0.59	0.597	1.63	0.823	0.292	0.28	3.86	0.506	0.677	0.321	0.624	0.786	600	5.14	0.435	0.461	0.32	7.19	3.23	150	126.7
	(0.152, 10)	(0.096, 10)	(0.142, 10)	(2.33, 10)	(0.529, 10)	(0.064, 10)	(0.09, 10)	(8.5, 10)	(0.129, 10)	(0.86, 10)	(0.11, 10)	(0.14, 10)	(0.34, 9)	(1165, 10)	(5.01, 10)	(0.118, 10)	(0.202, 10)	(0.085, 10)	(2.5, 10)	(2.22, 10)	(61.1, 9)	(70.5, 10)
Pb	31.9	1.48	1.46	50.4	39.6	0.808	2.19	107	3.32	5.83	15329	4424	10427	85423	56.5	8723	1.35	3.17	102	112	91.3	707.4
	(26.4, 10)	(0.625, 10)	(1.6, 10)	(96.4, 10)	(24.3, 10)	(0.492, 10)	(1.25, 10)	(151, 10)	(4.51, 10)	(10, 10)	(1185, 10)	(1612, 10)	(6248, 10)	(96402, 10)	(53.9, 10)	(2276, 10)	(1.47, 10)	(5.18, 10)	(37.4, 10)	(76.7, 10)	(122, 9)	(396, 10)
Bi	0.228	0.211	0.058	0.77	1.51	0.067	0.13	3.04	0.222	0.753	192	188	176	340	2.56	224	1.634	0.074	0.028	0.637	1.28	1.4547
	(0.146, 10)	(0.091, 10)	(0.048, 10)	(1.39, 10)	(1.06, 10)	(0.046, 10)	(0.204, 10)	(5.89, 10)	(0.278, 10)	(1.16, 10)	(77.8, 10)	(121, 10)	(98.1, 10)	(264, 10)	(2.46, 10)	(135, 10)	(4.79, 9)	(0.086, 10)	(0.016, 10)	(1.88, 10)	(0.661, 9)	(0.656, 10)

[1] Values outside of brackets are average values based on 'n' analyses

[2] Values inside of brackets represent ±1 s.d and 'n' analyses

[3] Respective archeological sites are listed below each artifact number

[4] GLR = Gaspereau Lake Reservoir

Table 3.3 continued

Element	819 *Muskrat Cove*	820 *Muskrat Cove*	821 *Muskrat Cove*	822 *Muskrat Cove*	Rlake *Rafter Lake*	851 *Sellars Cove*	859 *Sellars Cove*	863A *Sellars Cove*	863B *Sellars Cove*
S	375 (107, 10)	193 (18.7, 10)	204 (42.5, 10)	316 (152, 10)	179 (55.9, 10)	175 (17.4, 10)	208 (50.9, 10)	362 (44.5, 6)	416 (76.3, 5)
Cr	2182 (1175, 10)	1.71 (1.30, 10)	28.2 (34.2, 10)	126 (166, 10)	22.5 (48.2, 8)	0.717 (0.269, 9)	384 (962, 10)	118 (32.9, 6)	93.3 (72.6, 5)
Mn	2.86 (1.63, 10)	0.103 (0.028, 8)	21.9 (16, 10)	1.57 (1.36, 10)	4.01 (3.37, 8)	0.107 (0.057, 7)	1.97 (1.62, 9)	12.3 (3.21, 6)	21.1 (10.8, 5)
Fe	11199 (9360, 10)	1.19 (1.12, 10)	374 (560, 10)	3136 (4082, 10)	676 (1504, 9)	5.72 (1.53, 10)	1805 (3068, 10)	261 (91.7, 6)	206 (225, 5)
Co	24.4 (14.9, 10)	0.069 (0.055, 4)	0.47 (0.66, 7)	1.02 (1.73, 9)	0.563 (0.72, 4)	0.074 (0.057, 6)	0.31 (0.404, 9)	0.066 (0.035, 5)	0.071 (0.071, 4)
Ni	104 (43.9, 10)	0.31 (0.176, 4)	1.13 (1.29, 8)	3.36 (4.23, 10)	2.3 (1.64, 5)	0.49 (0.468, 8)	1.24 (1.33, 8)	0.95 (0.145, 6)	0.71 (0.285, 3)
Zn	33321 (11161,10)	4.11 (4.10, 10)	81.3 (39.3, 10)	196 (162, 10)	3.5 (3.76, 8)	0.758 (0.287, 10)	27.2 (23.8, 10)	41.4 (2.83, 6)	15.1 (5.81, 5)
Ga	5.97 (3.16, 10)	0.134 (0.083, 6)	0.902 (1.05, 10)	1.72 (0.479, 8)	0.584 (0.686, 8)	0.071 (0.072, 9)	0.778 (1.09, 9)	1.53 (0.629, 6)	1.94 (2, 5)
Ge	5.46 (1.92, 10)	0.212 (0.249, 5)	0.667 (0.668, 8)	0.521 (5.98, 10)	1.57 (0.952, 5)	0.247 (0.126, 7)	0.321 (0.572, 8)	0.578 (0.35, 5)	0.458 (0.211, 5)
As	592 (253, 10)	0.705 (0.486, 10)	7 (4.9, 10)	6.10 (0.921, 8)	1.09 (0.978, 8)	1.17 (0.339, 10)	11.3 (8.79, 10)	49.9 (4.57, 6)	28.6 (15.9, 5)
Mo	0.931 (0.195, 10)	0.164 (0.07, 9)	0.332 (0.2, 10)	0.656 (56.9, 10)	0.325 (0.145, 4)	0.067 (0.048, 7)	0.27 (0.233, 10)	0.248 (0.076, 6)	0.3 (0.121, 4)
Ag	734 (353, 10)	515 (649, 10)	559 (397, 10)	90.6 (0.105, 10)	16.7 (5.34, 10)	34.3 (13.8, 10)	105 (53.5, 10)	32.9 (23.6, 6)	63.1 (35.6, 5)
Cd	6.93 (8.42, 10)	0.041 (0.029, 9)	0.101 (0.094, 8)	0.167 (0.144, 10)	0.162 (0.116, 6)	0.026 (0.023, 6)	0.259 (0.129, 10)	0.713 (0.128, 6)	0.288 (0.118, 5)
In	334 (188, 10)	0.002 (0.002, 5)	0.094 (0.191, 9)	0.097 (143, 10)	0.014 (0.007, 7)	0.007 (0.008, 7)	0.028 (0.068, 9)	0.012 (0.008, 6)	0.005 (0.002, 4)
Sn	94000 (57736, 10)	0.095 (0.075, 9)	5.33 (2.52, 10)	86.7 (2.35, 10)	0.141 (0.253, 9)	1.76 (2.84, 10)	1.07 (1.01, 10)	3.45 (2.72, 6)	0.741 (0.539, 5)
Sb	199 (65.5, 10)	0.039 (0.021, 10)	0.762 (1.4, 10)	1.08 (0.00, 1)	0.154 (0.094, 7)	0.029 (0.037, 6)	0.089 (0.116, 7)	0.057 (0.028, 6)	0.048 (0.03, 4)
Te	0.179 (0.148, 8)	0.009 (0.003, 5)	0.236 (0.209, 5)	0.18 (0.944, 10)	0.061 (0.057, 4)	0.137 (0.113, 6)	0.058 (0.043, 7)	0.039 (0.053, 3)	0.127 (0.025, 2)
Au	41.1 (18.3, 10)	0.018 (0.017, 10)	0.174 (0.094, 10)	0.252 (0.231, 10)	0.011 (0.014, 4)	0.005 (0.003, 6)	0.02 (0.016, 8)	0.008 (0.001, 2)	0.004 (0.001, 2)
Hg	1.29 (0.518, 10)	6.30 (3.79, 10)	2.77 (2.37, 10)	1.54 (0.944, 10)	50.2 (53.3, 10)	8.40 (1.37, 10)	86.3 (50.2, 10)	3.73 (1.45, 6)	3.59 (1.57, 5)
Pb	41030 (21854, 10)	0.136 (0.271, 10)	5.34 (3.64, 10)	10.6 (12.6, 10)	0.376 (0.528, 10)	0.128 (0.159, 10)	3.19 (4.87, 10)	1.26 (0.441, 6)	0.496 (0.098, 5)
Bi	68.6 (26.1, 10)	0.005 (0.003, 7)	0.641 (0.389, 10)	0.273 (0.242, 10)	0.018 (0.017, 6)	0.004 (0.003, 5)	0.111 (0.162, 10)	0.04 (0.018, 6)	0.013 (0.011, 5)

[1] Values outside of brackets are average values based on 'n' analyses

[2] Values inside of brackets represent ±1 s.d and 'n' analyses

[3] Respective archaeological sites are listed below each artifact number

[4] GLR = Gaspereau Lake Reservoir

3.4.2 Group II

Group two (Figure 3.6C & D) only contains two artifacts (64, 230). This group contains very low concentration relationships for the indicator elements and nearly matches the artifacts found in group three. These two artifacts have a low Ag vs Pb relationship (8.02 – 26.05 ppm vs 6.86 – 7.59 ppm), and moderate Hg vs Bi relationship (6.42 – 22.97 ppm vs 0.18 – 0.55 ppm). The relationship that makes group two unique however, is the concentration of Zn (53.06 – 144 ppm) vs that of As (50.4 – 87.81 ppm). Most of the other groups have much higher concentrations of Zn, generally double or higher the concentration of As, however in this case there is not as big of a range. Larger scale differences are seen in the concentration of Sn (0.083 and 13.1 ppm) as well as the relationships between Ag and Pb, (Figure 3.6C&D). Artifact 64, has a higher concentration of Ag with respect to Pb (26.1 vs 7.59 ppm), whereas artifact 230 has a very small relationship between Ag and Pb (8.02 vs 6.86 ppm).

3.4.3 Group III

Artifacts in groups one through four, are all different than the last six groups, as they all contain extremely low Ag vs Pb relationships, in some instances, there are even artifacts that have diagnostically high Pb and low Ag as is the case with group four. Group three (Figure 3.6E& F) has an interesting Ag to Pb relationship, as they are both present in almost equal quantities. In fact, artifact 8579 has a Ag concentration of 226 ppm and a Pb concentration of 212 ppm. Relationships between Hg and Bi are low, with Hg still being more enriched than Bi (0.38 – 27.63 ppm s 0.06 – 7.51 ppm), and Zn to As relationships that are still high (60.9 – 5921 ppm vs 1.54 – 127 ppm). In group three, the concentration of Sn (1.45 – 170 ppm) is greater than the concentration of Sb (0.05 – 8.16 ppm), however the Sb: Te relationships are lower than in the first four groupings which sets this group apart. The highest average concentration of Sb is 8.16 ppm and the highest concentration of Te is only 2.38 ppm, nearly four times higher. Artifacts 8566, 8579, 8580, 8594, and 8597, all belong to provenance group five. These artifacts show good homogeneity (Figure 3.5E& F) in the overall trace element patterns for the group, however very slight differences are seen in the ranges of Cd (0.25 – 11.8 ppm), In (0.002 – 2.86 ppm), Te (0.09 – 2.38 ppm) and Bi (0.06 – 7.51 ppm), yet if the patterns between Zn and As, as well as Ag and Pb are examined closer, we see the same continuous relationships, albeit at slightly higher or lower orders of magnitude.

3.4.4 Group IV

The fourth provenance group (Figure 3.6G & H) is characterized by high concentrations of As vs Zn (65.36 – 139 ppm vs 36.2 – 41.7 ppm), high Pb vs Ag (102 – 112 ppm vs 12.4 – 14.9 ppm), and high Hg vs Bi (3.23 – 7.19 vs 0.03 – 0.64) relationships. However artifacts classified in this group also have relatively high enrichments in Mo as compared with the rest of the copper collection (18 and 36 ppm). Indium, Te, Au and Bi are all comparable to the depletions of these elements in other artifacts (tenths to hundredths of ppm), yet the majority of the other artifacts have depletions of Mo as well. Artifacts 99 and 211 are the two sole artifacts that have anomalously high concentrations of Mo. The most notable differences in chemistry between these two artifacts is the difference in Sn and Bi concentrations. Artifact 211 has a greater concentration in Bi and Sn (0.64 ppm and 2.64 ppm respectively), making it have a lower Hg vs Bi relationship, and a higher Sn: Sb relationship as compared with artifact 99 which has 0.03 ppm Bi and 1.09 ppm Sn.

3.4.5 Group V

The fifth provenance group (Figure 3.7A &B) is where we begin the high Ag vs Pb relationships instead of the low Ag vs Pb or high Pb vs Ag relationships. This provenance group contains artifacts 2015, 1949, 5377, 8568 and 8569. Diagnostically high relationships for this group are seen in Ag vs Pb, Hg vs Bi, Zn vs As. The range of silver concentrations is between 87 and 281 ppm, whereas the range for Pb is significantly smaller and is only between 0.31 and 3.47 ppm. Hg values range between 0.06 and 386 ppm yet the Bi values are low again and only run between 0.01 and 0.1 ppm. The relationships between Zn and As are also favourable to Zn (24.1 – 157 ppm) when compared to the small range of As concentrations (1.24 – 8.52 ppm). What separates this group apart from group six, is the relationship between Sn and Sb. They share similar concentration ranges (0.13-0.45 ppm for Sn and 0.06 – 0.49 ppm for Sb) yet are significantly higher than those of Te which only range between 0.01 and 0.08 ppm. This is one of the groups that must be differentiated using the relationship between Sb and Sn, as it bears a strong resemblance to the chemistry of artifacts in the sixth provenance group. Differences are seen in the concentration of In (0.00 and 0.47 ppm) as well as the orders of magnitude in the concentration of Hg (Figure 3.7A &B), yet not different enough to separate them into other groupings at this time. When more sources are found to compare with, this group may be revisited.

3.4.6 Group VI

The sixth group (Figure 3.7C & D) contains artifacts RLAKE, 173, 820, 2158, 2225, 8572, and 8584. This group is characterized by high Ag vs Pb relationships (16.7 – 11458 ppm Ag vs 0.14 – 91.2 ppm Pb), high Hg vs Bi relationships (3.2 – 315 ppm Hg vs 0.00 –

1.28 ppm Bi), and high Zn vs As relationships (3.5 – 993 ppm Zn vs 0.71 – 43.7 ppm). Sn is also more concentrated than Sb and Te which is the separator between groups five and six. The relationship between Sn (0.09 – 5.53 ppm), Sb (0.04 – 1.5 ppm) and Te (0.01 – 0.82 ppm) is a linear decreasing one whereas in group five there is more scatter in the relationship between these three elements. Group six does not present with the best homogeneity as compared with the other provenance groupings, as there is variation in the orders of magnitude between each of the artifacts, as well as significant variation in Pb (0.14 – 91.2 ppm), Cd (0.04 – 5.87 ppm), In (0.00 – 0.27) and to a lesser degree, Zn (3.5 – 993 ppm). Artifact 820 also presents with diagnostically higher Au (0.003 ppm), as compared to the rest of the artifacts in this group after the reduction by Fe has taken place, however when looking at the artifacts not reduced by Fe (0.02 ppm) artifact 820 falls better into the grouping presented here.

3.4.7 Group VII

The seventh provenance group created (Figure 3.7E& F) has significantly higher Ag vs Pb (34 – 4494 ppm vs 0.13 – 5.22 ppm) and Hg vs Bi (0.54 – 86.3 ppm vs 0.00 – 0.11 ppm relationships, however the relationship between Zn (0.76 – 41.3 ppm) and As (1.17 – 41.4 ppm) is much smaller than the others. Sn is also much more concentrated in this group than in group eight, ranging between 0.32 and 3.45 ppm. After the Fe reduction had taken place, the orders of magnitude of trace element signatures are quite different (Figure 3.7E& F), however the patterns remain similar amongst the artifacts. Another notable difference in this group compared to the others is the enrichment of Te compared to Sb. In the majority of artifacts, the concentration of Sb (0.03 – 0.09 ppm) has often been higher than that of Te, yet in this group it remains the opposite with Te concentrations ranging between 0.04

and 0.19 ppm. Differences in the concentration of Cd (0.03 – 0.71 ppm) and In (0.00 – 0.54 ppm) are notable in the group, yet again, not significantly enough to warrant separation into additional provenance groups. Artifacts sorted into the seventh provenance group include 851, 859, 863A, 863B 8577, and 8581.

3.4.8 Group VIII

Artifacts 8610 and 8590 have chemistries different enough to warrant an additional provenance grouping (Figure 3.8A&B). This group contains a higher Ag (29.7 – 78.1 ppm) vs Pb (1.35 – 1.48 ppm) relationship, however the concentration relationship between Hg and Bi is unique to this group as the concentrations of Bi (1.63 and 0.21 ppm respectively) are higher than those of Hg (0.46 and 0.59 ppm respectively). Also notable relationships exist between Zn and As where Zn concentrations are 60.1 ppm for artifact 8610 and 80.7 ppm for artifact 8590, and As concentrations are 41.4 and 15.2 ppm for each respective artifact. Similar relationships exist in the relationship between Sn and Sb. Most other groupings show higher Sn or higher Sb, yet in group eight, the concentrations of these elements are very similar with Sn concentrations of 0.24 and 0.19 ppm, and Sb concentrations of 0.33 and 0.15 ppm for artifacts 8610 and 8590.

3.4.9 Group IX

Provenance group nine (Figure 3.8C &D) has diagnostically high Ag (14.4 – 559 ppm) to Pb (1.44 – 56.5 ppm) and higher Zn (78.8 – 1042 ppm) to As (6.1 – 112.3 ppm) relationships, with moderate to low Hg (0.28 – 5.41 ppm) to Bi (0.07 – 2.56) relationships. However the notable relationship in this group is that which exists between Sn (0.39 – 86.7 ppm), Sb (0.07 – 1.33 ppm) and Te (0.01 – 1.25). Even after the reduction by Fe has taken place (Figure 3.8D) there is still a significant enrichment in the concentration of Sn in this artifact group. Variation among this artifact group exists in the concentration of Cd (0.10 – 3.03 ppm), Te, and Au (0.00 – 0.25 ppm). Differences in the concentration of Pb are visible before the reduction by Fe (Figure 3.8C) had taken place yet afterwards, these differences are slight. Artifact 821 also contains a greater concentration of Au than in the other elements (0.25 ppm), however the remainder of the relationships in the other elements are well enough to include that artifact in this provenance group.

3.4.10 Group X

The final provenance group created from this study contains artifacts 8576, 8589, 8591, 8592, 8595 and 8598 (Figure 3.8E& F). This group is characterized by high Ag vs Pb (40.6 – 479 ppm vs 0.21 – 50.4 ppm), and Zn: As (19.2 – 1511 ppm vs 0.75 – 25.9 ppm) relationships. The tenth provenance group has a significantly lower Hg vs Bi relationship as compared with the others (0.29 – 1.63 ppm vs 0.06 – 0.89 ppm), as well as a decreasing relationship between Sn (0.28 – 23.2 ppm) Sb (0.04 – 1.05 ppm) and Te (0.02 – 0.46 ppm) which separates these artifacts from the previous group. Variation of this grouping exists between Pb (0.21 – 50.4 ppm) and Cd (0.06 – 2.89) and in some instances In (0.00 – 2.16 ppm). These variations are viewed in lesser extent after the reduction by each respective concentration of Fe (Figure 3.8F). Overall, the concentration relationships of Ag vs Pb and Zn vs As are still high after the reduction has taken place (Figure 3.8F), and many of the patterns are still similar, yet the differences and variations of most elements are only seen in the non-reduced versions of the trace element patterns(Figure 3.8E).

4.0 Discussion

4.1 Provenance Groups and Source Location

The final fifty seven copper artifacts were compared against the six native source locations, and the expectation was to see all of the trace element signatures match those of Michigan USA, based on previous studies performed (Hancock et al. 1997; Rapp et al. 2000; Levine, 2007; Cooper et al. 2008;). However upon comparison of trace element concentrations between all fifty three artifacts with six different samples from copper mines in Michigan, none of the artifacts in this copper collection were a match. The concentration of As in the Michigan samples relative to the other samples, was too high. When compared to the other samples, there were artifacts that match copper from Nova Scotia, European sources, and unknown locations. Table 4.1 summarizes all provenance determinations.

4.1.1 Cap d’Or

Provenance group V (Figure 3.3, artifacts 8566, 8579, 8580, 8582, and 8594) have trace element chemistry that match the samples from Cap d’Or. The artifacts have similar relationships of the indicator elements such as Ag and Pb, Hg and Bi, Ni and As. When not reduced by the Fe content (Figure 3.2) the artifacts in this provenance group appear to have similar relationships compared to the source samples, albeit in lower orders of magnitude. This could be attributed to a number of different factors, such as weathering and the production of corrosion material (Dussubieux et al. 2008), referred to in this paper as patina, exact area where the copper was collected (cliff face copper vs copper from the centre of the deposit) and treatment and conservation products. An argument for the use of Nova Scotian copper was made in the accounts of Samuel de Champlain when he and his

Table 4.1 Summary data table showing all artifacts and their resepective provenance groupings

Artifact	Archeological Site	Provenance group	Diagnostic elemental relationships	Provenance Location
2	Margaretsville	I	high concentration of all trace elements with	Europe
19	Burnt Bone Beach	I	emphasis on high Au	Europe
20	Burnt Bone Beach	I	high concentration of all trace elements with	Europe
21	Clam Cove	I	emphasis on high Au	Europe
819	Muskrat Cove	I	high concentration of all trace elements with	Europe
8604	GLR [1]	I	emphasis on high Au	Europe
8605	GLR	I	high concentration of all trace elements with	Europe
8606	GLR	I	emphasis on high Au	Europe
8607	GLR	I	high concentration of all trace elements with	Europe
8609	GLR	I	emphasis on high Au	Europe
818	Muskrat Cove	I	European copper zinc alloy	Europe
64	Clam Cove	II	low Ag:Pb, moderate Hg:Bi, Zn:As	Unknown I
230	Clam Cove	II	low Ag:Pb, moderate Hg:Bi, Zn:As	Unknown I
8566	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
8579	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
8580	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
8582	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
8594	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
8597	GLR	III	low Ag:Pb, Hg:Bi, high Zn:As	Cap d'Or
99	Isle Haute	IV	low Ag:Pb, high Hg:Bi, low Zn:As	Unknown II
211	Isle Haute	IV	low Ag:Pb, high Hg:Bi, low Zn:As	Unknown II
1949	Enfield	V	high Ag:Pb, Hg:Bi, Zn:As, low Sn:Sb	Unknown III
2015	Enfield	V	high Ag:Pb, Hg:Bi, Zn:As, low Sn:Sb	Unknown III
5377	Enfield	V	high Ag:Pb, Hg:Bi, Zn:As, low Sn:Sb	Unknown III
8568	GLR	V	high Ag:Pb, Hg:Bi, Zn:As, low Sn:Sb	Unknown III
8569	GLR	V	high Ag:Pb, Hg:Bi, Zn:As, low Sn:Sb	Unknown III
173	Jeddore Harbour	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
820	Muskrat Cove	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
2158	Enfield	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
2225	Enfield	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
8572	GLR	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
8584	GLR	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
RLAKE	Rafter Lake	VI	high Ag:Pb, Hg:Bi, Zn:As, moderate Sn:Sb	Unknown IV
851	Sellars Cove	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
859	Sellars Cove	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
8577	GLR	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
8581	GLR	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
863A	Sellars Cove	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
863B	Sellars Cove	VII	high Ag:Pb, Hg:Bi, low Zn:As	Margaretsville
8590	GLR	VIII	high Ag:Pb, Hg:Bi, moderate Zn:As	Unknown V
8610	GLR	VIII	high Ag:Pb, Hg:Bi, moderate Zn:As	Unknown V
821	Muskrat Cove	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
822	Muskrat Cove	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8567	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8573	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8574	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8587	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8596	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8599	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8603	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8608	GLR	IX	high Ag:Pb,moderate Hg:Bi, high Zn:As Sn:Sb	Unknown VI
8576	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII
8589	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII
8591	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII
8592	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII
8595	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII
8598	GLR	X	high Ag:Pb,moderate Hg:Bi, high Zn:As low Sn:Sb	Unknown VII

1. GLR = Gaspereau Lake Reservoir

French explorers visited what is now North America “I went to the river St John, to find the Indian named Secoudon… Having found him I begged him to accompany us to which he very readily agreed and came with us to show [the copper] to us…” (Biggar, 1992, in Levine, 2007). This historic passage dates back to 1604 when Champlain arrived in the Bay of Fundy, and affirms that local aboriginal peoples did have knowledge of native copper present in Nova Scotia. Other studies, namely Rapp et al. 2000; Levine, 1996, 2007a, 2007b; Hill, 2012, have all hypothesized that samples could come from Nova Scotia, however the samples used in those studies were from Cumberland County – where Cap d’Or is found. This limitation of samples from only one area of the province, can be misleading. At one time the pre-contact archaeologists believed that all copper came from Michigan, and we now know this not to be the case, so why limit all source copper samples to one area of this province? By sampling more copper deposits and copper occurrences in Nova Scotia, we’ve begun to create a larger copper database for comparisons with other artifacts.

4.1.2 Margaretsville

Source samples from Margaretsville contain diagnostically high concentrations of Ag. All artifacts that also contain high Ag concentrations and low Pb concentrations, were compared to the Margaretsville sources, however only provenance group I, was determined to match the Margaretsville copper. The artifacts from Margaretsville have trace element patterns similar to the native source samples but again the exact concentrations appear lower after the reduction by Fe. Similar to the Cap’ d’Or samples, this could be a function of weathering processes, and geochemical zonation in the copper being used. Dussubieux et al. (2008) also describe in depth how different elements such as Pb and Zn are distributed through copper samples that have been subject to major corrosion and how samples that have a thick coating of patina, tend to be preferentially depleted in Zn. In the case of the artifacts from Margaretsville, we see that as Zn is depleted from the samples, As is as well. These relationships are important to understand not only as geochemical signatures at the time of sampling, but also regarding how elements behave in the copper over time.

Also important in the understanding of trace-element patterns in copper, is how the people using the copper were working this malleable metal. Ethnologists, and historians have known for years that for people in North America, the best way to work with copper at the time, was to anneal it by rolling and hammering pieces together (Hancock et al. 1991; Fitzgerald et al. 1993; Hancock et al. 1995; Leonard, 1996; Erhrhardt et al. 2000; Bourque 2001; Fenn, 2001; Hancock et al. 2007; Lattanzi, 2007; Cooper et al. 2008; Erhrhardt, 2009; Cooper, 2011; Hill, 2012; Michelaki et al. 2013). This method as it did not involve heat, or smelting processes, would only account for element transfer to the outer coating of the copper artifacts, and would no contaminate all the way through to the core of the copper sample (Harbottle et al, 1982; Jackson, 1992; Fitzgerald et al. 1993; Junk, 2001; Kennet et al. 2001; Aeschliman et al. 2004; Hancock et al. 2007; Frame et al. 2013.) Trace element fingerprints for copper that has been smelted or alloyed – such as the samples from European sourced copper, are very easily distinguished from non-smelted copper (Turgeon, 1990; Fitzgerald et al. 1993, Whitehead et al. 1998; Levine 2007; Dussubieux et al. 2008).

4.1.3 European

Nine of the artifacts sampled, contained trace elements with chemistry that were well above the other forty six artifacts in terms of concentration. These artifacts were not sourced from samples found in North America and in fact come from the early contact period when aboriginal people were trading with the European settlers. Large copper-alloyed kettles were brought over by the French and Spanish (Mason, 1981; Turgeon, 1990; Hancock et al., 1991; Biggar, 1992; Fitzgerald et al., 1993; Hancock et al., 1995; Leonard, 1996; Wilson et al., 1997; Whitehead et al., 1998; Moreau & Hancock, 1999; Rapp et al. 2000; Bourque, 2001; Fenn, 2001; Glascock & Neff, 2003; Anselmi, 2004; Levine, 2007; Dussubieux et al., 2008; Ehrhardt, 2009; Cooper, 2011; Hill, 2012; Hodge et al., in preparation) and these "copper kettles were not as pure as the native American Copper (Turgeon, 1990; Fitzgerald et al., 1993; Moreau & Hancock, 1999; Dussubieux et al., 2008; Lattanzi, 2008;) as they had been smelted by the Europeans and other metals had now been contaminated into the copper. Much like the work done by Dussubieux et al. (2008) in this study, we discovered that certain elements, notably Fe, Cr, and S, were being over reported by the data reduction methods when the purity of copper was imputed as 99%. After seeing the over estimation of these elements, the artifacts were then analyzed by a SEM (Figure 2.1D) and it was determined that the concentration of copper was between 95 and 97 percent pure copper. After this had been changed the concentration of many of the trace elements remained orders of magnitude higher than those found in North America. These artifacts match sources from Spain, Germany and Sweden and refined European copper, copper- Zn alloys, and copper- Zn- Sn alloys (Hodge et al. in preparation). According to Turgeon (1990), aboriginal peoples would often reuse and recycle many of their goods into other things, and that is what I suggest has happened to the artifacts that match the European samples. Some of the samples that match the high copper-Zn alloyed metals, are consistent with brass kettles that were brought over by the French, and have been found in areas of the province (Turgeon, 1990; Hancock et al., 1991; Whitehead et al., 1998; Levine, 2007; Dussubieux et al., 2008).

4.1.4 Artifacts with undetermined provenance groups

Three different provenance groups formed in the study, were found to match three different source areas, two in Nova Scotia, and then one group from Europe which is consistent with the literature (Turgeon, 1990; Fitzgerald et al., 1993; Moreau & Hancock, 1999; Dussubieux et al., 2008; Lattanzi, 2008;). This still leaves seven provenance groups of the ten unaccounted for. One would think that there would be artifacts that match the Michigan samples as mentioned by other sources (Harbottle et al., 1982; Hancock et al., 1991; Ehrhardt et al., 2000; Rapp et al., 2000; Anselmi, 2004;Cooper, 2011; Michelaki et al., 2013; Abel & Burke, 2014), however in this study, all of the Michigan source samples contained higher than average concentrations of As, much too high to match any artifacts present in the collection from the Nova Scotia Museum. A much larger known copper source location database must be created using LA-ICP-MS methods in order to have a higher certainty and understanding of provenance determinations. Work on narrowing down the exact source locations of the European artifacts, is being continued by Hodge et al. (in preparation.) Emphasis must be placed on the collection of more samples from places in north eastern North America such as has been suggested by Levine (2007a; 2007b). Comparisons must be made against sources from Newfoundland, New Brunswick, Quebec, Maine, New York, New Jersey etc. and with hopes of the comparisons being made by LA-ICP-MS. By expanding the collection of source samples, exact provenance of the remaining seven groups could eventually be made. This would inform the reconstruction of trade networks as currently understood, as well as contribute to a deeper understanding of how local aboriginal people were evolving their copper technology. For anyone continuing studies such as this, expanding the database of sources is imperative.

4.2 Laser ablation as an archeological tool

The use of laser ablation in chemical analysis is not a new notion. There have been scientists using laser ablation as far back as the early 1980s (Gray, 1985; Jackson et al., 1992; Aeschliman et al., 2004). However only recently has it been put to the test in archaeology (Junk, 2001; Garrison, 2003; Aeschliman et al., 2004; Cooper et al., 2008; Dussubieux et al., 2008; Lattanzi, 2008; Hill, 2012). Dominant methods for chemical characterization of trace elements were, for the most part, X-Ray Florescence (XRF) (Harbottle et al., 1982; Wisseman et al., 1998; Fitzgerald et al., 1993; Kobyliński et al., 1993; Bendall, 2003; Garrison, 2003; Constantinescu et al., 2001; Rapp & Hill, 2006; Abel & Burke 2014) and Instrumental Neutron Activation Analysis (INAA) (Rapp Jr et al., 1984; Turgeon, 1990; Hancock et al., 1991; Fitzgerald et al., 1993; Hancock et al., 1995; Leonard, 1996; Whitehead et al., 1998; Levine, 1999; Moreau & Hancock, 1999; Rapp et al., 2000; Garrison, 2003; Glascock et al., 2003;Anselmi, 2004; Rapp & Hill, 2006; Hancock et al., 2007; Levine, 2007a, 2007b; Mulholland & Pulford, 2007; Cooper et al., 2008; Pevarnik et al., 2008; Erhardt, 2009; Klein et al., 2010; Frame et al., 2013; Michelaki et al., 2013). These methods were considered for the most part to be the most non-destructive methods for chemical characterization of historical artifacts – until now. XRF and INAA methods require small pieces (no less than 100mg) of the artifact to be removed such as filings, or scrapings of the artifacts, whereas LA-ICP-MS can be performed on the entire artifact as one intact piece. The challenge with mounting the entire artifact into the ablation cell, is that pieces that are mounted are restricted by their size in the cell

(McFarlane, 2013 pers. comm.) Some pieces such as tiny artifacts like 863A and 863B, can be held in paraffin wax in hollowed epoxy pucks as mentioned above, and others can be mounted in bricks of paraffin wax to allow for stability. Overly large artifacts can have small portions of their edges analyzed as well, as was the case with 8609. A piece of the artifact which had already been compromised (<0.05 mg), was loaded into the ablation chamber and analyzed in lieu of the entire pot. Neutron activation also has the bonus addition of radiation in its methodology which means samples that have been analyzed cannot be returned to the collection. (Glascock et al., 2003; Rapp & Hill, 2006). Using laser ablation in the above mentioned methods, artifacts were able to be loaded directly into the ablation chamber, analyzed and then returned to the collection (Figure 2.1). LA-ICP-MS methodologies also have the added benefit of being a method of conducting in-situ analyses and not just bulk analyses (Aeschliman et al., 2004; Dussubieux et al., 2008; Cooper et al., 2008; Hill 2012) This means that any micro-inclusions of other minerals can be identified, and if need be, excluded (Figure 3.9, 3.10), whereas bulk analyses of the artifacts by INAA does not allow for this component. As the majority of provenance studies have stated the Michigan has been the most important source of copper this again brings into question how precise the INAA methods may actually be (Rapp Jr et al., 1984; Turgeon, 1990; Hancock et al., 1991; Fitzgerald et al., 1993; Hancock et al., 1995; Leonard, 1996; Whitehead et al., 1998; Levine, 1999; Moreau & Hancock, 1999; Rapp et al., 2000; Garrison, 2003; Glascock et al., 2003;Anselmi, 2004; Rapp & Hill, 2006; Hancock et al., 2007; Mulholland & Pulford, 2007; Cooper et al., 2008; Pevarnik et al., 2008; Erhardt, 2009; Klein et al., 2010; Frame et al., 2013; Michelaki et al., 2013). If inclusions were present in the studies performed by the above mentioned authors, the data could have been potentially skewed in favour of Michigan, when in actuality, they matched samples from north-eastern North America. The only way to verify this hypothesis, would be to retest all of the artifacts analyzed by other authors using LA-ICP-MS methods and comparing the results to those obtained using INAA.

In terms of the ability of LA-ICP-MS to be a non-destructive method of trace-element analyses, the process of actually creating laser – ablation pits is ideal in comparison to methods such as XRF and INAA, as there is no need to drill into the artifact to obtain fresh copper. As the laser ablation occurred, it removed the layers of patina until the freshest copper of the core was exposed (Figure 2.1). Doing this leads to no visible or structural changes to the artifact, as pits are only visible at the microscopic level. Once the analyses of the artifacts were conducted, select artifacts were then verified using an SEM to determine if fresh copper had been reached (Figure 2.1 E & F), and in this case it was.

Limitations to LA-ICP-MS are notably the size of an artifact, and the appropriateness of standards created by analytical laboratories. Artifacts that were larger than the ablation cell, and did not have any already compromised edges, were excluded from the study as there was no adequate way to remove a piece of the artifact without compromising the structural integrity of the piece, this however can be avoided in the future as manufacturers of these machines have already begun to build larger and larger ablation cells (McFarlane, 2013 pers. comm.) Sizes and shapes of artifacts also presented limitations during analyses as irregular shaped artifacts had to be mounted in bricks of paraffin wax, but mounted in such a way as to still be visible and clear in the camera of the laser ablation chamber. Artifacts out of focus had to be removed from the cell, adjusted and then returned to try again this adds on to the sample preparation time, and eventually the analytical time which is not always the most cost-effective way to analyze the artifacts, yet it still provides more accurate readings (Glascock, 2003; Rapp & Hill, 2006; Dussubieux et al., 2008; Hill, 2012). The appropriateness of standards was an issue during the first round of analyses in June of 2013, whereupon it was discovered that standards from the National Institute of Standards and Technology (NIST) were not ablating the same way as normal native copper. The first standards were flakes of copper and as the laser was striking the flakes, they were not ablating small craters like what was happening to the artifacts. This meant having to search out new copper standards that had a wide variety of elements already quantified, like what was found with the standards from MBH lab. As these standards came as pucks, it was easy to cut off edges, and mount them in epoxy for analyses. Once analyses had begun, these standards were checked to see if the ablation method was working. After analyses, the new standard were compared against their standard concentration certificates to determine what elements were being reported by the laser in the correct and acceptable concentrations. Doing such a quality control check using laser ablation allows for more standards to be used in quantification to ensure the highest possible levels of accuracy for the concentration (Lattanzi, 2007; Dussubieux et al., 2008; Hill, 2012). Another way to ensure the best possible results for chemical characterization is to use LA-ICP-MS with other bulk methods such as solution ICP-MS, and INAA, much like the work done by Cooper et al., (2008); Dussubieux et al., (2008); and Hill, (2012). The down side to using multiple methods of comparison, is the cost that would be associated with multiple types of analyses. As its own standalone method, especially in terms of non-destructive, in-situ analyses, laser ablation appears to be the most appropriate method that we have today (Rapp & Hill, 2006; Lattanzi, 2007; Dussubieux et al., 2008; Hill, 2012).

4.3 Implications in archaeology

This study has attempted to address several questions, however it now seems to have posed more than answered. Questions such as: what tools the aboriginal peoples were using to shape their tools, and how those tools may have allowed for contamination to either the copper piece or the tool? Bourque (2001) suggests that the aboriginal people were using stone tools and implements to pull small pieces of copper out of outcrop and cliff faces. If this was the case, when they were using cold annealing techniques, how did they avoid getting small fragments of their stone tools in the copper, or did they? By using LA-ICP-MS we can now begin to analyze micro-inclusions in the copper artifacts and continue working with archaeologists to determine if the inclusions are fragments or slags from other pieces or if they are geological inclusions, something already implied by Lattanzi (2007) and Hill (2012).

How and where aboriginal people were procuring the copper, whether it be from outcrop, or as many suggest: float copper moved during glaciation time (Turgeon, 1990; Hancock et al., 1991; Fitzgerald et al., 1993; Hancock et al., 1995; Leonard, 1996; Whitehead et al., 1998; Levine, 1999; Moreau & Hancock, 1999; Rapp et al., 2000; Mulholland & Pulford, 2007; Michelaki et al., 2013). Biggar (1992) suggests that the aboriginal people were picking it up off the ground and along beaches, however if copper was being collected from specific outcrops – as this study suggests, especially with the Cap d'Or samples – did these specific outcrops have a spiritual significance or were they being accessed just out of need, or convenience?. If this was the case, economic questions of supply and demand are then posed, and whether or not the limited availability of copper for use encouraged larger trade networks amongst several aboriginal groups and not just necessarily other Mi’kmaq tribes. Turgeon (1990) talks in great detail about the significance placed on copper once it was in use, and how the Mi’kmaq were assigning spiritual meaning to different sources of copper. For example, aboriginal people believed that “red copper” – copper found and procured in North America was valuable spiritually and representative of blood, and that “yellow copper” – the higher Zn containing copper that was coming from the Europeans – was also special as it was unlike anything the Mi’kmaq could procure here (Turgeon, 1990). The findings in this study help to affirm that the Mi’kmaq did in fact highly value their yellow copper, as they would have been recycling and reusing it for other purposes. The artifacts in provenance group I have chemistries consistent with the literature for the type of copper being brought over by the Europeans as pots, even though the pieces look nothing like pots now. Larger pieces may have become damaged or no longer required and turned into something else, similar to what we see with the tinkling cone that is artifact 20. It is also possible that if one aboriginal group no longer needed specific copper items, they could have been trading with another group who then could have turned pieces into other things (Hancock et al., 1991; Turgeon 1991; Fitzgerald et al., 1993; Whitehead 1993; Hancock et al., 1995; Leonard 1996; Whitehead 1997; Rapp et al., 2000; Bourque, 2001; Fenn, 2001; Lattanzi, 2007; Cooper et al., 2008; Dussubieux et al., 2008; Ehrhardt 2009; Klein et al., 2010; Cooper 2011; Hill, 2012; Michelaki, 2013).

Further work should also be done with archaeologists and environmental geologists to study soil samples from the archaeological sites, and better understand the weathering processes. Doing this will help to ensure a better understanding of how elements such as Zn are “preferentially depleted” in highly weathered samples (Dussubieux et al., 2008) and how the trace elements may leech into the soil surrounding the immediate area the artifacts were uncovered. This could also be useful in better understanding how the reverse could happen, and trace elements from deep within the ground could begin to affect the chemistry of the patina coating an artifact, or even the artifact itself. This would be an additional check again to see if the patina of an artifact can be used to test for provenance and once again negate the requirement to have fresh exposed copper from an artifact.

5.0 Conclusion

The main goal of this study was to determine the geological provenance of copper used by the pre- to post-contact aboriginal peoples in Nova Scotia through non-destructive analytical methods. The ability to determine the original source of copper now contained within artifacts, and to discriminate between natural copper and copper of European origin helps to increase our understanding of the lives of aboriginal people, how they made objects of spiritual or functional value, where they travelled and who they traded with. Using a relatively non-destructive (compared to bulk methods used in other studies), it was possible to determine with an acceptable level of certainty, the provenance of approximately a third of the Nova Scotia Museum copper collection in this historical context. Three definitive groups were identified: two groups sourced from within what is now Nova Scotia (Margaretsville, and Cap d'Or) and one group of European-sourced copper (refined copper and copper-based alloys with Sn, Zn and other metals). These artifacts have been analyzed, and returned to the copper collection of the Nova Scotia Museum, to be curated for exhibits, and used again in future studies. No artifacts used in this study were compromised visually or structurally; there were no negative impacts to the value of these cultural objects. Rather, the study has provided an opportunity to develop positive insights concerning the copper procurement traditions of the Mi'kmaq who clearly utilized their own copper from outcrops in what is now Nova Scotia in conflict with the Lake Superior model, and concerning the trade and reuse of copper brought over by European settlers and explorers. Future work stemming from this project should include the creation of a larger database of source copper localities to explain (hopefully) the provenance of the remaining two thirds of the copper artifact collection that was not Michigan-sourced, nor from key copper areas of the

Bay of Fundy. Work in progress by Hodge et al. (in preparation) is narrowing down the sources copper used in the European artifacts. Increasing the size of the database for sources will aide us in understanding further copper was being gathered and how it moved to its final place in the possession of aboriginal peoples in Nova Scotia before its discovery through archaeological excavation. The project has raised several key questions that could be addressed through integration of the chemical provenance data and archaeological data as well as further study:

1. Why was Michigan copper not used? Did this reflect a lack of trading relationship with other groups that had access to this copper? Was NS copper preferred because it was easier to manipulate and work (i.e., small crystals vs. large float fragments) or was it preferred because of spiritual connection or tradition?
2. What are the sources to explain the seven unknown provenance groups? Were these local sources and if so, are the documented currently or historically? If they were sourced from other parts of what is now the Maritime region or north-eastern United States, how does this better inform us of the relationships between neighbouring aboriginal groups?
3. Can the diversity in sources for artifacts recovered at an individual archaeological site reflect reuse of copper sourced from different areas over generations? Are variations in source material represented in artifact populations linked to the age of a particular area of the site and do these variations reflect changes in the availability of copper from different localities with time?
4. Was NS copper more prevalent than previously thought? Given the limitations in bulk analytical methods discussed here, will reanalysis of samples from other sites

in North America by LA-ICPMS tighten constraints on copper provenance, revealing a greater role for copper from the Bay of Fundy region in North American aboriginal cultures prior to European contact?

5. Where was the copper in European objects originally derived? Can constraints on their provenance and the production history for refined metals in Europe in general allow a better understanding of the age of sites of habitation, contact and trade involving Mi’Kmaq and European explorers and colonists? Can the chemistry of refined copper fragments be used to identify the European nation that brought the original objects (e.g., trade kettles) to eastern Canada?

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Appendix A – Laser Ablation Data for Artifacts

Appendix A - Laser ablation ICMPS data for all analyses of all artifacts in order of analyses, standard used for quantification is listed below each element

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8569-1	2800	231	2.9	7	500	0.14	1.93	67	0.48	1.3	5.4	0.71	303	0.99	0.01	0.39	0.47	0.16	0.00	1.18	1.01	0.02
8569-2	810	224	1.7	7	140	0.12	1.1	26	0.10	-0.1	2.12	0.19	410	1.2	0.01	0.7	0.14	0.03	0.15	0.66	0.4	0.06
8569-3	550	189	0.75	1	42	0.08	1.24	18.3	0.22	0.6	1.31	0.41	220	0.15	0.01	1.70	0.2	0.01	0.02	0.64	0.46	0.02
8569-4	580	211	0.95	0.64	42	0.17	2.5	18	0.24	-0.04	1.38	0.1	56	0.12	0.01	0.04	0.16	0.03	0	0.64	0.14	0.02
8569-5	131	215	0.64	0.78	21	0.04	0.56	7.5	0.03	0.27	0.9	0.15	195	0.34	0.01	0.05	0.04	0.05	0	0.39	0.19	0.01
8569-6	340	250	1.58	1.19	210	0.04	1.3	15.3	-0.06	0.75	1.48	0.23	139	0.12	0	0.03	0.12	0.02	0	0.48	0.27	0.01
8569-7	92	267	0.38	1.38	70	0.04	0.6	7.4	0.27	0.31	0.86	0.24	272	0.06	0.01	0.03	0.08	0.08	0	0.42	0.12	0.02
8569-8	257	271	1.29	0.24	60	0.09	0.8	14.1	0.14	0.00	0.74	0.15	101	0.03	0	0.02	0.05	0.07	0	0.47	0.13	0
8569-9	480	194	1.03	0.97	28	0.16	0.58	34	0.20	-0.49	1.55	0.1	319	0.15	0	0.04	0.12	0.01	0	0.36	0.15	0.01
8569-10	880	215	1.4	4.4	200	0.21	0.71	27	0.16	0.37	1.61	0.08	1090	0.18	0	0.11	0.01	0.04	0	0.72	0.24	0.01
8596-1	17200	315	15.7	1080	680	2.7	47	369	2.63	1.17	14.4	0.18	19.6	0.53	0.04	0.78	0.14	0.05	0	0.34	1.92	0.68
8596-2	28700	536	23.1	750	630	2.98	77	500	3.70	0.69	16.5	0.16	10.4	1	0.05	0.83	0.48	0.1	0	0.41	2.67	0.04
8596-3	11300	328	10.1	150	320	0.7	5.2	157	1.12	0.65	8.7	0.24	12.6	0.55	0.01	0.38	0.21	0.05	0	0.26	4	0.05
8596-4	17100	393	11.7	150	270	1.64	10.7	159	1.67	0.37	8.6	0.14	4.5	0.82	0.02	0.18	0.22	0.01	0	0.19	1.36	0.04
8596-5	15000	367	10.9	630	168	0.97	11	121	0.68	-0.29	6.6	0.1	9.9	0.45	0.01	0.21	0.04	0.06	0	0.26	1.26	0.04
8596-6	13200	344	11.5	94	145	0.84	6.2	95	0.90	0.43	10.4	0.2	7	0.3	0.01	0.56	0.09	0.04	0	0.15	1.13	0.07
8596-7	45600	362	33.5	254	308	3.1	42	350	2.97	1	21.2	0.27	28.9	0.66	0.08	0.25	2	1	-0.01	0.39	4.1	0.09
8596-8	15200	351	10.9	135	152	1.03	4	170	0.96	0.33	16.3	-0.01	15.7	0.4	0.01	0.19	0.08	0.02	0	0.22	1.16	0.03
8596-9	20400	403	14.9	101	133	1.65	10.4	185	0.46	0.23	14.7	0.12	13.8	0.9	0.02	0.16	0.07	0.06	0	0.33	0.88	0.03
8596-10	50900	549	30.5	300	280	1.51	10.9	276	1.95	-0.06	21.3	0.04	17.1	2.19	0.01	0.32	0.15	0.16	0	0.21	3.4	0.25
8584-1	97200	286	7.9	214	150	0.47	3.5	211	2.3	0	38.5	0.36	2070	1.15	0.33	0.38	0.4	0.12	0.01	9	5.7	0.02
8584-2	153000	657	9.1	376	262	0.38	3.3	243	3.2	1	38.7	0.05	21900	0.82	0.02	0.45	0.36	0.05	0.01	21.6	1.87	0.03
8584-3	151000	671	10.4	656	980	0.4	9	325	5	0.15	34.2	0.17	5800	1.26	0.05	0.46	0.2	0.01	0.01	7.6	1.54	0.02
8584-4	127000	462	8.0	820	580	0.29	4.62	266	4.43	0.93	33	0.37	1230	0.97	0.01	0.21	0.39	0.1	0	10.9	3.3	0.06
8584-5	120000	401	7.36	557	1050	1.8	10.6	204	5.7	0.41	34.7	0.21	1330	0.72	1	1.8	0.31	0.17	0.01	7.9	2.6	0.14
8584-6	172000	731	9.2	920	640	0.37	4.3	410	10.9	2.4	31.7	0.41	1820	1.31	0.01	0.39	0.33	0.03	0.01	12	4.9	0.02
8584-7	180000	801	8.8	928	1150	0.1	4.2	356	5.61	0.61	30.1	0.38	1290	1.03	0.02	0.12	0.22	0.03	0.04	7	1.4	0.01
8584-8	173000	641	9.5	990	1270	0.16	5.4	329	5.3	0	27.8	0.67	1470	1.03	0.02	0.17	0.16	0.0	0.01	11	1.04	0.05
8584-9	158000	580	10.4	450	830	0.31	5.3	327	9.6	11	23.4	2.4	1290	0.85	0.01	7	0.13	0.05	0.25	25	1.8	2.3
8584-10	117000	325	6	210	430	2	1.3	202	2.32	0.52	32.4	0.39	770	3.4	0.03	0.19	4.1	0.12	0.01	21	25	0.65
8603-1	110000	61.9	5	200	820	0.22	4.9	860	2.17	0.27	29.6	1.26	13.3	0.88	0.40	1.9	0.18	0.01	0.01	0.42	1.71	0.11
8603-2	45900	106	1.34	24.1	79	1	1.7	326	1.11	0.34	9.5	0.34	15.2	0.35	0	0.13	0.06	0.01	0	0.17	0.4	0.02
8603-3	52300	87.5	2.02	37	101	0.29	5.2	372	0.92	-0.01	13.3	0.49	11.8	0.53	0.02	0.93	0.15	0.01	0	0.27	0.73	0.08
8603-4	38100	138	1.18	12.1	70	0.04	1.4	258	0.59	0.28	8.1	0.08	13.1	0.27	0.01	0.25	0.05	0.02	0.01	0.39	0.17	0.04
8603-5	121000	54.4	4.24	67	1400	3	6.2	883	3.10	0.38	22.9	0.92	14.4	0.94	0.14	1.6	0.15	0.04	0.01	0.42	17	0.3
8603-6	44200	127	1.53	12.7	158	0.44	1.95	281	0.7	1.1	9.5	0.05	21.4	0.3	0.01	0.14	0.09	0.01	0.02	0.34	3.8	0.09
8603-7	86600	72.4	2.35	33	580	0.42	2.16	570	1.2	0.07	14.7	0.39	22.2	0.48	0.01	0.16	0.23	0.04	0	0.21	0.49	0.02
8603-8	85100	91.2	2.54	41.6	1200	0.31	2.3	589	1.89	1.8	19	0.34	14.5	0.49	0.01	1.6	0.07	0.02	0	0.37	5.8	0.03
8603-9	63900	89.5	1.99	38	620	4	2.2	435	1.61	-0.04	12.13	0.37	19.3	0.66	0.22	0.62	4.6	0.02	0	0.27	0.75	0.02
8603-10	68000	135	2.61	62	4800	0.57	9	472	0.96	0.12	13.5	0.94	14.2	0.58	0.03	4.5	0.01	0.02	0.01	0.32	0.84	0.04
8595-1	92400	65.1	4.89	136	740	0.36	3	563	1.57	0.22	12	0.1	39	0.91	0.02	10	0.2	0.03	0.03	0.32	1.6	0.07
8595-2	45300	96.9	2.46	150	168	0.38	3.5	326	0.74	0.65	6.24	0.2	43.7	0.51	0.04	0.52	0.16	0.04	0.01	0.28	0.8	0.06
8595-3	20200	126	1.62	57	147	0.10	0.87	235	0.65	0.23	4.86	0.15	43.4	0.44	0.05	0.1	0.11	0.02	0.01	0.34	1.1	0.04
8595-4	32800	126	1.63	30	77	0.14	1.5	184	0.58	0.33	4.2	-0.17	43.9	0.38	0	0.18	0.14	0.02	0	0.35	0.45	0.04
8595-5	27700	155	1.48	50	160	0.03	0.8	268	0.73	0.57	3.64	-0.13	42.1	0.52	0.01	0.11	0.9	0.04	0	0.25	0.44	0.08
8595-6	20900	153	1.75	11	34	0.03	2	77	0.15	-0.2	2.7	0.02	35.2	0.17	0.01	0.14	0.04	0.02	0.01	0.21	0.22	0.01
8595-7	25500	131	1.22	45	101	0.11	1.4	177	0.39	-0.08	5.1	0.13	34.0	0.14	0.01	0.23	0.13	0.05	0.01	0.17	0.33	0.03
8595-8	46300	127	2.64	83	206	1	4.3	421	0.88	0.11	6.1	0.34	41.6	0.49	0.01	1.01	0.11	0.09	0.0	0.36	0.79	0.08
8595-9	31000	122	1.66	40	140	0.16	1.38	164	0.49	-0.02	4.8	0.15	42.7	0.28	0.02	0.07	0.15	0.08	0.01	0.32	0.75	0.08
8595-10	80900	109	4.34	200	430	0.55	3.63	486	1.5	0.42	9.16	0.2	25.3	1.01	0.03	0.61	0.53	0.07	0.01	0.33	1.6	0.18

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8592-1	83000	342	63	1890	3170	29	92	1800	11.4	1.2	32	0.73	167	4.4	4	3.9	3.3	1.3	0.02	0.4	12.4	0.42
8592-2	165000	1180	85	12400	41800	189	339	4300	113	21	97	11.2	243	6.9	1	10.2	5.4	1.29	0.22	3.34	230	2.11
8592-3	202000	3230	242	58000	208000	268	440	5200	600	85	106	12	480	5.2	3.18	215	3.8	1.3	0.24	7.7	236	4.3
8592-4	72000	93	5.29	380	470	1.19	6.1	422	3.02	1.6	21.6	0.36	2130	0.88	0.02	0.99	0.35	0.13	0.13	1.69	15	0.25
8592-5	46600	124	4.20	46	410	1.3	3.7	315	0.88	0.17	13.2	0.28	1290	0.65	0.09	0.38	0.28	0.87	0.06	0.65	3	0.11
8592-6	25800	142	1.92	19	109	0.33	1.8	172	0.32	0.02	9.4	0.19	450	0.3	0.07	0.15	0.17	0.07	0.01	0.33	1.06	0.07
8592-7	53000	164	3.24	32	174	0.69	1.94	276	1.01	0.37	12.1	0.08	3800	0.38	0.01	0.6	0.2	0.06	0.01	0.54	2.51	0.12
8592-8	21100	198	1.69	23	34	0.37	1.8	163	0.6	0.11	11.3	0.27	530	0.19	0.01	0.16	0.11	0.05	0.01	0.62	1.02	0.09
8592-9	22700	120	1.88	17.8	89	0.27	1.3	143	0.75	0.35	8.8	0.26	1000	0.32	0.01	0.24	0.22	0.07	0	0.42	0.75	0.07
8592-10	34900	120	2.84	96.0	130	1.9	5.1	315	1.84	0.36	15.6	0.24	1030	0.95	0.02	0.36	0.28	0.09	0.01	0.59	2.12	0.17
820-1	8500	223	0.35	2.77	2.65	0.06	1.7	53	0.06	0.3	7	0.19	97	0.1	0.01	0.26	0.12	0.04	0.03	5.35	0.90	0.01
820-2	940	189	0.05	0.39	0.38	1.9	0.1	7.9	-0.04	-0.11	1.77	0.14	470	0.12	0	0.08	0.04	0.01	0.04	9.55	0.08	0
820-3	316	189	0.03	0.96	0.22	0.17	1.3	13.1	-0.06	0.15	0.9	0.16	83	0.07	0.01	0.09	0.1	0.03	0.01	2.77	0.12	0
820-4	1200	257	0.22	4.4	0.46	0.25	0.1	17.5	0.06	0.6	2.89	0.28	93	0.02	0.01	0.06	0.06	0.04	0.01	5.06	0.01	0
820-5	1520	228	0.31	2.74	1.28	0.15	0.8	22.1	0.21	0.0	2.9	-0.03	99.7	0.05	0.01	0.09	0.16	0.01	0.01	2.05	0.03	0
820-6	2260	205	0.31	1.85	1.37	0.02	0.6	8.1	0.25	0.01	2.03	0.02	107	0.09	0	0.02	0.09	0.01	0	1.37	0.02	0
820-7	610	192	0.08	0.5	0.42	0.01	0.3	4.9	-0.09	-0.1	0.64	0.21	630	0.01	0.02	0.02	0.05	0.44	0.05	12.4	0.02	0
820-8	232	188	0.01	0.33	0.36	0.08	0	1.43	0.07	-0.01	0.43	0.18	349	0.03	0.02	-0.01	0.01	0.38	0	7	0.02	0.01
820-9	610	191	0.07	1.86	1.27	0.14	0.79	5	-0.01	-0.28	0.93	0.13	380	0.12	0	0.07	0.1	0.01	0.02	11.1	0.08	0
820-10	1300	262	0.26	1.34	3.58	2	0.57	12	0.15	-0.14	1.59	0.16	136	0	0	0.17	0.16	0.04	0.01	5.96	0.08	0.01
8610 - 1	10500	138	1.05	147	1790	0.15	0.67	139	1.26	0.22	75	0.18	14.7	0.14	0.01	0.32	0.62	0.01	0	0.38	3	0.16
8610 - 2	4300	157	0.31	50	1500	0.11	0.05	74	0.76	0.80	50	0.09	31.5	0.08	0	0.35	0.43	0	0	0.44	1.64	0.04
8610 - 3	4090	149	0.77	211	1130	0	0.71	124	0.67	0.17	50	0	27.1	0.02	0.01	0.36	0.56	0	0.01	0.52	1.39	0.01
8610 - 4	1100	141	0.11	19	40	0.02	0.03	29	0.18	-0.24	19.5	0.18	15.1	0.1	0.01	0.17	0.09	0.01	0.01	0.27	0.2	0.01
8610 - 5	400	152	0.13	44	170	0.03	-0.02	41	0.06	-0.09	26	0.12	13.8	0.03	0	0.16	0.21	0	0	0.31	0.54	0.01
8610 - 6	430	162	0.19	14	69	-0.01	1	51	0.08	0.73	36	0.19	20.6	-0.09	0.02	0.13	0.17	0	0.01	0.97	0.49	0
8610 - 7	840	140	0.45	34	59	0.12	0.64	23	0.21	0.40	58	-0.03	32.7	0.05	0	0.12	0.28	0.01	0	0.58	0.92	14.4
8610 - 8	1050	174	0.25	42	137	0	0.07	17	0.20	0.10	27	-0.03	41	0.03	0	0.06	0.13	-0.02	0	0.43	0.15	0.03
8610 - 9	700	139	0.79	20	156	0.09	3	60	0.17	-0.46	15.5	0.33	58	0.05	0.01	0.42	0.21	0.01	0.01	0.36	4.73	0.04
8610 - 10	950	172	-0.05	63	460	0.12	0.42	43	0.44	-0.10	57	0.14	43	0.01	0.01	0.28	0.59	0	0	0.35	0.46	0.01
8598 - 1	126000	102	24.2	370	2120	3	8	855	4.24	0.73	15.5	1.01	74.2	2.6	1.03	2.4	0.98	0.05	0.11	0.73	16	1.01
8598 - 2	83000	141	18.4	115	614	0.57	4	606	2.45	0.28	11.1	0.26	73.8	0.8	0.15	0.59	0.23	0.01	0.03	0.59	2.3	0.18
8598 - 3	64000	157	14.9	340	1230	0.77	4	492	1.80	0.54	8.4	0.27	60.9	0.73	0.05	0.64	0.09	0	0.01	0.57	2.4	0.13
8598 - 4	48700	183	11.5	78	285	0.47	0.67	294	2.50	0.44	8.3	0.37	72.3	0.46	0.22	0.56	0.1	0.01	0.02	0.43	1.8	0.1
8598 - 5	40800	165	8.5	43	184	0.18	0.93	318	1.02	0.15	6.32	0.17	66	0.34	0	0.44	0.15	0	0.03	0.35	0.81	0.09
8598 - 6	40200	205	12.8	109	380	0.23	1.17	317	2.09	0.34	5.7	0.15	60.8	0.42	0	0.64	0.13	0.01	0.03	0.39	1.6	0.11
8598 - 7	61300	269	17.1	190	450	1.62	2.5	437	2.96	0.58	10.5	0.03	104	0.79	0.02	0.98	0.14	0.01	0.02	0.49	2.22	0.14
8598 - 8	91600	147	38.4	149	580	1.5	4.6	626	2.58	0.42	14.2	1.1	119	1.64	0.24	3.4	0.19	0.03	0.05	0.67	3.4	0.14
8598 - 9	69300	118	34.8	114	422	1.1	2.42	518	2.38	0.34	11.8	0.22	114	0.72	0.21	0.73	0.18	0.03	0.03	0.49	1.51	0.18
8598 - 10	29600	165	23.5	143	310	0.25	1.16	280	1.18	0.70	4.9	0.22	39.4	0.21	0.01	0.76	0.13	0.04	0	0.36	1.17	0.14
8589 - 1	16000	127	-64	150	4380	0.34	1.24	279	2.20	1.57	5.43	0.44	530	0.38	0.23	0.72	0.36	0.05	0.02	0.89	83	0.54
8589 - 2	12000	145	-30.1	74	2140	0	0.46	113	1.05	1.15	3.6	0.36	390	0.4	0	0.68	0.14	0.09	0	0.84	69	0.36
8589 - 3	6300	131	-15.2	65	2590	0.22	0.56	77	0.87	0.19	3.7	0.33	380	0.13	0	0.20	0.14	0.03	0.01	0.86	34.4	0.18
8589 - 4	4860	126	-10.4	37.1	1650	0.21	-0.02	128	0.95	0.8	3.2	0.67	432	0.25	0	0.58	0.26	0.08	0.03	0.79	23.3	0.19
8589 - 5	3700	150	-6.9	23	1100	0.17	0.74	88	0.4	0.55	1.62	0.56	579	0.29	0.06	0.40	0.11	0.01	0.01	0.63	10.2	0.22
8589 - 6	5400	171	-5.9	52	3800	0.05	0.25	105	0.81	0.38	3.8	0.29	421	0.22	0	0.25	0.20	-0.01	0.01	0.85	18.9	0.33
8589 - 7	3090	151	-4.9	21.5	1290	0.21	0.47	55	0.34	0.04	1.8	0.38	203	0.08	0	0.1	0.07	0.03	0.01	0.9	17.2	0.07
8589 - 8	2190	163	-2.5	36	800	0.02	0.84	59	0.4	-0.03	1.4	0.36	257	0.01	0.01	0.04	0.01	0.05	0.04	0.52	11	0.2
8589 - 9	4900	177	-16	36	2330	0.27	0.4	63	0.98	-0.09	1.58	0.18	259	0.12	-0.01	0.09	0.06	0.05	0	0.73	47	0.13
8589 - 10	1420	164	-1.32	11.7	3200	0.05	0.15	16.1	0.13	0.19	0.77	0.28	144	0.03	0	0.05	0.04	-0.01	0	0.48	5.7	0.06

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8590 - 1	130000	79.3	-23.1	59	1470	0.21	1.15	111	3.69	0.15	22.7	0.29	55	0.22	0.01	0.23	0.18	0.02	0.01	0.64	1.39	0.29
8590 - 2	115000	103	-14.7	39	960	0.22	0.64	92	2.72	0.13	17.1	0.28	60.4	0.17	0	0.24	0.17	0.11	0.01	0.57	1.11	0.19
8590 - 3	90500	119	-10.6	14.2	780	0.13	0.57	84	1.98	0.36	17	0.13	53.3	0.17	0	0.1	0.1	0.05	0.01	0.47	0.74	0.18
8590 - 4	105000	135	-8.6	13.8	621	0.04	0.66	85	1.75	0.38	14.6	0.02	42.4	0.14	0	0.11	0.11	0.14	0.01	0.45	0.77	0.08
8590 - 5	110000	113	-11.8	19	800	0.17	0.17	84.7	2.54	0.19	18	0.13	42	0.15	0	0.06	0.11	0.11	0.02	0.55	0.95	0.15
8590 - 6	94200	119	-8.9	17.4	1030	0.09	1.43	73.7	1.99	0.24	12.9	0.19	219	0.11	0	0.19	0.16	-0.04	0.01	0.72	2.37	0.13
8590 - 7	118600	100	-13	66	1330	0.16	2.06	108	2.86	-0.02	19.3	0.2	44.2	0.19	0.01	0.24	0.37	0.18	0.01	0.65	2.2	0.27
8590 - 8	105000	141	-10.4	24	1060	0.22	1.25	71	2.23	0.69	13.5	0.11	97.2	0.22	0.01	0.09	0.09	-0.03	0.01	0.53	1.45	0.28
8590 - 9	87000	161	-9.6	66	1200	0.29	1.2	60	1.82	0.15	11	0.17	83	0.07	0	0.2	0.14	0.17	0.01	0.6	1.49	0.38
8590 - 10	52000	157	-5.3	21.2	800	-0.01	1.3	37.4	0.81	0.4	5.9	-0.04	84	0.26	0	0.42	0.13	0.62	0.01	0.73	2.33	0.17
002 - 1	420	235	2.36	43	1220	1.2	135	7700	1.06	-0.25	134	2.49	270	4.72	0.05	31.2	6.90	0.66	0.79	265	384	1.1
002 - 2	146	212	1.49	25.3	980	0.92	88	4840	0.5	0.12	99	0.82	558	2.97	0.03	19.4	3.6	0.57	0.77	81	256	0.74
002 - 3	182	224	0.91	4.6	300	0.85	121	6800	0.14	0.18	194	0.53	367	7.36	0.04	21.6	12.6	0.76	0.88	96	766	1.38
002 - 4	570	259	4.2	87	2100	2.33	256	13100	1.41	0.28	250	4.2	372	8.9	0.05	27	12.3	0.96	0.75	217	756	1.08
002 - 5	93	227	0.39	7.4	260	0.36	65.1	3800	0.27	0.09	93	0.43	423	2.77	0.04	21.8	4.3	0.36	0.96	60	408	1.15
002 - 6	256	276	2.85	91	4490	3.03	161	7740	3.11	1.25	97	1.01	582	4.08	0.04	19.9	4.8	0.87	1.05	88	261	1.32
002 - 7	306	257	2	59	1670	1.64	169	8800	0.91	1.57	159	1.74	850	5.57	0.04	25.7	5.68	1.4	1.41	147	770	2.56
002 - 8	266	235	1.31	26	1330	0.85	161	7680	0.4	0.32	310	1.35	462	7.71	0.04	30.3	10.3	0.92	1.02	153	1137	1.76
002 - 9	146	228	0.79	7.2	208	0.45	101.1	5000	0.23	0.11	177	0.34	405	5.25	0.02	20.2	7.9	0.6	0.68	41	856	0.86
002 - 10	198	217	1.21	5.7	320	0.51	126	6670	0.22	-0.31	259	0.34	325	7.75	0.05	24	14	0.78	0.77	119	1480	2.60
2015 - 1	6500	179	0.17	7.1	78	0.01	0.32	59.4	0.19	0.39	1.74	0.15	129	0.14	0	0.08	0.08	0.04	0	140	0.69	0.01
2015 - 2	5260	214	0.12	7.6	39	-0.02	0	39.8	0.18	0.33	1.46	0.08	183	0.07	0	0.15	0.02	0.02	0	99	0.32	0
2015 - 3	3930	170	0.19	7.7	53	-0.01	0.33	48.9	0.14	-0.04	1.17	0.08	403	0.07	0	0.18	0	0.02	0	94.4	0.49	0.01
2015 - 4	5860	188	0.40	8.2	81	0.02	-0.21	47.3	0.09	-0.07	1.28	0.27	318	0.16	0	0.05	0.03	0.03	0	89	0.43	0
2015 - 5	3660	165	0.09	6.5	44	-0.01	0.19	38.2	0.11	-0.1	1.27	0.05	144	0.15	0	0.04	0.01	-0.02	0	233	0.51	0.01
2015 - 6	6290	181	0.42	7.8	129	0.03	0.03	58.0	0.17	0.28	2.09	0.12	217	0.16	0.01	0.43	0.07	0.01	0.01	264	1.03	0.01
2015 - 7	3530	197	0.19	7.22	84	0.02	0.38	48.2	0.19	-0.1	1.47	0.17	354	0.16	0	0.23	0.08	0.03	0.01	128	0.51	0.01
2015 - 8	4800	204	0.28	8.4	84	-0.03	0.05	64.0	0.19	0.06	1.05	0.09	226	0.17	0	0.13	0.01	0.07	0.01	113	0.29	0.01
2015 - 9	2330	171	0.22	2.22	16.2	-0.04	0.05	26.8	0.1	-0.11	0.92	0.1	248	0.06	0	0	0.03	0.04	0.01	60	0.14	0.01
2015 - 10	32700	324	5.33	910	9400	3.16	7.9	174	1.86	0.43	5.7	0.1	256	0.69	0.01	1.09	0.22	-0.01	0	240	1.48	0.07
2158 - 1	5440	182	0.19	7.6	45	0.01	0.45	38.7	0.16	0.11	1.03	0.22	225	0.07	0	1.86	0.1	0.01	0	82	0.55	0.01
2158 - 2	4200	173	0.33	10.1	39.3	-0.01	0.65	21.8	0.12	0.11	1.22	0.08	132	0.24	0	0.26	0.23	0.02	0.01	46.2	1.5	0
2158 - 3	4630	197	0.33	9.3	57	0.04	1.29	29.8	0.14	-0.1	1.05	0.25	307	0.92	-0.01	0.36	0.07	0	0	134	0.28	0
2158 - 4	3360	170	0.31	6.88	12	0.03	0.41	24	0.15	0.06	1.24	0.19	479	0.69	0	0.45	0.22	0.04	0	58.2	0.19	0
2158 - 5	3460	192	0.23	6.1	26	0.02	0.42	37	0.13	-0.12	0.87	0.52	337	0.34	0.01	0.45	0.06	0	0	92	0.17	0
2158 - 6	2020	171	0.11	2.71	9	0.01	1.28	17	0.16	0.16	0.67	0.22	262	0.11	0	0.26	0.03	0.04	0	53.7	0.14	0.07
2158 - 7	3920	171	0.1	6.3	13	0.18	0.13	29	0.18	0.4	0.88	0.07	212	0.21	0	0.17	0.05	0.0	0	50.9	0.22	0
2158 - 8	5670	180	-0.05	11.9	58	0.18	0	43	0.19	0.08	0.87	0.15	167	0.2	0.01	0.06	0.03	0.03	0	60.3	0.18	0.01
2158 - 9	3890	157	0.2	26	17	0.01	-0.27	32	0.19	0.21	0.31	0.21	68.4	0.08	0	0.01	0.05	0.06	0	56	0.14	0.02
2158 - 10	7400	172	0.05	8.1	34	-0.04	0.58	58	0.14	0.13	1.57	0.1	127	0.16	0	0.09	0.1	0.05	0	218	0.66	0
064 - 1	1250	224	0.41	38	330	0.43	2	70	0.37	0.45	24.8	0.57	6.04	0.39	0.01	28	0.17	0.08	0.03	11.1	9.4	0.03
064 - 2	4140	303	0.59	89	301	0.26	1.16	50	0.55	0.31	64.8	0.62	64.5	0.87	0.01	21	0.23	0.01	0.01	10.9	9	0.03
064 - 3	720	275	0.11	10.5	49	0.08	0.33	9.7	0.15	0.18	12.9	0.57	25	0.29	-0.01	2.05	0.06	0.07	0	5.62	1.86	0.01
064 - 4	2210	280	0.6	33	231	0.22	0.93	91	0.49	0.31	37.4	0.66	59	0.54	0.02	2.9	0.09	0.07	0.01	10.3	3.1	0.03
064 - 5	13980	518	1.26	1420	1860	2.59	5.6	103	1.84	0.43	131.7	0.85	10.9	1.88	0.02	16	0.19	-0.09	0.01	30.7	6.08	0.04
064 - 6	19100	432	1.9	1380	2360	2.02	6.1	134	2.4	0.94	125	0.66	13.5	2.59	0.12	7.1	0.19	0.22	0.02	39.5	6.52	0.16
064 - 7	19400	1340	23.4	2480	14700	20.9	66	550	15.8	3	213	1.41	19.8	2.95	0.1	24.3	0.62	0.16	0	26	19.1	0.16
064 - 8	11300	517	1.59	900	1500	2.03	4.8	119	1.95	0.19	89.2	0.79	15.7	1.85	0.27	6.4	1.9	0.09	0	32.2	7.9	0.24
064 - 9	10800	460	1.73	1700	2230	3.14	8.4	174	2.62	0.87	91.5	1.8	20.0	2.1	0.18	9.8	0.38	0.27	0.01	40.4	5.34	0.9

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
851 - 1	750	213	0.03	1.04	5.10	-0.15	0.06	0.8	0.04	0.46	1.04	-0.03	22.1	-0.02	0.01	0.33	-0.01	0.02	0	9.9	0.05	-0.01
851 - 2	610	181	0.17	0.58	3.36	0.04	0.87	0.79	-0.02	-0.19	1.18	0.1	31.8	-0.02	0	1.52	0.03	-0.05	0.01	8.04	0.08	0
851 - 3	590	184	-0.05	0.56	5.30	0.18	0.18	0.91	0.11	0.12	1.07	0.0	41.7	-0.03	0	1.09	0.1	0.04	0.01	6.92	0.07	0.01
851 - 4	570	188	0.03	-0.23	5.70	0.06	0.72	0.17	0.02	0.37	1.19	0.03	25.3	0.01	0	1.52	0.03	-0.04	0	11	0.09	0
851 - 5	418	181	0.11	1.13	4.1	-0.08	0.34	0.78	0.16	-0.45	0.66	-0.01	36.9	0.01	0.01	1.05	-0.02	-0.02	0	7.31	0.09	0.01
851 - 6	480	169	0.15	0.25	6.2	-0.11	0.11	0.74	0.21	0.25	0.84	0.07	26.6	0.02	0	1.47	0	-0.03	0	7.16	0.08	0
851 - 7	357	159	0.15	0.6	4.7	0.07	0.24	1	0	0.13	0.94	0.15	24.6	0.07	0.02	9.7	-0.01	0.31	0.01	7.06	0.58	0
851 - 8	537	159	-0.02	0.72	8.4	0.08	1.4	0.45	0.02	0.19	1.53	0.05	20.2	0.02	0	0.39	-0.03	0.21	0	8.9	0.11	0
851 - 9	610	160	-0.04	0.68	7.3	0.02	-0.15	1.22	0.03	0.21	1.78	-0.01	61.9	-0.07	0	0.33	0.02	0.17	0	8.35	0.08	0
851 - 10	470	160	0.11	0.89	7	-0.07	-0.48	0.72	0.06	-0.05	1.46	0.07	52.1	0.04	0	0.24	0.01	0.07	0	9.32	0.06	0
822 - 1	1990	323	1.16	330	2850	1.21	4	230	0.76	-0.5	14.9	0.39	101	0.31	0.42	430	1.04	0.18	0.52	2.44	36	0.71
822 - 2	4470	447	2.55	76	5600	0.76	3.1	184	4.3	1.3	6.9	0.23	108	0.29	0.04	33	0.23	-0.1	0.2	1.53	8.2	0.24
822 - 3	545	172	0.28	11.5	220	-0.01	0.29	48.3	0.25	0.29	0.8	0.04	32.8	0.07	0.01	6.05	0.07	-0.1	0.04	0.63	0.78	0.03
822 - 4	617	150	0.2	3.26	220	0.04	0.36	46.8	0.15	0.21	0.82	-0.04	32.7	0.09	0	2.76	0.06	-0.08	0.02	0.49	0.66	0.07
822 - 5	8300	517	4.2	235	13100	5.5	14.1	311	3.92	1.1	16.4	2.8	87.5	0.11	0.09	56	7.7	-0.09	0.37	2.4	23.4	0.53
822 - 6	950	304	1.46	45.7	663	0.22	2.1	149	0.61	0.32	2.58	-0.15	78	0.19	0.03	20.7	0.26	-0.2	0.21	1.76	3.45	0.25
822 - 7	6100	531	2.2	480	5200	0.79	6.3	500	3.4	0.8	8.5	0.76	81	0.24	0.3	260	0.75	-0.45	0.63	2.87	23.4	0.46
822 - 8	5700	401	2.9	66	3100	0.58	2	400	2.72	-0.8	8.6	0.86	149	0.27	0.07	51	0.63	-0.14	0.47	2.25	8.9	0.39
822 - 9	900	164	0.57	11.8	290	0.07	0.92	55.5	0.71	0.11	0.88	0.11	25.9	0.09	0.01	5.23	0.05	-0.06	0.03	0.66	1.01	0.05
822 - 10	854	153	0.19	2.49	123	0.05	0.43	43.8	0.33	0.04	0.61	0.06	210	0.02	0	2.7	0	-0.05	0.02	0.34	0.52	0.01
8582 - 1	90200	114	35.6	1270	4300	1.41	6.9	816	4.46	1.7	15.8	0.67	50.6	3.4	0.06	5.2	1.02	0.44	0.03	0.34	6.6	0.26
8582 - 2	88000	217	43.2	1250	3300	2.5	8.9	732	2.91	5.7	18.2	1.3	52.3	13.2	3.2	1.03	3.8	2.1	0.14	0.48	80	0.24
8582 - 3	62300	240	30.2	1020	1670	1.03	7.83	480	2.03	0.38	9	0.42	35.4	5.81	0.15	2.9	0.3	0.4	0.02	0.17	7.5	0.58
8582 - 4	45800	323	46.8	3180	5100	2.44	13.7	460	6.4	1.37	13.3	0.48	31.2	11.4	0.08	2.52	0.62	0.11	0.01	0.42	11.3	0.16
8582 - 5	58100	308	55.4	2850	2240	2.37	19.5	565	4	2.8	9.1	0.25	31.3	28.9	0.04	1.21	0.21	0.0	0.02	0.75	5.2	0.13
8582 - 6	38400	326	74.4	1680	970	1.9	11.8	327	2.01	0.26	4.8	0.28	30.6	16.7	0.01	0.81	0.16	-0.02	0.02	0.3	4.7	0.09
8582 - 7	54400	243	50.8	1030	618	1.23	9.4	342	2.06	0.7	8.4	0.37	33.7	9.25	0.08	0.51	0.15	1.8	0.08	0.17	3.09	0.68
8582 - 8	41800	349	91	1510	730	2.03	12.2	345	1.96	0.09	5.2	0.24	18.6	12.3	0.01	1.32	0.1	0.18	0.02	0.21	2.62	0.05
8582 - 9	71300	315	142	1400	1210	0.93	9.2	600	3.29	0.9	8.7	0.27	18.6	13.1	0.01	0.71	0.12	0.07	0.01	0.38	4.5	0.09
8582 - 10	154000	180	107	780	1000	0.88	4.41	910	3.38	0.6	16.6	0.24	46.5	4.2	0.06	0.4	0.27	0.19	0.11	0.55	5	0.2
8594 - 1	126000	145	-289	860	8600	7.4	21	490	27	7	25.5	1.05	148	3.2	1.7	11.4	2.2	0.22	0.18	0.78	90	1.38
8594 - 2	49000	183	-85	303	3060	1.71	6.9	129	11.7	3.4	11.3	0.44	36.4	0.48	0.58	4.4	0.4	0.52	0.02	1.14	36	3.52
8594 - 3	86000	275	-204	1230	10700	5.6	26	660	35.3	8.9	37	1.54	90	1.5	3	9.2	3.7	3.5	0.16	2.11	67	3.21
8594 - 4	50600	156	-79	360	3950	2.35	7.1	179	11.7	2.28	14.2	0.65	89.1	0.66	1.6	6.2	1.09	0.71	0.09	0.47	49	1.36
8594 - 5	38400	193	-33.8	204	1760	1.6	4.4	130	5.6	1.38	7.4	0.79	132	0.59	0.42	2.4	0.61	0.53	0.11	0.43	20.7	0.98
8594 - 6	40900	162	-38	154	1590	1.6	3.4	81	8.7	1.2	7.6	0.69	139	0.28	0.05	1.81	0.28	0.37	0.17	0.62	26.2	0.52
8594 - 7	49500	145	-30	155	1810	1.35	3.6	106	6.5	1.43	6.9	0.35	106	1.2	0.34	3.7	0.68	0.58	0.02	0.47	40	1
8594 - 8	20500	176	-14.9	55	730	0.44	1.46	41	2.5	0.48	3.59	0.16	65.6	0.21	0.02	0.99	0.66	0.55	0.01	0.4	8.4	0.4
8594 - 9	70100	208	-70	367	3380	3.29	9.2	218	16	3.7	15.7	1.7	112	0.36	3.5	8.9	1	0.46	0.04	1.15	39	0.98
8594 - 10	58500	189	-35.2	218	2700	2.1	4.3	121	13.1	2.4	8.8	0.32	108	0.37	0.29	2	0.1	-0.01	0	0.66	19.3	1.7
173 - 1	343000	450	-52	1080	2160	2.14	5.8	830	8.8	1.76	48.8	0.69	480	6.2	0.04	1.82	1.37	0.82	0.05	140	37	0.87
173 - 2	530000	4100	-303	3800	25900	54	135	2020	65	11.1	65	1	560	11.5	0.23	6.6	1.9	2.5	0.02	283	96	2
173 - 3	212000	667	-101	860	6150	9	28	598	16	2.71	39.6	0.29	313	4.5	0.14	4.2	1.05	0.8	0.02	116	44.3	1.43
173 - 4	212000	1110	-271	1490	21100	32.4	101	830	30.7	5.1	34.9	0.44	317	4.52	0.13	5.7	0.87	0.68	0.04	120	34	0.82
173 - 5	270000	3380	-238	2300	22200	26.4	87	1130	36.1	6.1	30.5	-0.03	218	5.43	0.13	6	1	1.1	0.03	100	62.4	0.8
173 - 6	325000	1030	-387	3850	45900	59	165	1180	41.2	8.5	46.1	0.13	530	5.6	0.18	5.7	1.32	0.18	0.02	139	76	0.86
173 - 7	148000	1590	-343	1830	34200	35.2	89	750	38.2	5.6	30.2	0.18	216	4.45	0.17	5.5	0.84	-0.11	0.01	84	45.4	0.71
173 - 8	325000	145	-34	339	2080	0.83	2.01	814	4.08	0.6	45.2	0.29	477.0	3.7	0.44	0.32	1.07	0.5	0.02	161	16.30	1.43
173 - 9	305000	293	-206	5800	18700	5.7	16.6	790	24.1	7	53.8	2.43	497.0	6.9	0.43	13.9	4.05	0.01	0.13	204	410	2.63

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
230 - 1	6190	200	223	143	8200	3	2.3	112	2.58	0.86	50.3	5	7.1	1.7	0.21	1	0.28	0.07	0.02	6.14	9.8	0.46
230 - 2	6390	188	102	36.1	3840	0.69	1.43	24	1.41	0.67	52.7	3.12	6.8	0.73	0.12	0.57	0.13	0.14	0.02	5.9	3.66	3
230 - 3	7700	258	75	91	5900	1.1	2.8	20	2.15	1.11	45.6	2.75	6.8	0.52	0.4	0.5	1.0	0.79	0.05	7.6	4.80	0.79
230 - 4	6500	173	81	121	6100	2.5	3.57	129	1.45	2.3	39.5	5.2	10.6	0.83	0.32	1.06	1.4	0.25	0.11	5.13	15.6	0.24
230 - 5	6850	227	60.1	252	11200	2.32	6.9	28.1	3.13	1.6	42.7	2.58	8.3	0.56	0.15	0.86	0.16	0.8	0.04	6.5	4.08	0.12
230 - 6	5100	168	23	270	5400	2	4	100	1.76	0.61	29.4	1.99	9.9	1.9	0.14	1.8	0.89	0.87	0.11	6.5	10.7	0.29
230 - 7	5260	172	30.5	302	8000	1.4	3.16	63	2.5	1.07	42.7	1.89	8.7	0.64	0.57	0.42	0.1	0.7	0.03	6.16	4.9	0.19
230 - 8	7500	250	23	76	2950	1.9	1.47	18	1.43	1.25	39.1	2.73	9.9	1.06	0.31	0.82	0.18	0.61	0.04	8.3	4.9	0.11
230 - 9	5710	211	27	58	3840	0.66	2.2	16	1.58	1.33	71.2	2.90	5.85	0.66	0.05	0.66	0.31	0.23	0.01	6.3	3.59	0.13
230 - 10	5730	212	23.7	52	3860	0.73	1.35	20.8	1.48	0.83	90.6	3.58	6.27	0.74	0.01	0.56	0.15	-0.02	0.02	5.73	6.6	0.15
021 - 1	17	135	0.3	1.9	2.1	-0.08	5.8	3.4	-0.62	0.8	-0.14	0.68	11.42	0.06	-0.01	0.74	-0.11	-0.8	-0.01	4.44	0.4	-0.02
021 - 2	1370	272	0.97	11.7	58	0.05	0.23	14.7	0.17	0.39	11.7	0.57	18.5	0.58	0	0.29	0.09	0.01	0	1.83	2.85	0.15
021 - 3	1980	240	1.17	12.5	372	0.38	0.63	7.14	0.18	0.35	4.62	0.32	184	0.02	0.01	0.13	0.04	0	0	2.56	0.52	1.33
021 - 4	530	246	0.63	17.2	41	0.07	0.65	12.8	0.12	0.01	3.55	0.11	216	0.19	0.02	0.41	0.07	0.27	0.01	2.11	2	0.05
021 - 5	29	279	4.8	746	8190	5.83	15.5	105	5.44	2.3	0.85	-0.08	143	0.21	0.02	1.1	0.1	1.2	-0.01	11.1	1.65	0
021 - 6	15	207	-0.2	-0.4	4.5	-0.13	-0.5	9.2	0.1	0	0.86	-0.03	229	0.02	0	1.88	0.21	0.3	0.03	10.2	0.65	0.02
021 - 7	11	139	-0.4	-0.8	2	0.21	-5.2	2.7	-0.16	1	0.37	-0.21	200	0.06	-0.01	0.96	-0.19	1	0.01	5.12	0.25	0
021 - 8	460	250	0.32	4.17	11.7	0.06	0.34	7.9	0.15	0.16	5.11	0.69	219	0.19	0	0.25	0.03	0.15	0.01	1.57	1.23	0.01
021 - 9	149	250	0.18	2.24	8	0.11	-0.62	4.6	0.03	-0.01	2.14	0.26	329	0.11	0	0.11	0.05	-0.08	0.01	2.54	0.48	0.43
021 - 10	17300	309000	440	9200	366000	1340	9300	7900	410	310	3440	190	2950	170	5	264	240	510	44	5500	2310	291
19a - 1	5120	245	1.94	289	31800	13.2	214	256000	4.74	1.94	853	0.70	560	0.78	22.8	1180	280	1.36	21.6	4.76	24200	33.5
19a - 2	2350	300	1.14	130	22300	27.7	320	594000	3.54	1.38	536	0.67	499	2.27	12.6	525	199	0.29	12.85	5.33	21200	19.3
19a - 3	3140	302	2.4	226	30200	24.6	307	543000	3.31	1.62	671	0.64	530	2.14	11.4	551	217	0.57	11.66	4.71	26900	24.8
19a - 4	562	182	0.87	78	6060	14.3	156	322000	1.58	-0.18	348	0.21	608	1.49	18.2	758	161	1.47	16.3	2.14	10200	72.5
19a - 5	158	184	0.33	28.2	1720	5.32	65.2	139000	1.17	0.42	248	0.39	675	0.61	15.6	721	134	0.73	19.5	2.28	6190	17.4
19a - 6	96	182	0.63	78	2080	12.2	135	286600	1.24	1.39	266	-0.21	622	0.94	19.5	844	149	0.95	21.8	2.17	7000	19.8
19a - 7	580	177	0.23	58	4080	9	88	179900	1.76	0.68	436	0.22	678	1.05	18.3	910	232	0.59	21.8	2.8	8400	26.7
19a - 8	3120	334	3.04	272	28700	21	277	524000	6.9	1.6	740	0.76	860	2.05	21.9	920	238	1.71	20	14.5	18000	27.3
819 - 1	38100	363	2.02	1280	6020	21.3	71.7	32600	6.19	5.9	477	0.88	1090	7.65	298	71400	176	0.48	58	1.35	37000	63.9
819 - 2	20290	267	2.07	870	3670	13.3	115	23350	3.5	3.99	320	0.97	294	0.87	137.5	38200	105	0.11	26	0.67	27800	44
819 - 3	52000	413	1.97	2260	7000	14.6	213	44200	4.46	3.15	470	0.98	610	10.6	442	128000	200	0.03	38	1.23	41100	40.9
819 - 4	21200	277	1.71	1430	5740	12.8	70.5	19400	3.74	4.83	355	0.69	405	0.84	214	66600	150	0.15	16	0.57	23200	52.2
819 - 5	33500	308	2.37	2000	7150	19.1	117	35320	5.81	7	572	0.74	743	1.85	286	78200	232	0.27	43.5	1.52	34700	69.8
819 - 6	35000	340	2.4	1880	7840	29.2	70.3	30500	6.51	5.4	532	0.91	580	4.31	293	81600	206	0.08	32.5	1.24	23100	75.7
819 - 7	65300	536	7.3	4600	26900	30	88	36800	14	6.8	1050	0.85	1400	10	442	107200	301	0.25	54	2.05	67200	94.4
819 - 8	35500	378	3.3	2020	10400	21	70.8	25620	4.69	4.3	659	0.9	710	2.64	246	71000	171	-0.16	27.7	1.32	39800	57.3
819 - 9	29900	292	2.4	1580	6970	19	101	27720	3.22	3.68	465	0.98	430	2	193.4	55800	143	-0.03	37	0.86	25400	59.8
819 - 10	125000	579	3.1	3900	30300	63.1	126	57700	7.54	9.5	1020	1.41	1080	28.5	790	242000	306	0.07	79	2.12	91000	128
859 - 1	52600	181	3.43	31.1	1080	0.7	1.16	45.0	0.93	0.02	31.4	0.31	101	0.34	0.02	3.6	0.11	0.05	0.03	154	4.96	0.17
859 - 2	18800	193	1.0	30.0	600.0	0.11	0.47	21.6	0.37	-0.06	12.6	0.23	138	0.25	0.01	0.97	0.04	0.03	0.02	72	1.52	0.05
859 - 3	9100	174	1.35	280	262	0.16	1.06	18	0.2	-0.34	7	0.19	128	0.21	0.01	0.67	0	-0.01	0.01	41.4	0.79	0.02
859 - 4	5900	173	0.95	3.9	108	0.15	0	6.8	0.52	0.03	5.9	0.08	159	0.27	0.01	0.54	0.01	0.07	0	47.5	0.28	0.01
859 - 5	8000	183	0.89	16.9	320	0.07	1.42	26.2	0.23	0.26	6.8	0.17	89.3	0.19	0	1.83	-0.01	0.06	0.06	175	3.52	0.53
859 - 6	8100	199	0.9	14.9	360	0.07	-0.3	9.2	0.32	0.41	7.1	0	125	0.13	0	0.47	-0.01	-0.03	0.02	60	0.77	0.01
859 - 7	5400	225	-0.28	10.4	330	-0.02	-0.8	8.2	-0.04	0	4.75	0.19	131	0.17	0	0.24	-0.02	-0.05	0.02	59.1	0.44	0
859 - 8	5600	187	1.1	9.5	192	0.02	0.11	6	0.16	0	3.63	0.19	160	0.17	0	0.4	0.07	0.06	0	63.7	1.2	0.06
859 - 9	47600	343	5.6	340	9100	1.24	4.2	75	3.6	1.69	21.4	0.79	13.1	0.58	0.21	1.36	0.34	0.14	0.01	142	16.4	0.2
859 - 10	20900	227	2.54	3100	5700	0.27	1.51	56	0.67	0.16	12	0.55	13.3	0.28	0	0.62	0.05	0	0.01	48.5	1.98	0.06

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
082 - 1	121000000	5400000	36000	240000	42000000	15000	146000	36000000000	890000	1030000	610000	4300	750000	101000000	1720000	1530000	5600000	3700	90	1310000	720000000	17400
082 - 2	87000000	2400000	98000	340000	18000000	100000	16000	31000000000	200000	82000	340000	8200	830000	43000000	720000	1180000	290000	3000	20	3500000	540000000	13500
082 - 3	6400000	680000	-800	28000	2240000	200	6800	6900000000	38000	3700	26000	1800	106000	13900000	102000	172000	58000	660	12	670000	147000000	3000
082 - 4	116000000	4100000	99000	1060000	42000000	12000	87000	26000000000	330000	94000	330000	600	730000	47000000	730000	700000	280000	1300	-67	1390000	590000000	14200
082 - 5	128000000	5660000	101000	850000	30000000	4100	167000	22900000000	479000	171000	299000	9200	1120000	28600000	726000	1010000	602000	2300	90	1190000	800000000	22300
082 - 6	109000000	6140000	108000	560000	40000000	11600	122000	22600000000	343000	146000	306000	3300	1150000	59900000	804000	1120000	741000	1000	57	1870000	869000000	18900
082 - 7	165000000	6220000	45000	83000	4360000	3300	170000	21700000000	479000	200000	637000	5100	1110000	5580000	796000	814000	899000	3100	78	2640000	557000000	25900
082 - 8	43000000	25000000	9000000	520000	10300000	-19000	140000	240000000000	770000	510000	820000	300000	2200000	380000000	3700000	5200000	5000000	55000	-300	18000000	4400000000	93000
082 - 9	15400000	10700000	53000	50000	6220000	6700	118000	44400000000	547000	338000	69000	-600	1150000	59400000	827000	800000	1150000	1400	90	2850000	1290000000	29000
082 - 10	101000000	5800000	58000	124000	7900000	4500	233000	22600000000	386000	157000	360000	2600	890000	17300000	610000	753000	600000	5400	56	1830000	490000000	19400
8606 - 1	14800	141	7.3	16	690	155	7300	230	1.07	0.35	4130	0.36	12700	0.18	79	130	19500	3.49	970	1.36	18500	351
8606 - 2	12500	138	6.7	14.8	600	137	6440	190	0.81	0.48	2540	0.21	9060	0.17	51.7	190	15400	2.55	960	1.3	12000	220
8606 - 3	4720	159	6	5.2	240	59	2700	67	0.47	0.52	1400	0.14	5400	0.06	40.9	62	8800	1.09	312	0.61	8500	162
8606 - 4	2910	155	4	8.7	360	80	2000	203	0.35	0.2	665	0.06	4120	0.08	112	4440	4190	0.88	217	0.46	5400	70.00
8606 - 5	7300	141	9	12.4	492	91	2940	118	0.68	0.52	1930	0.25	6040	0.19	68	880	11200	2.01	641	0.96	10900	202
8606 - 6	3150	174	2	4.2	320	84	1560	194	0.19	0.2	730	0.12	3670	0.06	69	1220	4800	1.06	219	0.54	5020	65.8
8606 - 7	2340	121	19	7	212	28	1180	13.4	0.67	0.4	525	0.13	2890	0.24	16.7	116	3500	0.47	145	0.52	3150	49.3
8606 - 8	15600	178	10	76.0	970	127	3410	400	0.76	0.21	2120	0.18	6900	0.2	105	360	11500	1.64	458	0.64	12800	177
8606 - 9	8100	170	7	7.8	342	88	3700	102	0.44	0.3	2380	0.11	9100	0.08	77	360	12400	1.79	548	0.68	22400	293
8606 - 10	2850	180	5	3.06	98	46	1680	51	0.17	0.52	929	0.16	5600	0.04	35.4	630	5170	0.6	239	-0.07	5600	174
218 - 1	16000000	51000000	860000	7800000	570000000	200000	320000	910000	145000	40000	152000	100000	3600	60000	-20	9200	28000	-34000	900	84000	132000	140
218 - 2	29000000	70000000	1600000	2630000	470000000	75000	150000	1800000	152000	38000	240000	-13000	-3800	19000	1600	21000	23300	23000	-220	86000	280000	1230
218 - 3	19300000	26300000	2100000	6700000	1390000000	243000	660000	640000	420000	80000	183000	7300	4200	5700	1760	54000	2000	0	260	29000	259000	1160
218 - 4	8200000	14100000	1880000	3400000	850000000	130000	420000	270000	192000	56000	43000	1100	1300	3700	1150	32000	10500	-3500	70	9000	72000	-9
218 - 5	14000000	26000000	11300000	2210000	1320000000	160000	540000	450000	330000	71000	92000	4100	1800	-3800	1670	51000	26100	12000	80	17400	159000	370
218 - 6	13400000	68000000	-7400000	10500000	760000000	83000	295000	310000	243000	160000	137000	2900	1400	80000	1050	44000	95000	25000	90	42000	201000	750
218 - 7	11000000	18000000	-1790000	2900000	870000000	119000	360000	239000	221000	51000	84000	5500	18000	400	1320	29000	18400	3700	90	11600	122000	550
218 - 8	8900000	16900000	-1530000	2070000	1480000000	153000	621000	350000	337000	94000	71000	1800	1950	5400	1400	51500	7600	80000	-85	10100	72000	290
218 - 9	40000000	92000000	-2100000	14400000	2800000000	290000	610000	1580000	400000	700000	330000	-40000	11800	11000	300	73000	80000	700000	-500	118000	265000	1300
218 - 10	16000000	58000000	-2000000	1250000	700000000	29000	63000	1490000	194000	40000	350000	28000	10300	11000	300	19000	46000	34000	440	60000	177000	-90
RLAKE - 1	50	158	-4.6	1.1	-6.6	0.44	-1.9	-0.76	-0.32	-1	-0.2	0.37	24.9	0.17	0.01	0.01	-0.12	-0.05	0.03	29.4	0.03	-0.01
RLAKE - 2	41	131	5.4	0	10.6	-0.07	1.3	0.5	0.1	2.3	0.23	0.40	25.1	-0.01	0.01	0.06	-0.13	0.03	0	37.1	0.05	-0.01
RLAKE - 3	0	153	-1.8	-0.6	1.5	0.01	-0.4	-0.29	0.19	2	-0.38	-0.07	10.5	0.15	0.01	0.03	-0.09	0.01	-0.01	56.3	0.11	0.02
RLAKE - 4	52	154	4.3	-1.2	15.2	0.19	-0.4	5.2	0.14	-1.15	1.48	-0.03	15.5	0.14	0.02	0.09	0.12	-0.02	0.01	38.9	0.39	0.04
RLAKE - 5	176	286	10.8	141.0	4660	1.61	5.2	11	2.21	1.35	3.28	0.11	9.48	-0.17	0.03	0.23	0.11	0.06	-0.01	16.8	1.26	0
RLAKE - 6	39	175	1.3	14.1	390	-0.08	1.8	1.29	0.58	2.2	0.45	-0.59	18.4	0.06	0.02	0.01	0.24	-0.05	0	25.1	0.15	0
RLAKE - 7	13	195	5.9	5.4	234	-0.69	1.3	0.5	-0.13	0	1.27	-0.5	17.2	-0.44	0	0	0.2	-0.1	-0.01	26.9	0.13	0.01
RLAKE - 8	34	118	1.1	14.9	410	-0.28	1.9	2.6	0.62	-1.5	0.58	-0.35	13.5	0.07	0.01	0.05	0.06	0.14	-0.01	25.2	0.16	0
RLAKE - 9	5	149	1	0.5	7.7	-0.14	-1.9	0.59	0.46	-0.86	0.7	-0.16	18.6	-0.01	-0.01	-0.05	0.05	-0.01	-0.01	48.3	0.04	0
RLAKE - 10	91	267	2.3	3.1	355	-0.04	-0.8	6.3	0.37	-1.5	0.69	0.42	13.7	0.38	-0.01	0.79	0.3	-0.02	0	198	1.45	0.04
1949 - 1	25900	176	31	32.0	1000	0.22	1.34	187	0.92	0	7.8	0.14	58.9	0.22	0	0.18	0.19	0	0.01	404	3.03	0.02
1949 - 2	14700	213	20	23.0	380	0.08	0.65	126	0.42	0.12	5.3	0.13	65	0.18	0	0.1	3.4	0	0.01	232	1.62	0.01
1949 - 3	18300	250	61	18.8	291	0.05	0.92	119	0.51	0.16	5.8	0.08	119	0.24	0	0.06	0.07	0	0.09	324	2.8	0.01
1949 - 4	28100	229	-429	85.0	3800	1.05	3.61	223	0.87	0.5	14.7	0.67	1210	0.4	0	0.3	0.14	0.03	1.5	351	7.7	0.03
1949 - 5	24400	204	-29	33.0	650	0.1	0.62	140	0.76	0.21	7.9	0.29	350	0.18	0	0.28	0.1	0.01	0	341	2.43	0.01
1949 - 6	14500	219	-5.2	6.4	218	-0.05	0.58	90.0	0.34	0.21	4.9	0.11	372	0.14	0	0.12	0.03	0	0	183	1.0	0.01
1949 - 7	8500	233	-0.4	7.4	188	0	-0.01	68.6	0.12	0	2.98	0.01	350	0.13	0.01	0.03	0.9	-0.01	0	139	0.74	0.01
1949 - 8	6200	238	-6.2	3.3	86	-0.05	-0.12	46.3	0.17	0.22	2.12	0.2	60.6	0.14	0	0.03	0.03	0	0.02	88.7	0.34	0
1949 - 9	6440	256	-0.7	6.3	104	0.09	0.44	46	0.07	0.04	2.38	0.06	60.6	0	0.01	0.22	0.03	0	0	151	0.51	0
1949 - 10	6310	248	-1.6	5	79	-0.09	0.41	39.9	0.05	-0.29	2.09	0.14	172	0.04	0	0.02	0	0.01	0	94	0.35	0.04

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
5377 - 1	49500	166	3.36	430	2360	0.97	10	403	2.72	0.44	16.8	0.96	202	0.81	0.42	1.1	0.5	0.07	0.15	905	7.4	0.19
5377 - 2	20600	194	0.99	168	1000	0.27	1.35	196	0.93	0.22	7.46	0.15	187	0.42	0	0.4	0.09	0.04	0.04	489	2.92	0.09
5377 - 3	20300	167	1.03	214	1110	0.37	2	247	1.44	0.21	10.7	0.2	205	0.54	0.11	0.36	0.31	0.04	0.01	546	14	0.34
5377 - 4	14400	166	0.6	124	515	0.19	1.17	199	1.05	0.32	7.97	0.15	176	0.36	0	0.36	0.13	0.01	0.01	419	2.7	0.07
5377 - 5	10900	175	0.45	126	363	0.2	0.93	158	0.69	0.23	7.3	0.22	379	0.38	0.03	0.2	0.09	0.01	0.01	402	2.5	0.07
5377 - 6	8400	164	0.37	101	272	0.23	0.79	134	0.58	0.3	5.68	0.61	177	0.31	0.01	0.08	0.1	0.02	0.01	326	1.99	0.07
5377 - 7	6740	161	0.26	76	219	0.09	0.94	100	0.49	0.33	5.26	0.05	239	0.24	0.01	0.1	0.05	0.01	0	304	1.43	0.08
5377 - 8	2730	156	0.12	46	112	0.03	0.98	45.9	0.33	0.28	2.66	0.01	254	0.16	0	0.07	0.06	0	0	141	0.53	0.03
5377 - 9	3460	148	0.08	53	122	0.02	0.8	56	0.32	-0.04	3.29	0.07	281	0.17	0	0.06	0.09	0	0	209	0.94	0.07
5377 - 10	1400	138	0.06	30	45	-0.01	0.68	28.4	0.21	0.15	2.45	0.04	95.8	0.05	0	0.05	0.07	0	0	125	0.33	0.03
8567 - 1	9200	260	1.44	4210	1960	1.96	16.1	273	7.7	1.72	16.8	0.5	205	1.3	0.17	5.9	0.29	0.01	0.03	1.19	6.9	0.18
8567 - 2	6600	256	1.07	1820	840	0.82	11.4	197	3.59	1.47	10.3	0.37	162	1.63	0.02	3.0	0.17	0	0.04	0.45	3.83	0.11
8567 - 3	7200	222	0.87	3250	1040	0.93	12.0	267	3.56	0.94	9.9	0.22	188	0.82	0.03	1.97	0.18	0	0.03	0.5	4.7	0.14
8567 - 4	9000	283	1.24	1240	680	0.35	8.2	167	2.8	0.31	13.6	0.04	490	1.1	0.03	1.16	0.12	0	0.04	0.88	3.06	0.17
8567 - 5	7700	243	1.03	1430	830	0.62	6.7	213	2.49	0.91	11.2	0.21	780	1.16	0.02	0.88	0.09	0	0.02	0.78	1.89	0.1
8567 - 6	8660	286	1.04	1110	560	0.43	6.1	184	1.97	0.63	18.6	0.09	53.6	1.72	0.02	0.98	0.16	0.01	0.02	0.23	1.42	0.08
8567 - 7	5550	367	1.27	1310	660	0.89	7.9	150	2.4	0.58	7.43	0.12	81.5	1.86	0.04	1.6	0.2	0.03	0.02	0.48	1.84	0.1
8567 - 8	3910	344	1.4	930	440	0.61	4.3	109	1.73	0.27	6.06	0.53	96.5	1.57	0.01	0.56	0.11	-0.03	0.02	0.42	1.25	0.09
8567 - 9	16600	312	2.6	1010	1290	0.79	6	265	2.99	0.81	22.0	0.48	250	1.94	0.06	3.5	0.11	0.04	0.1	1.9	3.4	0.19
8567 - 10	11900	380	2.7	830	940	0.77	7.3	228	6.37	1.07	13.9	0.02	152	2.47	0.01	0.48	0.27	0	0.04	0.35	1.74	0.11
2225 - 1	33100	175	0.79	350	1690	0.56	2.2	350	2.91	0.48	14.1	0.44	55.4	1.13	0.05	3.8	0.33	0.09	0.12	444	3.7	0.23
2225 - 2	27100	225	0.57	212	1100	0.37	1.3	254	2.17	0.9	9	0.17	80	1.27	0.05	10	0.31	0.03	0	287	3.3	0.2
2225 - 3	35000	185	0.88	390	1490	0.84	2.2	380	2.7	0.6	11.6	1.7	74.2	1.7	0.39	0.91	0.51	0.09	0.17	247	6.3	0.27
2225 - 4	26600	196	0.24	107	268	0.22	2.3	182	1.6	0.95	12.7	0.85	73.3	0.37	0.84	0.7	0.59	0.25	0.01	323	4.1	0.18
2225 - 5	50000	239	0.53	82	357	0.25	2.8	210	1.91	1.1	15	0.8	103	1.1	0.31	1.6	3.6	0.12	0.06	840	5.5	0.2
2225 - 6	44300	242	0.83	596	1050	0.4	0.55	358	1.91	0.1	13.7	0.23	47.6	2.22	0.01	0.14	0.12	0.38	0.01	297	2.11	0.19
2225 - 7	31100	262	0.73	288	1140	0.41	1.67	308	1.99	0.29	6.4	0.29	60	1.02	0.04	0.2	0.1	0.04	0.01	122	2.42	0.5
2225 - 8	40700	214	0.46	356	440	0.38	2.0	284	1.6	0.16	10.1	0.09	46.7	0.74	0	0.16	0.1	0.02	0.01	292	1.1	0.09
2225 - 9	66000	207	2.1	250	860	0.2	1.09	420	2.58	0.59	13.8	0.36	148	0.84	0.27	0.39	0.31	0.09	0.03	203	3.8	0.17
2225 - 10	18200	162	0.2	65	134	0.02	0.62	136	0.65	0.3	4.8	0.3	118	0.54	0.01	0.03	0.05	0.06	0	97	0.54	0.04
818 - 1	3500000	244000	-4900	430000	372000000	620	2000	341000	800	3400	1700	-10	106	100	158	40000	130	41	15	1490	115000	39
818 - 2	1270000	289000	-1000	840000	410000000	1150	-210	510000	80	3590	860	200	206	-30	107	16400	220	-60	28	1320	13700	48
818 - 3	2460000	115000	-5800	450000	164000000	282	1530	205000	447	1360	680	56	118	8	59	11000	99	32	6.7	630	41400	44.9
818 - 4	990000	277000	-3000	570000	426000000	830	290	332000	330	2800	750	-20	106	-10	97	18500	207	67	10	1910	13400	1200
818 - 5	3940000	292000	-3300	1440000	440000000	850	2600	464000	690	3070	1110	20	209	170	115	19600	126	122	64	1750	26200	290
818 - 6	1400000	245000	-6900	660000	414000000	860	1400	341000	410	3300	970	-50	178	50	65	15000	199	-94	38	1640	16400	94
818 - 7	1600000	336000	3200	910000	530000000	890	400	500000	210	4000	1350	70	271	-70	60	16600	151	50	18	1750	15600	111
818 - 8	2440000	185000	-2400	530000	312000000	550	660	260000	240	2040	1030	-80	115	38	147	30300	156	-62	52	850	19200	58
818 - 9	2020000	268000	-1700	570000	450000000	460	960	390000	290	3000	800	250	181	-72	133	23000	190	-50	36	1310	20200	56
818 - 10	2630000	410000	5400	670000	670000000	760	500	450000	420	3400	700	-160	200	90	98	26000	108	-150	27	1010	37300	74
8580 - 1	19200	233	-26.7	105	3240	0.36	2.53	70	1.83	0.24	1.73	0.31	2.59	0.23	0.02	1.79	0.03	0.10	0.02	0.36	4.01	0.03
8580 - 2	35200	281	-28	171	3290	0.36	2.49	92	2.19	0.11	2.57	0.11	2.3	0.41	0.03	0.9	0.07	0	0	0.69	7.7	0.04
8580 - 3	15200	268	-27.7	106	1090	0.23	2.06	56	1.25	0.02	1.58	0.09	2.81	0.11	0.03	3.6	0.07	-0.09	0	0.45	3.9	0.11
8580 - 4	13700	246	-35	88	3200	0.36	1.88	55	1.03	0.03	1.42	0.2	2.65	0.17	0.04	3.2	0.08	-0.22	0.01	0.35	4.9	0.15
8580 - 5	26700	305	-55	105	1510	0.42	1.3	80	1.24	0.22	2.0	0.3	2.11	0.33	0.01	0.49	-0.01	-0.18	0	0.62	5.53	0.05
8580 - 6	13700	263	-20.1	80	1060	0.24	1.26	39.7	1.7	0.28	1.29	0.1	3.24	0.18	0.02	0.79	-0.01	0.06	0.01	0.52	3.13	0.11
8580 - 7	16800	227	-43	134	2030	0.42	2.17	71.7	1.86	0.23	1.32	0.28	1.97	0.3	0.01	0.84	0.03	0.26	0	0.35	4.54	0.03
8580 - 8	11700	252	-59	86	1910	0.28	1.45	43.4	0.98	-0.31	1.25	0.26	2.27	0.25	0.02	0.66	0.02	-0.21	0	0.52	3.38	0.03
8580 - 9	7540	237	-31	72	1010	0.22	0.44	26.4	0.75	0.05	0.8	0.07	2.96	0.23	0	0.47	0.03	-0.04	0	0.33	2.02	0.04
8580 - 10	15500	284	-95	106	2430	0.22	1.68	75	1.28	0.32	1.44	0.14	4.07	0.26	0.01	1.8	0.04	0.05	0	0.51	3.2	0.05

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8587 - 1	59600	181	15	79	1250	0.26	2.08	125	3.18	0.46	14.6	0.3	600	0.49	0.11	2.6	0.37	0.48	0.03	1.36	1.97	1.33
8587 - 2	48600	212	10.4	56	1090	0.58	1.32	121	2.38	0.27	13.1	0.3	257	0.29	0.02	0.98	0.1	0.12	0.01	1.32	2.5	0.9
8587 - 3	29700	247	6.87	17.4	840	0.1	0.91	74.7	2.01	0.22	8.21	0.21	221	0.18	0.01	0.45	0.04	0.09	0.01	0.87	1.03	0.47
8587 - 4	25800	285	7.1	23.9	830	0.14	0.92	67.3	1.62	0.45	7.46	0.47	810	0.11	0.24	0.48	0.07	-0.02	0	2.5	2.22	0.34
8587 - 5	32000	295	8.9	41	1130	1.7	1.39	85	3.04	0.87	10.7	0.26	612	0.33	0.07	0.8	0.09	0.14	0.21	1.34	1.55	0.63
8587 - 6	20700	296	6.1	13	360	0.12	0.39	58	0.69	0.00	6.4	0.16	400	0.24	0.02	0.78	1.7	0.14	0.03	1.9	2.6	0.22
8587 - 7	14400	195	2.31	10.7	260	0.04	0.4	40.3	0.68	0.01	4.83	0.06	295	1.6	0	0.19	0.03	0.07	0	0.66	0.38	0.15
8587 - 8	25000	269	2.93	28	680	0.1	0.31	79	1.36	0.16	7.1	0.2	491	0.2	0.01	0.23	0.05	0.14	0	0.99	0.86	0.28
8587 - 9	30300	297	5.33	100	1480	0.31	0.79	108	2.50	0.92	10.5	0.26	263	0.41	0.01	0.81	0.07	0.1	0	0.93	1.39	0.24
8587 - 10	6600	177	1.43	7.3	160	0.1	-0.04	29.5	0.65	-0.09	3.08	0.05	930	0.09	0	0.2	0.00	-0.03	0	0.33	0.26	0.14
8577 - 1	680	155	2.62	31.9	1620	1.73	1.91	14.1	1.23	0.54	1.56	0.89	97	0.02	0.01	0.27	0.04	0.08	0	1.79	0.63	0.02
8577 - 2	461	209	1.91	42.2	3840	2.8	2.8	18.8	1.42	0.40	1.60	1.5	48.1	0.01	0	0.3	0.07	0.01	0	0.54	1.11	0.02
8577 - 3	154	202	0.66	3.3	260	0.16	0.62	4.5	0.30	0.22	0.41	0.48	93.3	0.06	0	1.56	0.01	0.09	0	0.44	0.35	0.01
8577 - 4	139	287	0.55	12.7	970	0.91	1.38	6	0.50	0.54	1.03	2.8	36.5	0.11	0	0.26	0.03	0.16	0	0.56	0.19	0.02
8577 - 5	64	240	0.23	2.7	180	0.18	-0.3	2.1	0.16	0.55	0.11	0.4	88.3	0.06	0	0.06	0.05	-0.01	0	0.56	0.06	0.01
8577 - 6	110	273	0.22	5.04	650	0.11	0.22	4.34	0.09	0.32	0.37	0.95	45.8	0.07	0	0.07	0.02	0.09	0	0.33	0.07	0.01
8577 - 7	255	267	0.68	18.1	880	0.85	0.9	4.85	0.50	0.33	1.24	1.48	33.1	0.08	0	0.1	0.06	0.11	0	0.25	0.13	0
8577 - 8	164	304	0.38	8.8	380	0.24	0.92	3.4	0.16	0.20	0.69	1.27	19.4	0.03	0	0.07	0.01	0.04	0	0.24	0.06	0
8577 - 9	261	306	0.97	34.1	2560	1.6	2.44	9.1	0.86	0.53	4.54	6.37	42.6	0.06	0.01	0.32	0.07	0.05	0	0.34	0.13	0.01
8577 - 10	428	371	0.92	54.6	5060	2.34	3.91	11.8	1.75	0.90	11.5	17	42.6	0.15	0	0.16	0.04	0.08	0.01	0.4	0.26	0.01
099 - 1	11870	440	4.55	20	1150	0.28	3.5	33.6	1.28	0.40	145	52.9	4.05	0.56	0.01	2.6	0.83	0.08	0.01	4.9	144	0.06
099 - 2	11800	467	3.95	27.7	1270	0.35	3.88	34.7	1.17	0.60	93	28.1	10.9	0.22	0.01	2	1.17	0.05	0	7.96	100	0.04
099 - 3	16300	423	5.3	7.8	910	0.21	1.82	84.9	1.23	0.41	154	46.4	5.8	0.37	0.22	1.16	1.06	0.08	0	6.81	150	0.01
099 - 4	18200	428	4.94	10.2	1200	0.2	1	99.7	1.04	0.67	143	34	7.64	0.29	0	0.79	0.73	0.08	0.01	5.64	136	0.01
099 - 5	16900	430	5.15	7	930	0.24	0.8	61.9	1.22	0.61	174	44.9	7.86	0.39	0	0.88	0.92	0.01	0.01	6.77	135	0.01
099 - 6	13200	402	5.11	12.62	1010	0.28	2.06	23.3	1.57	0.72	93	35.7	18.1	0.47	0.01	0.66	0.9	0.01	0.01	8.34	78	0.05
099 - 7	13900	338	4.41	10.7	474	0.2	2	16.7	1.08	0.66	130	36.4	11	0.4	0	0.79	1.04	0.01	0.02	13.6	74.5	0.03
099 - 8	7500	345	3.33	4.7	588	0.09	0.93	16.3	0.47	0.15	98	15.1	10.5	0.28	0	0.42	0.49	0.01	0.01	6.55	50.5	0.01
099 - 9	7390	360	5.8	7.9	1100	0.14	1.85	28	0.85	0.45	281	45.4	2.77	0.29	0	1.12	0.68	-0.01	0.01	5.25	93.6	0.02
099 - 10	11400	315	2.93	4.11	480	0.24	0.7	17.6	0.74	0.54	83.6	24	45	0.28	0	0.46	0.65	0	0	6.03	55.6	0.02
8568 - 1	67900	124	2.81	57.1	1670	0.32	1.53	73	2.41	0.28	20.2	0.32	140	0.35	0.06	1.8	0.59	0.2	0.04	1.59	15	0.22
8568 - 2	42300	174	1.42	33.2	800	0.09	2	47	1.39	0.69	12.3	0.18	63.9	0.18	0.37	0.37	1.3	0.1	0.05	0.95	1.7	0.01
8568 - 3	41100	158	1.19	31.2	890	0.1	0.49	46	1.75	0.26	11.5	0.07	52.5	0.14	0.01	0.24	0.16	0.11	0	0.7	0.74	0.01
8568 - 4	48400	134	2.19	37.7	1370	0.48	0.89	42.4	1.77	0.29	11.8	0.1	67	0.2	0.01	0.44	0.42	0.08	0.01	1.27	1.6	0.02
8568 - 5	31800	131	1.28	22.5	630	0.08	0.32	27.1	1.08	0.16	8.1	0.12	115	0.14	0.01	1.09	0.8	0.1	0.06	0.55	0.46	0.03
8568 - 6	22500	185	0.92	11.4	245	0.15	0.46	25	0.74	0.02	5.3	0.12	111	0.15	0	0.12	0.12	0.03	0	0.61	0.53	0.03
8568 - 7	17300	198	0.68	11.4	140	0.1	0.56	14	0.56	0.49	4.08	0.27	40	0.18	0.06	0.12	0.07	0.05	0	1.5	1.3	0
8568 - 8	27900	196	0.64	15.1	277	-0.04	0.47	40	0.99	0.32	6.24	0.18	47.9	0.23	0.01	0.19	0.23	0.04	0	0.79	0.36	0.03
8568 - 9	9800	189	0.33	6.2	70	0.04	0.62	10	0.47	0.2	2.94	0.12	139	0.15	0.05	0.07	0.06	0.02	0	0.52	0.11	0
8568 - 10	7600	206	0.63	5.1	46	0.03	-0.53	12	0.19	-0.12	2.76	0.22	93	0.11	0.01	0.06	0.06	0.02	0.01	0.62	0.37	0
8572 - 1	104700	101	3.41	62	402	0.8	3	246	2.15	0.38	10.9	0.7	130	0.83	0.4	1.45	1.31	0.29	0.03	6.5	7	0.53
8572 - 2	71200	109	2.34	69	359	0.77	1.22	164	2.25	0.4	7.4	0.22	171	0.72	0.12	2.2	0.19	0.1	0.09	1.63	1.84	0.08
8572 - 3	49300	117	1.68	54	213	0.14	1.23	118	1.1	0.27	4.36	0.15	163	0.32	0	1.53	0.14	0.07	0	0.89	0.79	0.03
8572 - 4	40200	116	1.42	32	175	0.15	0.82	113	1.02	0.26	4.09	0.03	152	0.23	0	0.38	0.08	0.09	0.01	0.75	0.55	0.1
8572 - 5	31900	111	1.88	23	183	0.13	0.87	78.6	0.71	0.4	2.73	-0.03	250	0.24	0.01	0.28	0.06	0.1	0.01	0.9	0.67	0.02
8572 - 6	98000	950	3.40	275	390	0.14	4	260	1.78	0.6	9.4	-0.12	182	0.54	0.04	0.75	0.26	0.17	0.02	7.65	38	0.12
8572 - 7	47800	773	3.22	247	123	0.04	1	128	1.1	0.83	10.4	0.27	118	0.4	0.01	0.24	0.23	0.1	0	3.44	1.5	0.03
8572 - 8	44000	2350	2	630	97	0.9	3	253	0.77	1.1	9	-0.29	126	0.51	0.04	0.32	0.14	0.24	-0.01	6	0.51	0.03
8572 - 9	45900	103	3	41	101	0.11	0.62	93	0.99	0.26	3.19	0.16	142	0.25	0.39	1.4	0.25	0.09	0.12	1.25	0.57	0.03
8572 - 10	19200	125	2	11	45	0.07	0.69	48	0.5	0.1	2.02	0.08	359	0.17	0	0.2	0.1	0.08	0.01	3	0.21	0.02

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
821 - 1	8400	207	35	35	410	0.25	-0.1	154	1.18	0	9.3	0.54	1500	-0.04	0.05	7.5	0.38	-0.34	0.26	4.01	5.29	0.88
821 - 2	6300	178	30	22	313	0.34	1.4	77	1.16	-0.65	14.5	0.23	317	0	0.04	8.3	0.62	-0.07	0.14	2.53	6.9	0.92
821 - 3	1520	136	12.3	1.66	39	0.23	0.33	49	0.17	0.71	1.53	0.27	315	-0.01	0	1.26	0.11	0.2	0.05	1.09	0.84	0.22
821 - 4	3300	160	8	9.2	175.00	0.31	1.4	43	0.36	0.98	2.57	0.24	308	0.05	0.02	2.14	0.2	0.04	0.1	1.17	1.47	0.46
821 - 5	890	183	4	1.36	35.8	-0.04	0.2	45	0.16	0.08	1.81	0.07	296	0.06	0.01	2.63	0.11	0.09	0.06	1.47	1.39	0.2
821 - 6	2430	205	13	14.7	209	0.03	0.4	64	0.31	0.26	5.4	0.1	414	0.07	0.03	5.66	0.15	0.28	0.21	2.5	2.51	0.37
821 - 7	14400	276	58	114.00	1920	1.95	4	124	3.6	2.1	14.6	0.71	940	0.28	0.6	7.7	4.7	-0.09	0.29	9	9.5	1.15
821 - 8	7100	258	26	51	417	0.18	1.3	125	1.39	0.65	10.2	0.45	758	0.06	0.07	7.3	0.75	0.57	0.32	2.83	8.7	0.8
821 - 9	782	222	16	29	107	-0.08	-0.1	54.4	0.39	0.56	5.3	0.27	304	0.21	0.02	5.7	0.21	-0.01	0.16	1.35	10.7	0.23
821 - 10	1430	218	17	4.1	119	-0.11	0	77.4	0.3	-0.24	4.8	0.44	440	0.08	0	5.1	0.39	-0.08	0.13	1.78	6.10	1.18
211 - 1	23100	281	183	151	5440	4.35	13	107	3.79	1.06	117	22.6	5.6	0.75	0.05	9.5	1.31	0.04	0.03	3.41	289	6.0
211 - 2	7350	236	79	39.9	1960	0.88	3.7	36.5	1.65	0.47	97.5	21.6	5.89	0.84	0.03	2.9	0.7	0.01	0.01	2.21	199	0.09
211 - 3	6900	247	68	60	2080	1.48	4.7	33.9	1.59	0.33	69.6	19.2	8.6	0.56	0.02	1.72	0.48	-0.01	0	1.96	131	0.06
211 - 4	6010	229	32	32	919	0.72	1.7	23.7	0.67	0.25	48.4	13.2	22.2	0.4	0.01	2.1	0.44	-0.04	0.02	1.76	71.8	0.03
211 - 5	7180	214	26	38.3	1430	1.12	3.2	23.6	1.12	0.49	43.0	13.8	30.9	0.4	0	0.92	0.35	0.03	0	8.9	57.3	0.02
211 - 6	9870	250	37	36.9	1280	0.32	3.4	31.7	0.9	0.52	62.6	20.7	16.5	0.47	0.02	2.6	0.55	0.04	0.01	2.55	111	0.03
211 - 7	8280	256	31	29.2	764	0.5	2.69	27.1	1.15	0.74	54.9	17.3	19.5	0.25	0	0.88	0.47	-0.05	0.01	4.7	65.7	0.04
211 - 8	6230	282	31	63.5	1220	1.22	4	32.8	1.43	0.42	52.6	14.9	14.1	0.45	0.01	1.89	0.4	0.08	0.01	3.39	55.9	0.03
211 - 9	3970	290	23	46.6	840	0.59	3.2	22.1	1.18	0.6	48.3	19.2	10.9	0.34	0.02	2.03	0.35	0.04	0.01	1.86	63.1	0.05
211 - 10	4060	272	21	24.2	700	0.28	2.33	23.3	0.98	0.39	59.7	17.9	15.2	0.44	0	1.87	0.34	0.02	0.01	1.56	75.4	0.02
863A - 1	9900	341	8	113	210	0.03	0.94	37.5	2.19	0.19	44.2	0.2	34.0	0.62	0.02	5.9	0.09	-0.06	0.01	2.83	1.65	0.04
863A - 2	12400	308	10	73	261	0.03	0.85	41.8	0.72	-0.08	51.1	0.26	14.3	0.72	0.01	5.3	0.03	0.01	0.01	4.09	1.45	0.05
863A - 3	11100	344	12	169	320	0.11	1	40.5	1.31	0.81	47.1	0.21	74	0.91	0.01	0.67	0.02	0.1	0	2.67	0.88	0.07
863A - 4	13300	353	13	139	330	0.09	0.8	46.1	0.98	0.54	53.3	0.15	12	0.82	0.02	6.5	0.06	0.01	0	2.1	1.83	0.03
863A - 5	14900	393	17	110	340	0.07	1.21	42.0	1.78	0.31	56.6	0.33	19.2	0.6	0	1.22	0.08	-0.15	0	5.86	0.93	0.02
863A - 6	12700	434	14	102	103	-0.01	0.9	40.2	2.22	1.04	47.4	0.34	43.9	0.61	0.01	1.11	0.07	-0.04	0	4.83	0.81	0.03
863B - 1	1690	357	15	200	570	0.17	1	10.6	0.86	0.27	7.4	-0.04	99	0.18	0	0.73	0.03	-0.04	0	5.40	0.5	0.01
863B - 2	5800	338	18	111	281	0.01	0.43	15.8	1.15	0.47	32.1	0.3	72	0.32	0	0.71	0.04	0.15	0.00	2.09	0.5	0.01
863B - 3	6240	530	11	105	68	0.03	0.7	23.9	5.4	0.8	39.8	0.47	31	0.47	0	0.55	0.09	-0.1	-0.01	4.26	0.65	0.01
863B - 4	8400	442	39	26.8	60	-0.01	-0.15	15.9	1.83	0.45	46	0.23	20.6	0.19	0	0.12	0.03	0.11	0	4.41	0.41	0.03
863B - 5	3530	413	22.2	23.7	53	0.07	-0.43	9.1	0.44	0.3	17.7	0.2	92.7	0.28	0.01	1.6	0	-0.02	0	1.8	0.41	0.01
8604 - 1	4360	330	8.5	23.1	15600	0.87	25.3	8910	10.9	14.4	1070	1.13	600	0.26	325	126000	491	0.16	121	0.33	16900	188
8604 - 2	2870	278	15.9	31.4	12780	0.74	24.8	9170	8.45	9.94	785	1.03	690	0.28	242	85700	303	0.17	104	0.45	15480	379
8604 - 3	2770	269	17.2	113.5	11700	1.13	25.6	9550	7.21	8.59	674	1.42	1430	0.43	213	70500	256	0.21	99.5	0.39	14860	132
8604 - 4	2390	195	11.4	23.2	9960	0.8	21.8	9220	7.28	8.88	692	0.99	750	0.34	217	73700	273	0.14	98.2	0.33	12950	145
8604 - 5	2940	287	10.5	24	14000	0.85	29.5	11490	8.09	11.9	937	1.05	1180	0.26	253	87300	344	0.14	110	0.29	15780	145
8604 - 6	3760	252	18.1	79	18500	0.92	25.7	9550	10.3	11.8	970	1.28	720	0.39	277	90700	387	0.15	107	0.5	17000	178
8604 - 7	1960	268	2.3	20.9	9600	1.08	17.6	8170	5.52	5.79	601	0.89	500	0.2	240	74800	218	0.09	117	0.16	14500	133
8604 - 8	3320	289	3.8	30.8	15520	0.87	25.7	11090	8.17	11.6	871	0.86	1440	0.21	250	82400	321	0.16	94.9	0.22	15460	141
8604 - 9	3080	270	4.8	11.7	13150	0.74	18.4	8000	8.17	10.1	787	0.91	652	0.18	248	80600	314	0.26	96.2	0.36	14660	224
8604 - 10	3470	246	2.8	25.8	13200	0.88	20.5	7950	9.04	12.4	856	0.9	940	0.23	299	97000	358	0.23	116	0.19	15700	256
8579 - 1	580000	5900	1000	37200	341000	48	191	3640	146	26.3	135	9.1	204	5.0	0.62	730	2.8	-1.2	0.8	11.4	228	12.1
8579 - 2	520000	5700	880	37600	313000	35.3	171	4500	135	29.9	101	5.2	215	8.8	1.15	66	7.7	0.4	0.7	26	181	9.8
8579 - 3	870000	11900	1060	50800	318000	63	291	6090	206	38	138	9.5	370	7.9	2.0	380	48.0	-1.5	2.7	36.4	208	8.2
8579 - 4	670000	9400	770	44000	318000	79	317	6100	155	29	107	-1.4	209	9.4	1.02	54	2.6	-0.2	-0.01	25.3	204	8.5
8579 - 5	830000	9900	1030	44000	269000	67	280	5900	232	43	147	6.1	291	8.3	1.36	150	2.5	-5.3	-0.08	37.1	172	5.81
8579 - 6	820000	8600	820	52000	340000	39.6	217	6700	158	37	136	7.1	203	9.8	0.94	54	2.4	0.5	-0.03	31.8	204	6.6
8579 - 7	710000	12900	1720	32300	460000	131	410	10300	376	40	168	8.7	204	19.1	2.19	126	3.5	6.9	-0.01	41	311	8.4
8579 - 8	790000	7000	890	34600	133000	73	185	5780	114	28	135	4.5	262	9.3	0.88	58	6.6	1.7	0.14	23.8	198	6.7
8579 - 9	450000	6100	620	22400	82000	37	148	4000	82	30	109	2.0	125	6.8	0.84	44	1.9	-0.4	0.22	14.8	229	4.3
8579 - 10	490000	17000	1370	15700	136000	50	246	6200	144	42	101	5.4	180	6.0	0.48	40.5	3.6	-1.4	-0.02	28.7	187	4.7

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8608 - 1	121000	296	32	89	6920	0.45	5.7	129	9.1	0.66	16.6	0.98	484	1.14	0.9	21	1.8	2.4	0.02	3.6	37.2	2.6
8608 - 2	26300	258	9.3	129	2590	0.34	6.9	91	4.23	1.6	7.7	0.67	170	0.65	0.62	4.7	0.61	0.31	0.01	1.31	21	0.78
8608 - 3	63500	357	8.9	104	2400	0.34	5.8	121	3.82	-0.02	7.76	0.29	231	0.11	0.01	0.48	0.23	0.13	0.01	3.8	20.7	0.46
8608 - 4	162000	469	19.4	196	6550	1.22	4.7	240	8.7	0.42	19.2	0.95	492	2.1	9.0	10.9	1.4	2.8	0.05	8.3	57	1.33
8608 - 5	152000	891	14.3	121	5200	0.58	5.1	114	8.3	0.91	23	0.86	430	0.15	0.02	5.8	0.54	0.7	0.02	4.1	47	4.23
8608 - 6	284000	1142	19.8	113	10280	2.41	7.5	480	27.2	6.3	37	3.8	630	7.2	7.5	83	5.1	2.3	1.4	17	133	8.7
8608 - 7	23100	428	2.45	93.9	1560	1.37	3.28	29.1	3.06	0.9	4.3	0.07	100	0.21	0.04	2.3	0.15	0.16	0.01	0.51	10.4	0.85
8608 - 8	17300	463	0.9	131.9	1050	0.91	1.3	28	1.84	0.57	3.43	0.08	97	0.17	0	1.1	0.58	-0.04	0	0.55	8.1	1.42
8608 - 9	194000	612	19.9	123	7800	2.2	5.9	420	12.1	3.1	23	2.2	1040	1.2	6.4	35	2.2	1.2	0.14	8.4	170	3.1
8608 - 10	191000	1238	21.1	540	7400	0.91	10.3	134	17.1	-0.8	19	1.21	649	0.55	0.08	1.7	0.69	-0.27	0.02	3.82	60.3	2.13
8573 - 1	33600	99	11.5	194	1440	0.1	1.26	311	0.97	0.19	8.47	0.11	280	0.58	0.02	1.39	0.18	0.1	0.01	0.42	2.9	0.22
8573 - 2	17600	144	5.8	61	580	0.08	1.18	160	0.39	0.3	5.5	0.23	144	0.3	0	0.69	0.15	0.03	0	0.32	0.59	0.27
8573 - 3	18100	194	4.4	36.3	1400	0.13	0.76	173	0.38	0.25	4.43	0.27	71.2	0.27	0	0.9	0.06	0.15	0.02	0.4	1.01	0.07
8573 - 4	16100	149	3.9	32	152	0.02	0.74	156	0.34	0.11	3.77	0.15	186	0.31	0	0.48	0.05	-0.03	0	0.16	0.68	0.06
8573 - 5	27900	221	7.7	430	1730	0.14	3.06	321	1.61	0.28	10.7	0.28	168	0.58	0.01	1.31	0.19	0.01	0.02	0.55	2.2	0.11
8573 - 6	26900	143	6.7	113	860	0.09	2.7	306	0.56	0.44	7.4	-0.01	188	0.33	0.01	1.8	0.08	0.15	0.02	0.56	0.95	0.24
8573 - 7	21200	199	5	95	560	0.1	2.77	180	0.59	0.34	5.01	0.08	193	0.37	0.01	0.72	0.12	0.18	0.06	0.37	1.32	0.11
8573 - 8	22700	240	10	410	3510	0.55	7.61	338	1.28	0.59	7.8	0.26	398	0.54	0.01	1.25	0.12	0.03	0.01	0.22	1.35	0.06
8573 - 9	38900	344	12.7	781	1930	0.46	15.8	657	2.58	0.81	15.8	0.33	168	1.26	0.01	1.74	0.13	0.09	0.02	0.42	1.18	0.05
8573 - 10	17800	280	27.9	352	4120	1.2	11.1	362	1.35	0.45	22.1	0.47	210	0.44	0.01	0.65	0.17	-0.1	0.01	0.5	2.22	0.11
8574 - 1	135000	365	17.7	4800	44600	3.13	22.1	651	20.5	3.53	41.2	0.92	367	1.95	0.14	13	1.9	0.16	0.05	1.9	29.9	0.78
8574 - 2	172000	830	24.7	5440	67700	5.81	36.3	910	29.9	8.3	770	1.14	408	2.56	0.08	14	0.86	0.32	0.02	2.98	33.3	0.86
8574 - 3	181000	1210	26.9	8300	77000	7.4	40.8	1190	30.1	5.7	50.1	1.6	309	2.99	0.14	18	1.38	0.43	0.00	4.35	30.4	1.23
8574 - 4	142000	1300	23.0	5620	70700	8.8	47.1	1060	29	6.8	35.6	1.66	167	4.4	0.09	11.6	0.86	0.16	0.03	3.52	24.4	1.23
8574 - 5	114000	686	14.6	4790	38200	4.04	22.9	646	17.4	3.78	32.6	1.12	560	2.2	0.07	7.22	0.56	0.25	0	2.32	19.3	0.64
8574 - 6	54600	565	5.59	630	7800	0.75	6.7	245	4.79	1.87	15.6	0.18	102	2.2	0.04	2.0	0.22	0.21	0	1.47	4.71	0.67
8574 - 7	16200	195	1.01	77	910	0.05	0.57	45.4	0.64	0.34	7.1	0.23	191	0.13	0	0.4	0.08	0.1	0	0.72	1.14	0.08
8574 - 8	23400	251	1.34	104	610	0.19	0.82	103	0.93	1.01	12.1	0.31	220	0.2	0.06	1.5	2.3	0.17	0.04	0.95	1.6	0.12
8574 - 9	276000	2620	39.8	13700	155000	13.7	94.3	2540	64	18.8	76	1.87	240	7.1	0.26	36.4	1.39	0.51	0.01	9	53	2.7
8574 - 10	326000	4010	48.4	20900	174000	18.5	105	3030	82	16.1	83.1	3.4	165	6.6	0.38	62.5	1.67	0.7	0.06	10.4	65	2.51
8607 - 1	170000	-30000	5400	2800	230000	240	2700	47000	200	-4800	34000	-1000	2900	-100	2400	52000	5800	100	1170	560	148000	530
8607 - 2	310000	-270000	44000	1000	290000	-2800	42000	58000	-4100	-70000	18000	-6100	3300	1000	1180	72000	3500	-7000	660	1800	304000	510
8607 - 3	72000	-900	1220	840	28000	0	-420	30300	110	590	7900	-50	2640	-41	58	6460	256	140	54	140	178000	208
8607 - 4	700000	600000	12000	50000	2650000	4400	-10000	15000	-2200	-12000	19000	-20000	6000	300	300	39000	1100	-6300	710	3500	57000	930
8607 - 5	1260	231	1.03	33.3	2890	0.44	1.50	4690	1.9	0.8	2180	0.57	1650	0.39	59.6	4740	255	6.80	74.20	0.28	4940	88.3
8607 - 6	1750	241	0.15	10.1	2490	0.43	2.77	4000	2.09	0.39	2330	0.16	1423	0.29	77.8	6610	301	19.7	96	0.36	10500	140
8607 - 7	1850	192	0.92	51	4210	0.48	5.9	6330	2.29	0.77	2420	0.13	2970	0.75	90	7110	379	122	114	1.35	9090	450
8607 - 8	8900	308	0.53	50	5490	0.63	9.3	11800	2.63	0.4	4730	0.55	1489	1.71	140	10300	343	5.53	135	0.37	32400	166
8607 - 9	15900	356	1.77	56.9	10710	0.77	12.3	15340	4.61	1.19	5970	0.2	2400	1.99	131	9400	334	13.3	114	0.44	64700	243
8607 - 10	5130	299	0.31	25.9	3510	0.55	8	12500	6.62	1.1	4870	0.44	1233	1.73	116	8510	422	7.8	120	0.25	45600	139
8581 - 1	20600	87.5	1.56	10	1200	0.08	0.58	45.3	1.79	0.11	14.8	0.3	3900	0.63	0.09	7	0.09	0.2	0.06	3.52	8.3	0.27
8581 - 2	10800	136	1.13	3.8	294	0.15	1.8	33.4	0.84	-0.06	7.1	-0.02	3320	-0.01	0.03	0.63	0.12	0.33	0.06	5.59	1.95	0.03
8581 - 3	19200	84.3	1.24	7.1	680	1	0.79	35.0	1.33	0.23	12.7	0.39	4590	0.13	0.90	1.67	0.15	0.16	0.13	3.81	5.2	0.06
8581 - 4	13000	109	0.97	4.3	376	0.1	1.21	25.6	0.54	0.24	8.4	0.37	2880	0.15	0.05	0.24	0.05	0.23	0.01	3.96	0.7	0.01
8581 - 5	8000	81.4	0.80	4.3	272	0.42	0.18	19.5	0.79	0	6.6	0.14	2520	0.1	0.06	1.6	0.31	0.09	0.04	3.88	24	0.06
8581 - 6	7400	116	0.88	4.4	200	0.19	0.13	13.2	0.51	0.44	7.6	0.32	2260	0.2	-0.01	0.16	0.05	0.33	0.01	2.96	0.58	0
8581 - 7	5310	94.8	0.89	1.89	108	0.14	-0.43	12.3	0.51	-0.16	4.1	0.14	10500	0.08	0	0.2	0.07	0.18	0	4.69	0.28	0.01
8581 - 8	6490	66.0	0.74	2.37	130	0.04	0.22	11.2	0.41	0.21	4.84	0.12	4880	0.01	0	0.59	0.01	0.13	0	2.57	3.6	0.01
8581 - 9	17500	65.8	2.27	8.2	450	0.62	0.55	80	1.19	0.4	20.3	0.34	2290	0.13	3.2	18	0.07	0.13	0.05	3.44	6.7	0.01
8581 - 10	8300	57.5	0.76	3.28	190	-0.02	0.29	13.1	0.65	0.43	6.15	0.29	7800	0.03	0	0.42	0.01	0.09	0	7.7	0.88	0.02

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8609 - 1	3120	68.0	1.23	7.7	2630	0.49	6.43	12320	2.61	0.83	2120	0.23	2350	1.08	94	5530	455	5.9	145	0.39	11100	201
8609 - 2	3810	59.5	1.55	10.4	2130	0.62	4.7	10410	2.36	0.69	1790	0.14	2920	2.9	83.7	4720	377	7.5	112	0.71	11100	318
8609 - 3	1940	71.5	0.43	21.4	1720	0.41	4.4	8300	2.64	1.62	1490	0.24	2510	0.46	106	5700	361	5.4	121	0.39	5900	144
8609 - 4	4730	62.8	1.14	58	2410	0.64	5.8	12660	2.12	0.66	1630	0.18	2150	1.04	78.5	3940	331	10	93.4	0.45	10200	83
8609 - 5	3140	67.5	1.01	10.1	1090	0.4	5.22	15550	1.55	0.56	1370	0.01	2300	1.49	74.8	3610	337	53	103	0.47	7800	211
8609 - 6	1390	71.3	0.34	8.9	2490	0.46	3.21	6770	1.67	0.43	2110	0.17	1594	0.59	75	3490	361	14.3	81.1	0.37	6770	148
8609 - 7	1480	76.9	0.56	3.5	2100	0.48	2.89	7420	2.37	0.77	2660	0.12	1610	0.63	74.3	3370	426	16.2	96	0.24	8000	557
8609 - 8	3470	86.4	0.7	10.6	1870	0.52	4.84	11100	3.53	1.76	3250	-0.03	1740	5.1	112.7	5360	486	6.8	136	0.39	11250	264
8609 - 9	2850	65.7	3.0	51	3890	0.94	5.9	7460	4.1	1.01	2000	0.58	2960	0.55	119.4	4810	451	6.7	154	0.48	9900	137
8609 - 10	1710	101	1.68	2.76	1400	0.43	2.56	6840	2.9	0.8	1760	0.19	1986	0.69	81	3630	374	3.63	104	0.46	5210	177
8605 - 1	6400	93.9	6.0	19	2760	0.74	4.56	6550	4.13	0.73	1570	0.1	1670	1.55	149	5260	571	2.29	190	0.77	8600	263
8605 - 2	4090	115	0.3	4	1300	0.34	3.5	6230	3.05	1.41	1220	-0.01	1610	0.67	95	3770	413	1.07	115	0.4	4210	127
8605 - 3	3050	112	4.7	6	740	0.43	3.9	8170	2.25	0.93	1132	-0.01	1840	0.87	66	2820	336	3.7	89	0.37	3610	275
8605 - 4	2700	114	4.1	15	750	0.32	3.59	5670	1.76	0.54	1170	0.37	1490	0.37	75.1	2930	288	3.7	101.1	0.55	4110	124
8605 - 5	2680	117	6.3	6	630	0.43	5.7	10900	1.54	0.99	1120	0.36	1870	11.2	76	2960	369	6.2	89.2	0.65	4540	467
8605 - 6	3350	115	3.1	8	727	0.50	3.4	6070	1.58	0.87	2120	0.2	1510	1.22	86.4	3280	368	2.45	115	0.68	4940	202
8605 - 7	4500	126	-0.60	14	770	0.48	4.06	9480	2.52	0.97	1480	0.1	2200	0.73	93	5160	412	2.36	123	0.75	4730	156
8605 - 8	2760	120	21	8	310	0.38	3.65	9260	1.76	0.48	718	0.05	1805	0.96	63	2910	237	1.42	78.5	0.69	3240	68
8605 - 9	3030	133	-230	11	440	0.54	5.7	11660	2.31	0.5	711	0.24	1909	4.1	59.8	2680	223	0.81	69.2	0.71	3070	94
8605 - 10	1670	126	-8.5	7	232	0.5	5.51	13600	1.02	0.59	758	0.07	1820	0.72	48.8	2300	250	0.72	64.3	0.67	3190	100
8599 - 1	51200	260	3.92	179	620	0.28	2.56	373	0.81	0.3	7.40	0.02	30.4	0.54	0	0.58	0.11	0.04	0.02	0.52	5.2	1.2
8599 - 2	106000	1790	136	5100	106500	145	246	2120	46.6	7.4	31.4	0.76	38	2.18	0.13	10.5	0.42	0.09	0.04	1.03	7	0.24
8599 - 3	95000	6300	11900	22300	377000	470	1870	2540	61	54	78	2.9	152	7.5	0.99	14.4	3.4	0.24	0.04	3	33.6	0.71
8599 - 4	44500	658	96.7	1440	25130	40	70.9	681	17.8	1.64	10.6	0.18	14.8	1.2	0.02	0.6	0.12	-0.07	0	0.47	1.99	0.1
8599 - 5	37200	244	1.25	104	1010	0.28	7.33	700	0.61	0.59	5.86	0.17	17	0.63	0.26	0.71	0.3	0.03	0	0.31	0.91	0.1
8599 - 6	10000	228	-0.13	25	170	0.1	0.78	129	0.27	0.01	2	0.18	8.9	0.1	0	0.27	0.09	0	0	0.23	0.26	0.11
8599 - 7	3900	217	0.08	15	31.4	-0.03	0.84	43	0.12	-0.4	0.94	0.1	6.3	-0.02	0	0.22	0.05	0.04	0	0.12	0.22	0.04
8599 - 8	39300	940	29.4	2610	61400	84.8	124	1044	44.8	3.7	13.4	0.21	12.3	1.99	0	0.86	0.1	0	0.02	0.65	3.13	1.1
8599 - 9	25100	273	10.8	1450	4980	6.7	12.3	408	3.52	0.64	8.25	0.27	4.6	1.04	0.03	5.6	0.11	0.02	0.01	0.17	4.51	0.14
8599 - 10	2880	209	0.41	33	45	0.16	0.36	45	0.14	-0.27	1.2	0.08	11.5	0.02	0.01	1	0.02	0.18	0.01	0.27	1.52	3.8
8597 - 1	159000	-340	175	118	4600	-7	170	590	4	-51	38	-3	117	-2	1.57	81	1.9	4	0.63	28	137	1.7
8597 - 2	111000	183	14.5	46.7	3310	0.39	2.3	279	3.46	-0.1	27.1	0.32	220	0.92	0.04	1.27	0.48	1.02	0.06	2.59	10.8	0.09
8597 - 3	31000	232	3.74	32	370	0.13	-0.3	58	1.01	0.1	7.6	0.33	136	0.15	0.01	0.25	0.18	0.51	-0.01	1.62	2	0.04
8597 - 4	2600	269	1.20	4.7	60	0.41	1.6	27	-0.27	1.1	0.66	0.13	93.8	0.38	0.02	1.97	0.08	0.48	0	1.17	1.98	0.05
8597 - 5	25400	172	3.80	134	3800	1.92	7	273	3.80	2.8	18.2	0.4	89	0.9	0.54	41.4	2.29	0.61	1.12	0.98	171	19
8597 - 6	27600	123	7.20	47	1180	0.23	3.6	236	0.62	0.6	16.4	0.26	69	0.54	0.56	23.7	1.47	1.38	0.53	0.9	98	0.67
8597 - 7	25100	107	5.60	141	2480	0.34	4.4	209	2.49	-0.6	11.4	0.28	140	0.69	0.24	13.6	0.79	0.15	0.15	0.84	40.6	1.53
8597 - 8	99100	664	15.5	812	49600	28.4	56.5	674	11.50	3.0	32.7	1.39	202	1.78	0.67	38.7	2.63	0.92	0.86	1.49	108	6.03
8597 - 9	12200	127	5.30	218	3750	0.61	9.2	272	2.86	-0.43	24.5	0.28	56.8	0.41	0.77	52	2.72	0.24	0.95	0.68	500	1.25
8597 - 10	1014	302	-0.20	0.8	97	-0.28	1	7.4	0.04	-0.8	0.7	-0.13	107	0.14	0.03	1.47	0.23	0.7	-0.01	0.33	1.92	0.05
85914 - 1	4110	129	0.47	8.4	79	0.03	0.19	42	0.15	0.2	1.31	0.13	294	0.07	0.01	0.36	0.03	0.15	0	0.76	1.45	0.02
85914 - 2	2380	153	0.17	8.8	21.4	-0.03	-0.25	17.2	-0.02	-0.04	1.14	0.15	294	0.02	0.01	0.31	0.07	0.12	0	0.55	0.64	0.01
85914 - 3	4210	135	0.79	10.9	125	0.01	0.38	41.3	0.30	0.94	1.26	0.11	459	0.17	0	0.94	0.01	0.04	0.01	0.68	1.12	0.08
85914 - 4	3650	146	0.45	12.2	40	-0.01	-0.31	33.4	0.16	-0.09	1.8	-0.02	488	0.04	0	0.38	0.1	0.07	0.01	0.71	1.13	0.05
85914 - 5	2380	142	0.04	12	42	0.01	0.51	22.8	0.11	0.5	1.35	0.04	669	0.07	0	0.43	0.08	0.02	0	0.75	1.03	0.06
85914 - 6	2260	141	0.47	4.2	21	0.05	0.79	20.6	0.09	0.07	1.15	0.19	280	-0.02	0	0.64	0.09	0.02	0	0.63	1.17	0.08
85914 - 7	2410	145	0.27	5.9	37	-0.02	0.8	21.4	0.24	0.22	1.44	-0.08	129	0.13	0.01	0.63	0.1	-0.01	0.01	0.58	5.8	0.1
85914 - 8	2230	148	0.46	3.9	11.80	0.04	0.67	17.1	0.08	0.38	0.93	0.1	98.5	0.11	0	0.32	0.12	0.01	0	0.31	0.34	0.02
85914 - 9	4940	122	1.07	21.3	72	0.03	0.99	38.8	0.10	0.23	1.89	0.01	251	0.05	0.01	0.83	0.09	-0.07	0	0.45	1.8	0.16
85914 - 10	4900	149	0.56	9.8	37	0.02	0.87	47.2	0.19	0.07	2.09	0.11	300	0.03	0	0.29	0.07	0.01	0	0.54	0.13	0.01

Appendix A - continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
8576 - 1	730	153	1.21	1.21	15	0.07	-0.15	8.2	0.10	-0.58	0.55	0.05	160	0	0	0.05	0.06	0	0	0.39	0.05	0
8576 - 2	730	150	1.06	4.6	54	0.04	0.51	11.7	0.37	0.32	0.77	0.26	174	0.06	0	0.2	0.07	-0.04	0	0.35	0.21	0.01
8576 - 3	910	148	0.41	14	17	0.06	1.03	10.9	0.18	0.13	0.97	0.16	145	0	0	0.19	0.08	-0.02	0	0.51	0.38	0.07
8576 - 4	960	131	0.92	23	57	0.03	0.61	12.7	0.19	0.38	0.83	0.09	184	0.05	0.01	0.16	0.01	0.03	0	0.33	0.13	7.6
8576 - 5	760	136	0.19	1.4	7	0.06	0.17	8.9	0.14	0.13	0.95	0.13	268	-0.04	0	0.16	0.04	-0.04	0	0.42	0.08	0.01
8576 - 6	1490	130	0.25	7.7	106	0.01	2.79	24.7	0.02	-0.09	0.78	0.17	267	0.02	0	1.7	0.05	0.02	0.01	0.48	0.58	0.26
8576 - 7	2040	112	0.38	55	47	0.04	1.52	70	-0.03	0.23	0.83	0.14	193	0.08	0	0.14	0.05	-0.06	0	0.39	0.35	0.05
8576 - 8	650	115	0.58	3.4	9	0.06	-0.1	7.7	0.09	0.38	0.74	0.15	206	-0.02	0	0.01	0.01	-0.01	0	0.46	0.02	0
8576 - 9	1340	114	2.07	15.7	141	0.14	3.3	24.8	0.10	0.46	0.51	0.15	750	-0.03	0	0.18	0.04	0.02	0	0.58	0.24	0.01
8576 - 10	860	119	0.19	3	5	-0.04	0.53	12.8	-0.09	0.44	0.57	0.05	215	0.18	-0.01	0.01	0.03	0.06	0	0.7	0.10	0
020 - 1	2200	172	0.22	130	3010	46.8	616	450000	1.39	1.43	307	0.16	1018	1.07	53.4	13100	107	0.03	15.8	12.1	1690	13.6
020 - 2	18000	236	0.87	196	27000	11.3	450	50800	1.67	2.57	861	0.3	527	0.59	142	33800	499	0.03	23.6	1.85	4320	30
020 - 3	39200	324	1.14	486	55200	9.1	450	57300	1.95	1.35	817	0.23	432	1.05	98.8	19500	446	0.11	18.6	6	8450	41.6
020 - 4	42300	409	0.46	570	84000	21.9	1060	72100	3.05	2.47	1094	0.79	459	1.25	195	41700	1027	0.05	41	6.1	11700	58
020 - 5	34900	398	0.87	690	60400	13.7	429	94500	1.69	2.08	767	0.72	262	1.21	80.8	16460	382	0.05	15.5	4.0	8020	38.5
020 - 6	27100	353	0.55	583	40500	14.64	519	93500	1.55	1.25	561	0.55	180	0.99	78.1	15990	360	0.06	7.88	2.53	6780	44.6
020 - 7	6900	300	0.47	87	13800	15.82	318	46800	1.25	1.59	648	0.88	971	0.3	129	26000	345	0.04	29.4	0.95	3710	17.1
020 - 8	37100	547	1.42	1520	60500	18.5	641	123000	2.75	2.38	830	0.82	534	2.01	105	16900	396	0	14.3	4.55	12900	44.2
020 - 9	35700	517	1.63	1440	59800	16.5	670	84100	2.03	1.68	692	0.61	229	1.26	96	13500	364	0.05	8.42	4.49	11120	51.9
020 - 10	37800	563	0.49	970	85900	11.3	550	52400	2.21	1.31	615	0.72	234	1.3	112	14600	403	0.07	14	3.15	12370	46
8566 - 1	203000	950	25.9	4500	36200	6.1	18.2	910	13.10	5.9	32.8	2.2	161	3.6	3.3	28	4	0.33	1.1	3.8	36	2.2
8566 - 2	155000	656	11	2060	13900	2	12.6	663	7.20	1.34	19.3	0.49	133	1.64	0.05	6.6	0.74	0.08	0.01	1.64	12.3	0.69
8566 - 3	60600	361	4.3	590	4500	1.21	3.44	281	3.04	0.59	7.8	0.38	119	0.59	0.03	0.9	0.36	0.05	0.03	0.63	5.7	1.07
8566 - 4	32900	337	3.9	134	1310	0.07	1.1	154	1.06	0.01	4.6	0.33	82	0.19	0.02	0.51	0.12	0.03	0.07	0.51	1.87	0.76
8566 - 5	168000	990	15.2	1160	10600	2.3	14.3	740	7.40	1.9	18.1	1.04	138	2.9	0.54	4	2.3	0.32	0.15	2.8	170	1.01
8566 - 6	191000	864	21.8	1660	12800	1.89	12.6	670	5.70	2.6	56.0	0.03	138.0	2.28	0.04	1.39	0.47	-0.05	0.1	4.1	15.1	0.77
8566 - 7	235000	1500	30.2	2320	28200	11	22.1	970	12.90	0.7	27.9	2.48	88	2.63	0.55	8	10	0.05	0.4	5.7	15.8	0.68
8566 - 8	215000	970	38.0	3660	26400	6.6	23.9	1170	24.20	5.1	29.1	6.1	195	3.3	2.9	8	14	0.9	1.3	11.5	370	0.97
8566 - 9	216000	1100	26.8	2660	14500	3.9	13.7	880	13.30	5.2	21.6	0.36	152	4.6	21	20	2.2	0.41	0.04	4.92	22	4.1
8566 - 10	190000	769	23.9	1910	10200	2.94	11.2	740	8.60	2.5	20.3	0.28	141	2.32	0.16	9	0.84	0.11	0.21	2.74	11	1.4

Appendix B – Laser Ablation Data for Sources

Appendix B - Laser ablation ICMPS data for all analyses of all natural sources in order of analyses, standard used for quantification is listed below each element

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
NSCD-03	3.9	145	0.07	-0.5	-0.1	0.21	6.6	56.3	0.29	0.38	1.4	0.05	16.9	0.1	0.00	1.11	0.19	0.64	0.021	2.42	9.32	0.069
NSCD-03_1	3.4	172	0.09	0.5	2.2	-0.02	6.7	61	0.27	-0.65	0	-0.1	20.530	0.1	0.02	1.21	0.3	0.13	0.045	1.72	8.4	0.067
NSCD-03_2	4.2	152	0.13	-0.25	1.88	-0.01	7.9	78.1	-0.03	-1.18	1.48	-0.03	17.2	-0.103	0.01	1.41	0.22	0.33	0.018	2.2	10.7	0.08
NSCD-03_3	1.5	126	0.05	0.27	1.8	0.03	20.2	85.8	-0.03	0.38	2	0.17	15.560	0.02	0.02	1.64	0.27	0.32	0.03	2.61	12.7	0.132
NSCD-03_4	3.8	140	-0.09	0.8	1.8	-0.087	8.1	107	0.19	-0.3	0.87	0.13	11.260	0.02	0.01	1.97	0.258	0.22	0.027	2.27	13.7	0.12
NSCD-03_5	2.6	137	0.146	0.4	2.09	-0.06	7.2	101	0.13	0.2	0.7	0.14	17.2	0.1	0.00	1.61	0.165	-0.01	0.025	1.74	11.8	0.077
NSCD-03_6	3.8	157	0.01	-0.5	1	-0.08	7.6	119	-0.06	1.04	-0.67	-0.19	18.4	-0.07	0.00	1.87	0.5	0.17	0.012	2.14	14.1	0.141
NSCD-03_7	4.3	144	0.01	-0.5	0.8	-0.02	7	230	0.05	0.59	1.49	-0.18	10.9	0.23	0.00	3.26	0.44	0.24	0.047	2.34	27.7	0.232
NSCD-01	9.4	142	0.06	-0.3	2.6	0.01	8.4	233	0.36	0.36	1.57	0.15	8.1	-0.01	0.01	3.78	0.58	0.24	0.02	2.1	24.4	0.217
NSCD-01_1	9.3	148	0.03	-0.1	1.45	0.03	6.9	218	0.15	0.24	1.5	0.13	4.74	0.04	0.00	3.02	0.36	0.7	0.019	2.39	21.1	0.218
NSCD-01_2	13.5	144	0.01	6.1	0.6	0.11	10.7	199	-0.04	-0.1	1.4	0.01	17.4	-0.09	0.00	3.17	0.51	0.74	0.072	2.24	18.8	0.225
NSCD-01_3	7.6	154	0.15	-0.3	1.72	-0.14	7.9	215	0.15	-0.52	0.9	-0.04	18.8	-0.03	0.00	3.17	0.37	0.13	0.028	2.06	18	0.173
NSCD-01_4	6	145	0.04	-0.05	0.6	0.01	7.6	183	-0.05	-0.5	1.1	0.39	24	-0.11	0.03	2.39	0.46	0.47	0.025	2.38	14.3	0.145
NSCD-01_5	8.7	141	0.12	0.8	0.1	0.48	7	194	-0.1	-0.23	0.82	-0.04	7.69	-0.03	0.01	2.85	0.45	0.37	0.035	1.77	15	0.185
NSCD-01_6	9.3	166	-0.27	0.8	1.26	0.05	7.9	178	-0.15	-0.29	0.67	0.13	12.990	0.2	-0.01	2.53	0.16	0.36	0.022	1.62	13.2	0.158
NSCD-01_7	9	138	-0.23	0.3	66	0.43	693	590	-0.28	0.19	137	0.14	197	0.13	9.10	2110	176	171	9.23	2.64	147	36.3
NSCD-02	19	133	0.02	-0.1	0.87	0.07	10	273	0.39	-0.1	0.4	0.27	18.7	0.07	-0.01	3.36	0.48	0.57	0.024	2.86	19.8	0.225
NSCD-02_1	20.7	224	-0.03	1.1	1.46	0.12	6.2	234	0.1	0.9	1.83	0.07	10.9	0.09	0.00	2.75	0.4	0.16	0.038	2.95	18.4	0.185
NSCD-02_2	21	144	-0.05	0.4	1.11	0.08	7.9	263	-0.16	-0.4	1.38	0.06	13.9	0.27	0.00	3.13	0.42	0.18	0.031	3.15	20.1	0.197
NSCD-02_3	22	147	-0.51	0	1.62	0.03	8.7	250	0.16	-0.61	0.26	0.08	8.08	0.12	0.00	3.38	0.23	0.11	0.019	2.5	19	0.205
NSCD-02_4	24	155	-1.18	0.9	1.07	-0.06	9.3	243	-0.07	-0.18	0.97	-0.12	9.34	0.04	0.00	3.12	0.23	0.62	0.015	2.31	18.3	0.166
NSCD-02_5	-7.7	116	-0.11	-0.1	0.6	0.2	34.6	79.2	-0.01	0.22	1.1	0.36	6.19	0.02	-0.01	1.03	0.18	0.22	0.011	2.69	7	0.073
NSCD-02_6	2.6	121	-0.4	17.1	196	0.4	14.6	99	-0.02	0.5	2.22	0.03	19.8	-0.12	0.01	1.25	0.21	0.53	0.025	2.4	8.2	0.093
NSCD-02_7	8	118	0.5	0	1.01	0.09	7.5	161	-0.05	0.9	0.3	0.09	17.5	-0.01	0.01	1.83	0.24	0.1	0.003	2.59	12.7	0.113
NSCD-07	18	162	1.1	1.1	0.64	0.14	6.7	152	0.02	-0.93	1	0.08	16.3	0.08	0.00	1.47	0.173	0.2	0.018	1.8	13.4	0.108
NSCD-07_1	5	125	0.93	-0.51	0.18	-0.02	7.9	150	-0.01	-0.54	0.5	-0.02	11.9	0.16	0.01	1.64	0.164	0.39	0.033	2.32	12.8	0.082
NSCD-07_2	-2.7	396	1.62	1.4	0.16	-0.09	6.5	104	0.13	0.9	0.9	0.66	13.9	0.124	0.01	1.02	0.12	0.22	0.006	1.78	7.3	0.1
NSCD-07_3	22	164	-0.1	0.5	1.34	-0.17	10	148	-0.16	-0.1	2.9	-0.02	6.7	0.13	0.02	1.88	0.18	0.19	-0.002	2.36	13.6	0.091
NSCD-07_4	22	378	-0.9	2.2	0.51	-0.08	5.5	151	-0.14	-0.03	0.59	0.46	14	0.05	-0.02	1.65	0.25	-0.14	-0.004	1.92	13.1	0.13
NSCD-07_5	6.3	244	1.1	1.3	0.43	0.09	5.7	127	-0.12	-0.89	0.65	0.25	5.74	-0.15	0.01	1.37	0.14	-0.16	0.027	1.99	11.8	0.081
NSCD-07_6	20	142	1.7	0.82	0.84	0.07	6.1	130	0.15	-0.57	1.17	0.12	12.9	0.15	-0.01	1.85	0.19	0.03	-0.006	0.96	13.3	0.079
NSCD-07_7	3	137	-0.2	-0.61	3.4	-0.067	587	95	0.15	-0.85	139	-0.04	165	-0.02	0.19	68	64.5	7000	7.79	2.38	610	55
NSCD-06	6.5	142.8	-0.38	-1.3	0.32	-0.12	12.3	93.5	-0.04	0.5	1.63	0.5	7.95	0.1	0.03	1.41	0.164	-0.05	0.05	3	13.6	0.071
NSCD-06_1	2	147	-0.04	0.4	0.49	0.02	6.1	77.3	-0.04	-0.4	-0.36	-0.15	7.11	0.23	-0.01	1.19	0.18	0.16	0.002	1.88	11.6	0.067
NSCD-06_2	14.1	96	-0.09	0.6	0.44	-0.12	6.6	77.6	-0.06	-1.12	1.1	0.03	5.92	-0.04	-0.01	1.44	0.26	0.4	0	2.58	11.3	0.071
NSCD-06_3	10	124	0.27	2.07	0.65	0.03	2.7	62.3	0.26	-0.47	1.18	0.11	10.940	0.125	0.01	1.19	0.11	-0.01	0	2.71	9.3	0.04
NSCD-06_4	5.3	128	0.35	-0.12	0.36	0.09	4.6	41.9	-0.19	-0.1	1.31	0.3	13.8	0.05	0.00	0.79	0.06	0.25	0.006	2.06	6.84	0.06
NSCD-06_5	5.2	160	0.17	0.11	0.34	0.02	5.1	82	0.15	-0.2	0.29	0.12	9.84	0.23	-0.01	1.27	0.19	-0.11	0	2.56	11.5	0.066
NSCD-06_6	0.9	165	-0.16	0.87	-0.06	0	10.6	62.1	0.43	0.2	1.65	0.35	10.710	-0.1	0.00	1.06	0.065	0.03	0.024	2.25	9.3	0.064
NSCD-06_7	8.2	114	-0.049	1	1.27	-0.03	8	98.9	0.21	0.6	1.8	0.87	11.430	-0.07	0.00	2.33	0.371	0.1	0.018	1.74	16	0.102
NSCD-05	3.4	138	0.39	-0.24	2.21	-0.12	8.6	111	-0.02	1.7	1	0.48	3.2	-0.06	0.02	1.73	0.48	0.61	0.031	2.07	16.9	0.139
NSCD-05_1	3	135	0.2	0.4	1.34	-0.101	8.7	106	0.05	-0.1	1	-0.07	7.81	-0.08	0.02	2.03	0.34	-0.04	0.054	2.29	16.1	0.13
NSCD-05_2	2.6	126	-0.12	0.4	1.68	-0.1	6.7	111	0.05	0.9	0.6	0.06	10.430	0	0.00	1.79	0.48	0.32	0.008	2.57	17.1	0.154
NSCD-05_3	2.3	131	0.03	0.8	1.3	-0.2	7.8	115	-0.12	-0.54	2.3	0.07	7.08	0.04	-0.01	2.18	0.37	0.3	0.065	2.23	17	0.16
NSCD-05_4	4.5	139	-0.035	-0.7	0.8	-0.089	7.3	115	0.19	-0.7	0.9	-0.08	6.53	-0.05	0.01	2.09	0.49	0.05	0.028	2.12	17	0.146
NSCD-05_5	3.2	149	0.09	0.86	0.4	0.144	8.2	103	-0.12	-0.03	1.1	-0.1	7.86	-0.01	0.01	2.13	0.43	0.29	0.02	2.29	16.8	0.14
NSCD-05_6	2.1	155	0.001	1.4	1.9	0.1	7.4	104	0.22	0.5	0.47	0.08	7.87	-0.19	0.01	1.98	0.42	0.29	0.008	0.83	16.1	0.157
NSCD-05_7	1.5	128	-0.044	0.65	37	0.41	920	207	0.16	0.01	182	-0.03	169	0.13	0.46	109	540	237	8.87	2.19	356	43.1

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
NSCD-04	3.9	148	0.03	0.1	1.2	0.03	7.1	84.1	0.02	0	0.92	-0.17	2.91	-0.05	0.01	1.36	0.15	-0.04	0.021	1.67	12.53	0.094
NSCD-04_1	1.9	165	0.07	1.1	5.2	0.12	6.6	95.5	0.03	0.33	1.07	0.11	26.1	0.2	0.01	1.7	0.36	0.15	0.028	2.34	14.7	0.155
NSCD-04_2	3.9	142	-0.09	1.3	3.9	0.21	8.7	106	0.23	-0.3	1.3	-0.15	41.8	0.18	0.00	1.75	0.28	0.48	0	1.78	16.1	0.15
NSCD-04_3	6.4	144	0.13	0.05	2.5	-0.02	14	80	-0.06	-0.3	0.1	0.12	18.1	0.11	0.02	1.47	0.22	0.28	0.023	1.27	12.2	0.115
NSCD-04_4	4.8	151	0.09	0.75	3.7	0.25	7.3	119	0.35	1.34	2	0.2	26.5	0.13	-0.01	1.72	0.31	0.16	0.03	1.86	17.1	0.177
NSCD-04_5	1.3	147	-0.06	1	3.4	0.18	10.1	66.5	0.15	0.05	0.99	0	21.240	-0.02	0.01	1	0.32	0.46	0.018	2.16	9.35	0.064
NSCD-04_6	4	144.8	-0.14	0.5	3.2	0.16	50.8	78	-0.1	0.87	1.5	0.23	27.6	0.11	0.02	1.13	0.38	0.08	0.003	2.68	11.5	0.078
NSCD-04_7	4.6	121	-0.11	0.1	2.2	0.19	4	58	-0.04	-0.93	1.5	0.1	5.35	0	0.01	0.8	0.13	0.39	-0.002	2.61	8.2	0.088
NSCD-09	5.5	132	-0.09	-0.6	1.6	0.11	4.37	77	0.36	-0.07	0.81	0.03	21.550	0.28	0.00	1.15	0.05	0.35	-0.004	2	11	0.069
NSCD-09_1	3.4	357	-0.09	1.7	2.9	0.165	5.31	58.3	-0.13	-0.32	2.9	-0.07	11.8	0.18	0.01	0.84	0.13	0.2	-0.003	1.07	7.81	0.155
NSCD-09_2	2.6	135	-0.2	1.44	2.8	0.16	2.83	67	-0.16	-0.8	0.32	-0.02	11	0.15	0.00	1.08	0.13	-0.06	0.001	2.23	9.6	0.09
NSCD-09_3	5.4	168	0.13	0.63	1.4	0.01	6	92	0.08	0.4	0.7	0.02	9.8	-0.01	0.02	1.11	0.17	0	-0.006	1.47	11.7	0.087
NSCD-09_4	5	148	0.13	1.2	4.4	-0.11	6.2	90	-0.1	0.8	1.8	0.07	9.29	0.02	0.01	1.2	0.238	-0.06	-0.003	2.3	12	0.077
NSCD-09_5	4	131	-0.26	0.8	5.2	-0.03	8.2	117	-0.01	0.5	0.13	0.08	11.0	-0.04	0.00	1.49	0.11	0.48	0.014	2.1	14.7	0.102
NSCD-09_6	5.4	131.8	-0.35	0.8	1.5	0.05	5.8	118	0.17	0.36	-0.03	0.19	14.8	-0.03	0.01	1.41	0.289	0.22	0.037	1.21	13.8	0.116
NSCD-09_7	12.8	151	0.27	-0.34	2.3	-0.15	5.7	105	0.1	-0.34	0.7	-0.1	9	0.01	0.00	1.59	0.13	0.36	-0.0043	1.98	13.7	0.07
NSCD-10	10	149.4	0.16	-0.79	4.9	-0.09	5.3	108	0.07	-0.6	0.09	0.06	7.11	0.04	0.01	1.39	0.189	-0.05	0.013	0.71	15.3	0.103
NSCD-10_1	9	105	-0.48	0.4	39	0.33	630	280	0.05	0	162	-0.03	188	0.14	0.62	128	190	259	9.71	2.27	230	26.2
NSCD-10_2	13.5	126	-0.35	0.06	5.2	-0.09	4.4	150	-0.18	-0.6	1.46	-0.09	6.52	0.24	0.01	1.49	0.172	-0.03	0.008	1.98	16.6	0.09
NSCD-10_3	23	129.7	0.67	1.52	4.3	-0.07	5.4	152	-0.01	0.6	1.6	0.01	6.52	-0.05	-0.02	1.43	0.2	-0.22	-0.004	1.98	17.6	0.097
NSCD-10_4	12.9	156.1	-0.4	1.24	7.1	-0.19	5.9	142	-0.05	0.28	0.6	-0.26	11.57	0.03	0.02	1.4	0.22	-0.2	0.028	2.12	17.4	0.084
NSCD-10_5	3	147	-0.7	0.96	0.7	-0.21	7.5	151	0.2	1.31	0.7	-0.11	9.97	-0.01	0.01	1.68	0.21	0.42	-0.001	2.66	17.1	0.1
NSCD-10_6	22	138	0.2	0.38	7.5	-0.02	7.2	167	0.17	-1.3	1.34	-0.09	12.3	-0.08	0.01	1.71	0.33	-0.29	0.012	2.26	18.8	0.107
NSCD-10_7	22	146	0.9	0.05	6	0.14	5.3	148	0.05	-1.21	0.8	-0.06	17.3	0.16	0.00	1.47	0.185	-0.5	0.009	2.39	17.3	0.11
NSCD-11	8.8	117	0.3	0.2	4	0.04	4	132	-0.17	1.16	0.8	-0.22	15.0	0.23	-0.01	1.48	0.333	0.03	0.032	2.66	15.3	0.107
NSCD-11_1	19	103	-0.62	-0.2	3.1	0.1	7.7	139	-0.06	0.1	0.11	-0.02	20.1	0.05	0.01	1.69	0.15	0.55	0.011	2.28	15.4	0.065
NSCD-11_2	19	125	1.3	0	4	0.07	3.2	121	-0.13	0.6	0.7	-0.13	38.8	-0.18	-0.01	1.45	0.25	-0.08	0.023	2.44	13.4	0.097
NSCD-11_3	13	105	0	0.37	2.2	0.07	5.3	131	0.07	-0.36	0.6	-0.02	54.2	0.05	0.01	1.37	0.2	0.08	0.01	2.62	13.8	0.095
NSCD-11_4	21	138	-0.64	0.7	2.9	0	4.8	147	0.21	1.05	1.68	-0.01	58.2	0.17	-0.01	1.65	0.19	0.59	-0.001	2.43	15.6	0.14
NSCD-11_5	22	127	1.21	1.7	4.3	0.07	18.7	126	0.14	-0.97	1.17	0.14	55.8	0.15	0.03	1.56	0.11	0.2	0.022	1.46	13.5	0.081
NSCD-11_6	16	114	1.2	0.25	3.1	-0.17	4.3	170	0.07	0.69	0.22	-0.3	61.6	0.27	0.02	2.17	0.17	0.58	0.026	2.58	16.8	0.103
NSCD-11_7	17	134	-0.4	-0.12	2.2	-0.07	4.4	118	0.1	-0.46	0.24	-0.28	25.8	0.1	0.00	1.18	0.21	0.22	0.021	2.04	14.5	0.092
NSCD-12	2	128	0.7	-0.3	1.4	-0.11	4	119	-0.03	0.6	-0.2	-0.36	18.1	-0.06	0.01	1.4	0.295	0.08	0.01	1.9	14	0.099
NSCD-12_1	24	142.6	0.1	2.3	3.1	-0.07	6.2	136	0.05	-1.21	0.1	0.25	16.6	-0.04	0.03	1.76	0.209	0.21	-0.001	1.3	15.2	0.128
NSCD-12_2	21	142	0.2	-0.7	6.6	0.18	6.4	136	-0.02	-0.1	0	0.19	23.1	-0.04	0.00	1.59	0.1	0.62	-0.001	2.41	15.6	0.124
NSCD-12_3	14.2	106	0.32	2.4	6.4	-0.16	4.5	129	0.11	0.8	1.16	0.09	16.5	-0.09	0.00	1.28	0.19	1	0.015	1.83	14.8	0.104
NSCD-12_4	11	131	0.3	-0.63	1.9	-0.11	3.9	120	-0.04	-0.2	1.1	-0.24	19.2	-0.039	0.01	1.63	0.07	0.61	0.023	2.07	14.4	0.08
NSCD-12_5	10.7	124	0.6	-0.08	4.2	-0.08	4.4	115	-0.09	0.1	-0.1	0.26	24.6	0.1	0.01	1.42	0.176	-0.23	-0.011	2.39	13.8	0.062
NSCD-12_6	15.2	115.2	-0.5	0.9	5.6	0.09	3.9	141	0.16	-0.8	0.7	0.16	14.76	-0.12	-0.02	1.75	0.074	0.6	0.057	0.28	14.5	0.122
NSCD-12_7	21	140	-1.6	-0.6	6.2	0.1	587	158	0.32	-0.17	145	0.02	196	0.12	0.16	30.2	84	209	9	1.89	97	16
NSCD-13	38	122.5	-0.2	1	3.4	-0.09	2.9	148	-0.04	-0.11	-0.2	-0.22	10.2	0.24	0.01	1.4	0.21	0.64	0.017	2.82	16.4	0.1
NSCD-13_1	24	117	1.7	-0.1	4.3	-0.03	4.5	149	0.07	-1.05	-0.19	-0.26	11.4	0.07	0.01	1.64	0.29	0.42	0.026	2.63	17	0.101
NSCD-13_2	29	142	1.6	-0.57	4.2	-0.01	3.75	141	0.06	1	-0.24	-0.04	15.8	0.09	0.02	1.74	0.212	0.18	-0.006	2.55	16.3	0.118
NSCD-13_3	26	116	4.6	2.05	4.3	-0.03	4.2	145	0.08	0.91	0.8	0.08	9.46	0.1	0.00	1.67	0.13	0.11	-0.005	2.44	15.9	0.081
NSCD-13_4	22.9	147	0.3	0.4	1.7	-0.11	4.2	147	0.07	-0.45	0.72	-0.23	9.89	-0.02	0.03	1.6	0.2	-0.27	0.008	2.31	16.8	0.115
NSCD-13_5	19	150	0.3	-0.33	1.9	-0.13	4.4	118	-0.13	-0.67	0.61	0	8.82	-0.05	0.00	1.56	0.21	0.87	0.005	2.19	13.4	0.08
NSCD-13_6	37	152	-4.7	-1	4.8	-0.13	5	136	-0.07	-0.21	0.2	-0.12	10.5	-0.18	0.02	1.68	0.312	0.9	-0.005	2.33	14.3	0.067
NSCD-13_7	29	126	-8.8	1.2	3.1	-0.14	2.1	182	-0.03	0.14	1.4	-0.11	12	0.1	0.03	2.32	0.26	0.38	0.028	2.86	23.4	0.161

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
NSCD-14	40	87	7	-0.1	0.22	0.001	3.4	213	-0.27	0.43	0.43	-0.42	14.7	-0.13	0.04	2.71	0.289	0.97	0.02	2.88	26.9	0.145
NSCD-14_1	32	134	13	0.2	2.8	0.21	4.6	192	-0.06	0.05	0.9	-0.33	13.9	-0.19	0.03	2.54	0.37	0.5	0.006	2.03	26	0.145
NSCD-14_2	16	157	210	0.2	8.2	0.33	4.2	181	0.12	0.7	-0.37	0.07	17.8	0.07	0.01	2.31	0.106	1.1	0.012	1.92	24.1	0.151
NSCD-14_3	24.3	129	11	-0.1	2.9	0.05	4.1	188	0.19	0.42	2.2	0.38	9.93	0.29	-0.01	2.14	0.28	0.46	0.014	2.32	24.5	0.182
NSCD-14_4	10	156	1	1.4	3.8	0.11	7.9	223	0.12	-0.16	2.1	-0.01	17.4	0	0.01	2.77	0.22	1.07	0.034	2.08	28.2	0.198
NSCD-14_5	26	116	-5.2	5.6	0.6	0.07	6.6	116	-0.1	-0.3	1.4	-0.02	20	0.11	0.02	1.54	0.13	-0.67	0.009	1.78	16	0.093
NSCD-14_6	18	86.6	4.6	-1.92	1.6	0.09	6.4	154	-0.08	1.17	0.5	0.16	24.2	0.08	0.02	1.83	0.129	0.7	0.006	0.57	19.5	0.128
NSCD-14_7	21.9	136	-5.3	1.9	1.66	0.01	496	142	-0.11	0.79	141	-0.1	191	0.24	0.21	34	62	660	9	3.11	177	20.3
NSCD-15	23	124	-7	0	0.29	-0.03	4.6	157	0.57	-0.27	0.34	0.25	21.1	0.11	0.01	1.73	0.16	0.7	0.003	1.39	18.6	0.128
NSCD-15_1	20	172	1	-0.8	1.09	-0.08	1.4	127	0.08	-1.07	1	-0.25	24	-0.09	-0.01	1.29	0.186	0.19	-0.001	2.14	15.2	0.097
NSCD-15_2	13	150	-41	1.18	0.19	0.07	2.6	110	0.05	-0.54	-0.1	0.19	20.5	0.01	-0.01	1.25	0.041	0.08	0.01	2.72	13.2	0.081
NSCD-15_3	21	130	46	0.7	-0.2	0.05	4.7	115	0.2	-0.63	0.8	0.01	26.2	-0.03	0.01	1.21	0.12	-0.24	0.012	2.7	14	0.099
NSCD-15_4	14	172	-7	0.1	0.4	-0.06	3.5	122	0.22	0.47	-0.1	-0.11	29.6	0.04	0.00	1.58	0.18	0.4	-0.001	2.72	14.2	0.065
NSCD-15_5	10	158	-12.6	0.28	0.36	0.11	1.8	118	-0.287	0.7	0.02	0.2	20.85	-0.12	0.01	1.45	0.25	-0.57	0.03	2.93	13.2	0.094
NSCD-15_6	22	162	5.8	-0.9	0.13	0.05	2.1	124	-0.27	0.01	-0.15	-0.14	13.6	0.17	0.01	1.45	0.198	0.8	0.008	2.3	15.3	0.085
NSCD-15_7	8	166	-2.3	0.3	0.29	0.04	3.4	131	0.27	0.4	0.6	0.07	13.3	0.26	0.01	1.38	0.19	-0.07	0.006	3.03	16.8	0.074
NSCD-16	14	138	1.5	-0.2	0.24	-0.02	9.3	156	0.16	-0.42	0.7	0.01	11.5	0.17	0.02	1.87	0.21	0.8	0.025	2.36	19.1	0.099
NSCD-16_1	21	136	-3.6	0.2	0.41	-0.06	6.8	172	0.06	-0.44	0.55	0.07	13.6	0.1	0.00	1.94	0.2	-0.39	0.006	2.53	21.1	0.095
NSCD-16_2	23	168	-0.4	1.3	0.16	0.08	6.6	187	-0.35	0.06	1	0	11	0.02	0.01	1.72	0.15	-0.09	0.011	1.77	22	0.136
NSCD-16_3	19.1	180	2	1.6	0.25	0.16	6	192	0.1	-1.07	1.4	-0.05	18.8	0.03	0.00	1.74	0.342	0.03	0.018	2	25.3	0.116
NSCD-16_4	20	150	1.1	1.31	0.25	-0.03	6.6	196	0.19	0.08	0.65	-0.07	5.82	0	0.01	1.9	0.17	-0.82	0.036	1.35	26.3	0.105
NSCD-16_5	15.5	119.8	-1.3	0.1	-0.01	0.06	4.2	126	-0.06	-0.35	-0.7	0	5.52	-0.05	0.00	1.49	0.038	1.3	0.009	1.95	17.4	0.11
NSCD-16_6	9.8	150	-0.4	0.7	0.15	-0.12	5.8	166	0.03	0	-0.3	-0.27	14.4	-0.03	0.04	1.59	0.24	0.72	0.006	2.56	21.8	0.12
NSCD-16_7	20	183	0.6	2.5	0.14	-0.07	5.2	148	0.07	0.17	1.2	0.1	29.8	0.02	0.00	1.66	0.2	-0.45	0.025	2.3	18.5	0.076
NSCD-08	6.4	152	1	0	0.47	0.05	5.56	151	-0.13	0.6	1.61	-0.06	36.9	0.06	0.03	1.44	0.29	0.94	0.007	1.6	18.9	0.106
NSCD-08_1	21.2	164	1.7	0.9	0.18	-0.04	5.6	151	0.03	-0.26	0.27	0.33	11.4	0.06	0.01	1.45	0.1	0.54	0.029	1.76	19.8	0.096
NSCD-08_2	22.7	140	1.7	0.56	0.383	0.02	3.3	166	-0.22	-0.61	-0.01	-0.1	12.2	-0.02	0.00	1.84	0.18	1.09	0.004	1.82	21.3	0.126
NSCD-08_3	22	120	1.9	3.4	0.05	0.21	8.9	163	-0.21	-0.26	0.85	0.07	21.7	0.05	-0.02	1.73	0.23	-0.28	0.002	2.16	22.7	0.108
NSCD-08_4	15	144	1.9	-0.3	0.15	-0.11	6	166	0.08	-0.13	0.8	0.01	29.3	-0.09	-0.01	1.6	0.28	1.17	0	2.28	22	0.118
NSCD-08_5	16	107	0	0.5	0.121	-0.04	3	166	0.13	0.8	0	0.36	36.7	-0.02	0.01	1.71	0.28	0.78	0	2.01	21.7	0.087
NSCD-08_6	16	151	2.3	0.2	0.25	0.08	5.4	175	0.3	0.27	-0.2	0.04	10.9	0.01	0.00	1.76	0.32	0.18	0.003	0.77	23.9	0.134
NSCD-08_7	-2.6	171	0.5	-0.1	20.7	1.04	672	840	-0.01	0.16	146	-0.18	177	0.37	8.30	1750	620	3040	7.91	2.26	2410	134
Bolivia	3.4	158	0.7	0.79	1.4	0.006	-0.03	-1.03	0.003	1	-0.15	-0.023	0.86	-0.0414	0.01	0.03	0.041	-0.02	0	1.7	0.014	0.045
Bolivia_1	9.9	182	-0.2	-0.1	14.1	0.016	0.16	0.05	0.024	-0.35	0.8	0.029	2.89	0.034	-0.01	0.15	0.12	0.08	0	1.54	0.094	0.104
Bolivia_2	-3.1	148	-0.8	1.5	11.8	0.018	0.52	0.33	-0.005	-0.93	0.58	-0.004	2.21	-0.0335	0.00	0.06	0.07	-0.0915	-0.001	1.48	0.65	-0.008
Bolivia_3	5.5	139	-0.91	0.5	0.7	0.011	-0.24	-0.53	0.025	0.46	0.21	0.004	1.87	0.09	-0.01	0.06	-0.01	0.06	-0.001	1.75	-0.001	-0.021
Bolivia_4	9.9	150.3	-1	0.4	0.05	0.002	0.24	-0.43	-0.002	0.1	0.8	-0.009	1.09	0.063	-0.01	0.037	-0.23	-0.1037	0	2.47	0.017	0.023
Bolivia_5	0	142	0.4	0.4	0.8	-0.01	-0.45	0.39	0.001	-1.16	0.6	-0.030	0.72	0.053	0.02	0.008	-0.07	-0.05	0	1.81	0.017	0.026
Bolivia_6	4.8	142	0.1	1.4	3.9	-0.008	-0.44	1.49	0.036	-1	0.5	0.008	3.43	0.001	0.01	0.07	0.23	-0.05	0	1.46	0.198	-0.0041
Bolivia_7	9.9	162	0.1	1.9	33.8	0.014	0.46	0.02	-0.009	0.42	-0.04	0.019	1.7	-0.009	0.00	-0.02	-0.02	-0.163	-0.001	2.15	0.103	0.005
Kazakhstan	3.3	124	1.2	1	0.1	0.028	0.18	-0.33	0.1	-0.66	0.94	-0.045	99.7	0.02	0.02	-0.044	-0.07	-0.056	-0.001	2.54	0.046	0.015
Kazakhstan_1	0.9	125	-0.28	0	-0.1	-0.005	-0.32	-0.33	-0.022	-0.99	0.5	-0.039	155	0.076	-0.01	0.11	-0.02	-0.004	-0.001	2.94	0	0.009
Kazakhstan_2	7.2	127.3	-0.2	0.5	-0.5	0.014	0.04	-0.42	0.008	-0.45	0.24	-0.009	57.8	-0.024	0.00	-0.028	-0.05	0.03	-0.001	1.43	0.009	0.019
Kazakhstan_3	3.2	182	0	0.42	0.3	0.024	0.2	-0.8	0.029	0.5	0.65	-0.044	96.6	0.008	0.01	0.04	0.017	0.024	0.000	3.02	0.068	0.017
Kazakhstan_4	5.2	115	1.9	1.2	-0.7	0.016	0.25	0.87	-0.023	-0.32	0	0.1	100.2	-0.026	0.00	0.1	0	-0.018	-0.006	2.61	0.022	0.035
Kazakhstan_5	0.6	131.5	1.4	1.03	-0.5	0.074	-0.19	-0.16	0.043	0.7	0.55	-0.016	40.7	-0.023	0.02	0.008	-0.08	0.07	-0.005	2.02	0.037	0.016
Kazakhstan_6	5.1	113	0	0.26	-1.5	-0.019	-0.36	0.02	-0.028	0.94	0.5	0.087	43.4	0.029	-0.01	0.06	-0.134	0.008	0	1.9	-0.024	0.022
Kazakhstan_7	0	113	2.5	-1.12	-0.9	0.01	-0.28	-0.3	0.037	0.3	0.47	-0.003	43.4	-0.034	0.01	0.07	0.12	-0.05	0	2.41	-0.007	0.002

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
MuM-LS2	7	125.4	1.4	-0.46	1.7	0.035	0.11	-0.64	0.015	0	0.05	0.005	30.5	-0.016	0.00	-0.054	-0.01	-0.0162	0	2.23	0.001	-0.01
MuM-LS2_1	0	130.4	0.9	-0.9	-4	0.042	0.05	-0.07	0.01	-0.14	0.2	0.078	36.8	-0.018	-0.01	-0.047	0.09	-0.022	0	2.45	0.04	0.00
MuM-LS2_2	14	122	-0.4	0.2	3.8	-0.005	0.4	0.44	0.007	0.09	1.2	0.006	35.5	-0.022	0.01	-0.025	0.02	-0.057	0	2.49	-0.039	-0.02
MuM-LS2_3	3.1	132	0.7	0.44	-0.8	0.011	0.14	-0.09	-0.015	-0.51	0.5	0.02	52.6	0.061	0.01	0.105	-0.008	-0.043	0	2.22	0.004	0.00
MuM-LS2_4	-9	138	0.7	-0.53	0.9	0.003	-0.06	-0.41	0.024	-0.4	0.04	0	43.1	0.029	0.01	-0.091	-0.111	0.005	0	1.64	0.005	0.00
MuM-LS2_5	-0.1	133	-1.3	0.8	-0.2	0	0.13	1.6	-0.013	-0.36	-0.04	0.061	10.7	-0.005	0.00	-0.025	-0.104	0.13	0	2.28	-0.017	0.02
MuM-LS2_6	3.1	114	1.23	-0.7	-1.1	-0.018	0.29	0.5	0.013	-0.05	0.72	0.038	14.2	0.004	0.03	0.092	0.04	0.06	0.006	2.15	-0.006	0.00
MuM-LS2_7	3.9	150	-0.6	0.2	-0.9	-0.004	-0.1	-0.79	-0.008	0.47	1.04	0.083	14	-0.0152	0.00	-0.104	0	-0.1451	0	2.35	-0.008	0.00
MuM-LS1	8.4	155	1	0.4	0.9	0.085	-0.39	0.6	0.039	-0.71	-0.42	-0.004	70	-0.005	0.01	0.031	-0.03	-0.115	0	1.95	0.044	0.01
MuM-LS1_1	4.2	187	-0.9	-0.23	1.7	0.013	-0.21	0.08	0.014	-1.11	0.18	0.012	53.9	0	0.00	0.057	-0.083	-0.062	0	2.63	0.06	-0.01
MuM-LS1_2	-2.7	139	0.5	-0.6	1.1	-0.008	0.24	1.17	-0.02	-0.44	-0.17	-0.012	64.6	0	0.03	0.14	0.04	0.12	0	2.25	0.015	0.01
MuM-LS1_3	2.1	142	-0.4	-0.96	2.9	0.02	0.26	0.51	-0.022	0.09	0.25	-0.027	46.8	-0.013	0.00	0.05	-0.101	-0.0599	0	2.16	0.042	0.00
MuM-LS1_4	2	148	-0.2	-0.3	-0.8	-0.014	0.15	0.22	-0.013	-0.39	0.91	-0.029	17.1	-0.014	0.00	0.09	0.07	0.019	0	2.07	0.052	0.01
MuM-LS1_5	2.2	190	0.4	1	-2.3	0.016	-0.38	0.87	-0.008	1.75	0.43	0.052	64.9	0	0.01	0.033	0.042	-0.042	0	2.6	0.006	0.01
MuM-LS1_6	-4	155	-1	0.1	0.1	0.004	-0.16	0.65	-0.017	0.21	-0.78	-0.013	93	-0.009	0.00	-0.031	0.02	-0.0465	0	2.7	0.003	0.00
MuM-LS1_7	-9	209	0.2	-1.6	-3.9	-0.009	-0.2	-0.36	0.016	0.12	-0.1	0.051	97.2	-0.010	-0.01	0.042	-0.1	0.023	0	2.36	0.021	0.00
MuM-CW1	-5	149	-0.26	-0.1	0	0.02	0.04	0.3	0	-0.1	43.5	0.072	236	0.009	0.00	-0.027	-0.019	-0.005	0	4.99	-0.002	0.00
MuM-CW1_1	2.2	170	-0.5	0.2	0.7	0.03	0.06	0.9	0.022	0.28	26.3	-0.008	239	-0.005	-0.01	0	0.06	-0.0303	0	4.44	-0.04	0.00
MuM-CW1_2	-2	183	-0.32	-0.4	1.9	-0.007	-0.24	-0.17	0.009	0.45	28.3	0.039	246	0.002	0.00	0.042	-0.01	-0.0256	0	4.6	0.023	0.01
MuM-CW1_3	-3	174	-0.94	-0.4	2.2	-0.006	0.05	1.7	0.053	-0.04	24.9	0.035	228	-0.010	0.00	0.061	-0.032	0.014	0	5.22	0.036	0.00
MuM-CW1_4	1	176	-0.91	0.3	-1.6	-0.0101	-0.23	1.24	-0.006	0.56	34.3	-0.004	255	0	0.00	0.006	-0.046	-0.006	0	4.97	-0.007	0.00
MuM-CW1_5	0.7	200	-0.27	0.3	-1.5	-0.003	0.4	0.51	0.021	0.05	37.3	-0.014	252	0.08	0.00	0.09	-0.081	0.012	0	5.4	-0.043	0.00
MuM-CW1_6	12.7	180	-0.52	-0.97	0.9	-0.014	0.45	-0.3	0.025	-1.27	31.7	-0.009	217	-0.015	0.00	-0.025	0.04	-0.007	0	4.4	-0.015	0.002
MuM-CW1_7	-3.9	144	-0.54	-1	0.9	-0.011	0.17	-1.4	0.012	0.13	37.9	0.015	246	-0.015	0.00	0.017	0.09	-0.006	0	5.32	0.015	0.012
MuM-CW2	1.7	139	-0.33	-0.3	0	0.006	0.38	-0.65	0	-0.24	65.7	-0.004	435	0.089	0.00	0.054	0.08	0.034	0	4.67	-0.006	0.001
MuM-CW2_1	2.2	139	-0.11	-0.8	2.9	0.014	0.14	0	-0.003	0.81	58.4	0.013	382	0.018	0.00	-0.057	0.147	0.006	0	4.7	0.008	-0.005
MuM-CW2_2	2.5	137	0.64	-0.2	-1.6	-0.007	0.61	0.14	-0.0054	0.48	61.6	0	367	0.014	0.00	0.018	-0.096	-0.007	0	4.7	0.005	0.006
MuM-CW2_3	-6.2	111	0.35	0.1	-3	-0.009	-0.02	0.49	-0.0343	0	60.5	-0.008	371	0	0.00	0.035	0.06	-0.009	0	4.86	0.018	-0.006
MuM-CW2_4	1.1	139	-0.03	1.58	-4.6	-0.014	0.12	-0.32	-0.042	0.66	57.6	-0.012	385	-0.005	0.00	0.067	-0.004	-0.008	0	3.44	-0.017	0.014
MuM-CW2_5	7.2	116	-0.37	-0.6	1.3	-0.009	-0.08	0.39	-0.010	0.37	61.7	-0.004	366	-0.009	0.02	0.05	0.067	0.002	0	4.35	0.038	0.008
MuM-CW2_6	-1.6	108	0.34	0.8	1.7	0.01	0.04	-0.02	0	-0.66	55.8	0.036	369	-0.004	0.00	0.005	0.018	-0.008	0	3.83	0.023	-0.003
MuM-CW2_7	-5.8	151	0.17	-1	-8.3	-0.005	0.09	-1.22	-0.008	-1.17	65.4	-0.004	366	0	0.00	0.008	0.039	-0.003	0	3.59	-0.001	0.001
MuM-Kew1	-8	118	0.47	-0.9	-0.8	-0.006	0.26	0.21	0.049	-0.08	147	0.045	287	-0.009	0.00	0.071	-0.11	0.016	0	5.74	-0.011	-0.022
MuM-Kew1_1	6.7	117	-0.41	-0.2	-0.5	0.053	-0.25	-0.3	0.012	0.41	124	0	405	0	0.00	0.018	-0.07	0.011	0	8.9	0.034	-0.006
MuM-Kew1_2	6	106	-0.31	0.37	-2	-0.011	-0.02	-0.52	-0.003	0.83	23.9	0	286	0.016	0.01	0.017	-0.13	-0.007	0	4.6	-0.005	-0.012
MuM-Kew1_3	4.5	125	-0.43	0.2	-3.5	0.005	-0.31	0.3	0.011	0.36	16.6	0	297	0	0.00	-0.013	0	0.003	0	6.15	-0.043	0.004
MuM-Kew1_4	3.7	108	0.5	-0.3	0.9	-0.013	0.11	0.06	-0.002	0.32	33.5	0	239	0	0.00	0.042	-0.08	0.014	0	4.86	-0.017	-0.001
MuM-Kew1_5	4.1	111	-0.05	1.5	0.7	0.012	0	-0.31	0.008	-0.17	47.1	0.037	277	0.014	0.00	-0.01	0.024	-0.002	0	5.22	0.004	-0.011
MuM-Kew1_6	4.8	104	-0.33	-0.08	2.9	0.036	-0.3	0	0.07	0.34	44.2	0.014	263	-0.005	0.00	0.027	-0.036	-0.007	0	5.55	-0.009	0.01
MuM-Kew1_7	7.4	108	-0.21	0.47	-0.5	0.068	0.04	-0.18	-0.005	-0.98	54.2	0	259	-0.009	0.00	0.017	-0.06	-0.014	0	4.8	-0.01	-0.006
MuM-Kew2	0.2	79	0.2	-0.05	-0.6	0.007	-0.18	0.33	-0.003	0.01	0.22	0	273	-0.009	0.00	0.061	-0.096	-0.014	0	5.69	0.037	0.003
MuM-Kew2_1	2.3	103	-0.33	0	-1.5	-0.012	0.32	0.41	-0.003	-0.24	0.89	0	259	0	0.01	0.043	0.001	-0.006	0	5.93	0.02	0.002
MuM-Kew2_2	5.4	114	-0.06	1.04	-1.8	-0.005	-0.51	-0.62	0.012	0.21	35.9	-0.012	276	0	0.00	0.012	-0.12	-0.007	0	5.48	0.002	0.005
MuM-Kew2_3	0	89	0.25	0.3	-1.61	-0.007	-0.13	0.28	-0.011	0.43	54.7	-0.012	267	0	0.00	0.035	-0.11	0.009	0	4.8	0.002	0.002
MuM-Kew2_4	0.8	123.1	0.17	-1.5	0.6	0.02	0.17	-0.07	0.002	0.44	3.98	0	273.5	0.001	0.00	0.03	-0.162	0	0	5.61	0.034	0.002
MuM-Kew2_5	4.2	94.2	0.28	0.1	-2.7	-0.015	0.48	0.7	0.057	0.02	8	0	265	-0.019	0.00	0.036	-0.041	-0.003	0	5.31	0.018	-0.018
MuM-Kew2_6	3.4	110	0.13	0.77	-2.2	-0.003	-0.03	0	-0.005	0.46	5.7	-0.020	299	0.016	0.00	0.019	0.04	-0.0169	0	6.69	0.035	0.01
MuM-Kew2_7	-0.8	110	0.33	0.29	-5.2	0.004	-0.43	-0.96	0.005	0.45	20.1	-0.029	274	-0.015	0.00	-0.006	-0.02	-0.0225	0	5.36	-0.014	0

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
MuM-Co1	1.1	103.3	-0.16	-0.08	-0.7	-0.026	-0.27	0.1	-0.006	0.18	-0.5	0.018	0.098	0	0.01	0.103	-0.15	0.07	0	2.82	0.078	-0.016
MuM-Co1_1	9.3	107	-0.17	1.1	0.36	0.052	0.23	0.53	0.025	0.4	-0.3	0	0.044	0	0.00	0.023	0	0.005	0	2.2	0.018	0.006
MuM-Co1_2	1.2	101.7	-0.26	-0.54	0.4	0.025	0.32	-0.16	0.003	-0.09	0.31	0	0.298	0	0.02	0.089	-0.009	0.006	0	32	0.032	2.86
MuM-Co1_3	4.9	110	0.83	-0.22	17.4	0.083	0.4	1.1	-0.008	-1.3	1.01	0.054	1.48	-0.015	0.00	0.088	0.002	-0.0443	0	2.32	-0.001	0.172
MuM-Co1_4	11.9	137	0.1	-0.33	0.82	-0.007	0.04	1.28	0.023	-0.01	0.46	0	0.087	-0.029	0.02	0.068	0.043	0.03	0	181	0.293	17
MuM-Co1_5	2.3	118	-0.2	0.23	0.52	-0.001	0.19	0.7	0.016	0.28	0.81	0	0.107	-0.032	0.00	0.076	-0.036	0.048	0	24.2	0.023	0.116
MuM-Co1_6	2.8	122.4	1.15	1.22	1	0.011	0.43	-0.43	0	0.5	0.55	-0.004	0.246	-0.010	0.00	0.054	0.065	0.12	0	2.25	0.029	0.182
MuM-Co1_7	4	132	-0.93	-0.47	-0.22	-0.004	-0.04	0.54	-0.006	1.17	0.47	-0.004	0.021	-0.006	0.01	0.057	0.03	0.1	0	2.7	0.022	0.022
MuM-Co2	3.2	128	0.36	-0.5	0.18	0.059	0.32	-0.39	-0.005	-0.04	1	0.01	1.22	0.051	0.01	0.016	-0.048	0.035	0	3.18	0.03	0.036
MuM-Co2_1	1.5	114	0.86	-1.1	43.4	0.075	0.72	1.25	0.011	-0.67	0.9	0	0.97	-0.006	0.14	0.081	0.05	0	0	2.22	0.209	7.9
MuM-Co2_2	3.4	143	0	-1.5	1.99	0.005	0.37	0.25	-0.006	-0.42	0.14	-0.009	20.4	0	0.05	0.026	-0.04	0.107	0	8.3	0.054	19.4
MuM-Co2_3	-0.1	135	-0.45	0.4	0.1	-0.002	1.01	0.17	-0.005	0.17	0.8	-0.008	12	0.017	0.02	0.146	0.022	0.028	0	9	0.097	16.2
MuM-Co2_4	7	133	-0.6	-1.06	0.87	0	0.08	1	0.01	0.43	-0.02	0	8.12	0	0.04	0.09	-0.11	-0.0294	0	2.8	0.057	1.73
MuM-Co2_5	3.7	134.3	0.4	-0.6	0.13	0.02	1.27	-0.05	0	-0.11	0.12	0	62.4	0	0.01	0.194	0.15	0.12	0	3.55	0.033	2.86
MuM-Co2_6	-6.6	150	-0.2	0.5	13.9	0.03	-0.36	0.27	-0.003	-0.19	0.3	0	7.6	0.09	0.08	0.151	-0.024	-0.0415	0	56.6	0.162	18.4
MuM-Co2_7	9.7	146	0.2	-0.19	-0.59	0.009	0.16	0.15	-0.003	0.51	-0.29	0	0.68	0.015	0.00	0.037	0.093	-0.001	0	2.88	0.031	0.444
MuM-Cu1	-0.6	150	-1.4	0.7	-0.02	0.026	0	0.23	-0.009	-0.48	0.34	-0.005	101.3	0	0.01	0.098	-0.089	0.06	0	2.81	0.034	0.125
MuM-Cu1_1	-2.5	148	1.7	0.14	1.27	-0.007	-0.11	-0.2	-0.003	-1.14	1.39	-0.004	63.6	-0.005	0.00	0.1	-0.063	-0.014	0	2.62	0.028	0.02
MuM-Cu1_2	7.5	190	1.7	-1.4	0.88	0.04	-0.03	0.34	0.011	-0.8	2.2	0	68.2	-0.006	0.00	0.016	0.14	0.17	0	2.55	0.026	0.479
MuM-Cu1_3	-8.9	163	-0.8	0	-0.2	-0.002	0.77	-0.35	0	-0.36	2.27	0	77.4	0.02	0.01	0.048	0.012	-0.0332	0	2.29	0.014	0.712
MuM-Cu1_4	2	133	-0.4	-0.4	0.45	0.005	0.58	0.06	0	-1.64	0.3	0.014	56.2	0	0.01	0.072	-0.078	0.008	0	2.15	0.053	0.018
MuM-Cu1_5	7	136	-1.7	0.05	0.25	-0.002	0.17	-0.2	-0.00259	0.01	-0.25	0.049	62	0	0.00	0.017	0.02	0.21	0	2.27	0.063	0.011
MuM-Cu1_6	6	151	-1.6	0.5	0.37	0	0.33	0.78	-0.00272	0.1	0.08	0	56.1	0	0.01	0.023	-0.043	-0.0474	0	2.59	0.094	0.01
MuM-Cu1_7	-5.3	105	0.5	0.86	0.43	0.032	0.19	0.52	-0.005	0.2	0.41	-0.004	68.4	-0.005	0.01	0.127	-0.025	0.05	0	2.3	0.077	0.023
MuM-Cu2	-1.1	121	-0.1	-0.71	0.15	0	0.59	0.03	-0.005	-0.09	0.4	-0.004	76.3	-0.005	0.01	0.004	0.06	0.13	0	2.19	0.01	0.012
MuM-Cu2_1	-0.9	131	-0.4	-0.4	-0.32	0	2.23	0.24	0	-0.04	0.51	0.014	47.6	0.1	0.00	0.056	0.047	0.1	0	2.25	-0.014	-0.001
MuM-Cu2_2	10.9	135	1.7	-1.8	-0.84	0.021	0.47	0.62	0	0.59	0.18	0	82.7	-0.006	0.00	0.047	0.08	-0.0139	0	1.62	0.039	0.031
MuM-Cu2_3	9	172	1	-0.79	1.4	0	0.47	1.04	0.006	0.61	0.65	0	60.8	-0.005	0.01	0.203	0.03	0.31	0	2.1	0.042	0.029
MuM-Cu2_4	-2.5	133	-1.5	0.14	-0.47	0.043	0.32	0.18	-0.006	-0.45	0.83	0	35.2	0.075	0.01	0.167	0.08	-0.101	0	1.78	0.184	0.035
MuM-Cu2_5	5	153.7	-1.9	0	-0.39	-0.005	0.26	0.33	0	0.07	0.03	-0.005	85.4	0	0.01	-0.009	0.117	-0.05	0	2.56	0.047	0.000
MuM-Cu2_6	2.4	167	-0.4	0	0.07	0.011	-0.23	-0.2	0.012	0.19	-0.19	-0.014	58	0.022	0.00	0.151	0.09	0	0	2.16	0.084	0.017
MuM-Cu2_7	-5.8	144.6	-1.9	0.9	-2.61	-0.004	3.3	0.8	0	-0.47	0.42	0.001	58.6	0.022	0.01	0.095	0.075	0.14	0	1.62	0.092	0.007
Penn-S	12.5	194	1.1	-0.26	6	0.021	0.36	6.3	0	0.34	322	-0.018	203	0.014	0.00	-0.017	0.017	-0.0465	0	4.27	0.45	-0.004
Penn-S_1	-11.5	142	1.4	-0.27	1.59	0.003	-0.04	0.04	0	-0.15	367	0	221	0.033	0.00	-0.033	0.033	-0.0482	0	4.74	0.021	0.002
Penn-S_2	-1	126	0.8	-0.61	1.6	-0.012	0.28	1.06	0.01	-0.34	333	-0.004	193	-0.004	0.00	-0.037	0.028	-0.0307	0	3.66	0.005	0.004
Penn-S_3	0.9	133.4	-0.4	-0.14	1.1	-0.003	0.45	-0.13	0	-0.03	389	0.012	194	0	0.00	0.018	-0.002	0.14	0	4.8	-0.016	-0.009
Penn-S_4	19.5	147	2	-0.24	-0.4	-0.002	0.01	-0.69	0	0.64	351	0	193	0	0.00	0.011	-0.017	0.21	0	4.32	0.004	-0.002
Penn-S_5	-2.4	147	-0.2	-0.64	-0.7	-0.009	-0.03	-0.15	0	-0.19	346	0.017	188	0	0.00	-0.006	0.08	0.1	0.005	4.55	-0.008	0.000
Penn-S_6	-1.2	112	-1.9	0.1	2.1	-0.010	-0.29	0.7	-0.008	0.14	371	0	191	0	0.00	-0.026	-0.026	-0.1152	0	5.06	-0.004	0.0004
Penn-S_7	4	109	1.4	1.3	0.9	-0.002	-0.02	-0.88	0.021	-0.22	323	0.022	192	-0.005	0.00	0.016	-0.041	-0.0951	0	4.56	0.031	0.0054
MuM-Marg1	-0.5	130.1	-1	-0.1	1.4	0.044	0.37	-0.2	-0.009	0.05	0.78	0	57.8	0	0.05	0.068	0	-0.06	0	1.45	0.004	0.041
MuM-Marg1_1	2	135	-1	0.85	-0.3	0.001	0.62	-0.2	-0.009	0.73	0.23	0	52.7	0	0.00	0.128	0.056	0.17	0	2.21	0.099	0.045
MuM-Marg1_2	-6	148	-0.14	0.3	0.2	0.004	0.27	0.5	-0.003	0.54	1	0	86.9	0	0.01	0.08	0.01	-0.0492	0.006	2.46	0.091	0.03
MuM-Marg1_3	8.8	144	-0.8	0.2	2	-0.016	0.71	0.12	0.028	-0.48	0.13	0	66.8	0	0.01	0.025	-0.03	0.17	0	1.78	0.074	0.007
MuM-Marg1_4	3.9	121	-2.5	0.09	1.4	0.006	0.2	-0.33	0	-0.32	0.65	0	55.9	0	0.02	0.035	-0.006	0	0	1.6	0.027	0.011
MuM-Marg1_5	4	157.4	0.7	-0.1	0.8	0	0.19	0.95	0.006	0.56	-0.35	-0.004	62.9	0.028	0.00	0.011	0.03	-0.0476	0	2.12	0.115	-0.003
MuM-Marg1_6	5	125	0	0.6	0	0.007	0.03	1.4	-0.00587	1	0.56	-0.004	77.7	-0.011	0.01	0.005	-0.065	0.05	0	1.78	-0.008	0.017
MuM-Marg1_7	0	140	-0.4	0.5	1.7	-0.006	0.79	0.62	0.036	-0.23	0.42	0	98	-0.011	0.00	-0.011	-0.011	0.03	0	1.71	0.042	0.007

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
MuM-Marg2	7	120	0.4	0.3	0.4	-0.022	0.66	1.4	-0.008	1.07	-0.14	0	102	-0.010	0.02	0.029	0.06	0.27	0.005	1.34	0.072	0.084
MuM-Marg2_1	4	148	-1.1	-0.5	-0.4	0.009	-0.29	0.59	0.025	0	0.25	0	98.4	-0.006	0.00	0.047	0.01	0.12	0	2.06	-0.009	0.002
MuM-Marg2_2	2.5	154	0.6	-0.09	-2.4	-0.009	0.53	0.94	0	-0.7	1.02	0	135	-0.005	0.01	0.027	0.03	0.02	0	2.67	-0.008	3.26
MuM-Marg2_3	8.8	142	-0.3	1.3	-1.9	0.016	-0.11	0.09	0	-0.04	0.21	0	108.7	0	0.00	0.006	-0.106	0.16	0	1.81	-0.006	3.5
MuM-Marg2_4	6.8	135	-0.42	-0.06	-1.5	0.007	-0.01	0.1	0	0.93	0.37	0	165	0	0.02	0.069	-0.04	0.23	0	1.47	0.04	2.22
MuM-Marg2_5	7.3	130	-0.1	-0.6	-3.5	0.013	0.38	-0.21	0.028	-0.03	0.13	0.008	126	0	0.01	0.045	-0.033	0	0	1.85	0.037	1.26
MuM-Marg2_6	4.4	139	0.9	0.5	0.7	-0.004	-0.04	0.74	0.033	-0.2	0.43	-0.008	123	0	0.01	0.014	0.002	-0.034	0	1.38	0.059	1.35
MuM-Marg2_7	-5	129	0.1	-1.4	0.3	-0.002	0.08	0.2	0	-0.06	0.09	0	148	0.023	0.00	0.064	-0.034	0.015	0	2.34	-0.024	1.59
Penn-L	-5.4	144	-0.1	-1.02	2.1	0.009	0.07	-0.06	0.042	0.8	463	0	219	0	0.00	0.027	0.002	0.11	0	5	0.034	0.004
Penn-L_1	-6	151	-0.39	-0.5	-1.8	-0.011	0.1	0.3	0.013	-0.35	436	-0.014	227	0	0.00	-0.01	-0.014	-0.091	0	5.62	0.047	-0.008
Penn-L_2	0	154	-0.2	-1.26	2.8	0.006	0.28	-0.22	0	0.57	442	-0.013	222	0	0.00	-0.02	0	-0.008	0	6.14	0.019	0.008
Penn-L_3	2.1	152	0	-1.01	-2.5	-0.004	0.44	-0.6	-0.003	0.21	419	0	240	-0.006	0.00	0.019	-0.038	0.25	0	5.5	-0.014	0.013
Penn-L_4	9.1	129	-0.41	0.9	1.8	-0.004	0.31	-0.23	-0.003	0.97	379	0.038	199	-0.005	0.00	0.004	0.042	-0.038	0	4.7	0.043	-0.010
Penn-L_5	8.3	135	0.55	0.76	1.4	0.002	-0.16	0.35	-0.010	-0.97	410	0	201	0	0.00	-0.002	0.01	-0.058	0	4.69	0.043	-0.003
Penn-L_6	-8.4	129	0.37	0.07	3.3	0	-0.14	1	-0.014	-0.4	431	0	242	0.016	0.00	0.018	0.08	0.11	0	4.59	0.041	0.004
Penn-L_7	-7.1	124	-0.19	1.2	2.4	0.002	0.09	0.8	-0.006	-0.3	492	0	221	-0.005	0.00	0.034	0.077	-0.019	0	3.7	-0.004	-0.002
MM-IRH	6	161	0.2	-0.46	-1.42	-0.01	-0.48	0.52	0.07	0.2	13.2	0.14	184	0.08	0.01	0.06	-0.09	0.22	0	2.07	-0.003	0.003
MM-IRH_1	-6	128.5	-0.35	-0.2	-0.83	-0.17	-0.1	0.2	-0.042	0.6	11	0.32	193	0.02	-0.01	-0.002	0.086	-0.1	-0.003	1.64	-0.005	-0.016
MM-IRH_2	12	131	-0.77	-0.5	0.4	0	-0.7	0.01	0	-1	12.5	0.02	215.3	0.05	-0.01	0.05	-0.13	0.02	-0.003	2.33	-0.004	0.002
MM-IRH_3	-7	179	0.3	-2	-0.3	-0.01	-0.8	0	0.08	1.4	16.3	0.09	317	0.02	0.01	-0.044	0.04	-0.1	0	3.42	0.007	-0.005
MM-IRH_4	-2	156	-0.41	0.93	-0.08	-0.09	-0.28	0.08	-0.09	0.88	13.6	0.17	204.7	0.14	0.01	-0.089	0.013	-0.15	-0.002	2.18	0.004	0.004
MM-IRH_5	-2	141	-0.04	1.04	-1.2	0.07	-0.12	0.13	-0.15	-0.27	9.5	-0.15	163	-0.046	0.00	0.002	0.006	0.08	0.025	1.46	-0.001	0.012
MM-IRH_6	7.6	160	0.32	-0.47	-1.5	-0.115	-0.17	0.07	-0.02	-0.81	12.2	0.05	267	0	0.00	0.097	0.05	-0.14	0.001	2.22	-0.012	-0.019
MM-IRH_7	3.6	138	-0.24	-0.1	-1.66	-0.053	-0.45	0.32	0.09	-0.78	11.7	-0.1	202	0.003	0.01	0.029	0.1	-0.12	0.029	1.36	-0.016	0.008
MM-CMK	0.9	151	-0.17	-0.1	0.1	-0.01	-0.33	-0.22	-0.083	0.88	10.4	-0.24	109.9	0.01	0.00	0.02	-0.05	0.15	-0.002	4.33	-0.001	-0.001
MM-CMK_1	-7.7	144	0.27	0	0.53	-0.21	-0.2	0.23	0.013	-0.3	11.4	-0.06	116.3	-0.029	-0.01	0.013	0.01	0.035	-0.001	3.98	0.007	-0.001
MM-CMK_2	2	111	0.3	-0.6	-1.35	0.17	-0.01	0.08	-0.04	-0.91	11.4	0.21	49.5	0.04	0.00	-0.074	0.07	0.18	0.006	1.13	0.011	0.003
MM-CMK_3	-1.7	135	-0.02	0	-0.09	-0.01	-0.8	0.19	0.21	0.3	10.5	0.13	130.3	0.01	-0.01	-0.065	-0.02	0.2	0	3.8	0.022	-0.001
MM-CMK_4	-2.6	113	-0.01	-0.63	0.8	0.06	-0.88	0.1	0.07	0.6	10.4	0.17	63	0.04	0.01	0.041	0.09	0.01	-0.001	1.42	0.0013	-0.012
MM-CMK_5	4.4	119	-0.2	0.4	0.1	0.01	1.14	-0.21	-0.3	-0.16	10	0.09	56.7	0.02	0.01	0.007	0.05	0.1	0.012	1.48	0.005	0.007
MM-CMK_6	2	116.1	0.32	0.1	0	0.13	0.7	0.18	-0.12	0.7	9.8	0	97.9	-0.056	0.00	-0.029	0.03	0.13	-0.003	5.03	-0.015	0.0015
MM-CMK_7	-0.5	126.1	-0.25	-0.32	-1.2	-0.09	0.4	0.01	-0.03	0.27	11	-0.07	97.6	-0.004	0.00	0.011	-0.02	0.01	-0.003	2.08	0.005	-0.005
MM-PMK	7.2	94	-0.44	-0.56	-2	0.01	-0.06	-0.25	0.17	0.44	12	0.2	26.2	0.06	0.01	-0.018	0.11	-0.012	-0.003	1.54	0.006	-0.008
MM-PMK_1	-7	105	0.34	1.2	-0.6	0.078	-0.29	0.46	-0.07	0.58	13.4	-0.09	20.8	0.08	0.02	-0.032	-0.004	0.002	-0.009	1.42	-0.002	0
MM-PMK_2	9	91	0.01	0.95	1.2	0.01	0.44	0.4	0.02	0.38	8.9	0.07	18.9	0.048	0.01	0.05	0.076	-0.053	-0.001	1.29	0.019	0.011
MM-PMK_3	10	135	-0.23	-0.61	0.8	-0.04	0.49	-0.42	0.27	-0.8	11.9	0.06	24.4	0.12	0.00	-0.058	0.076	-0.137	-0.005	1.91	0.014	0.013
MM-PMK_4	-2	122.4	-0.61	0.43	-0.6	-0.28	-0.85	-0.07	0.06	-0.78	8.1	0.1	27.2	-0.047	0.00	-0.108	0.12	0	0.002	1.59	0.007	0.001
MM-PMK_5	-4	93	0.13	0.9	-1.9	0.14	0.7	-0.01	0.19	0.45	5.9	-0.06	24.5	0.08	0.00	0.071	0.047	0.16	0.005	2.01	0.008	-0.002
MM-PMK_6	-9	103	0.27	1.2	0.5	0.04	-0.2	0.04	0.15	-0.5	11.5	-0.02	24.9	0.05	0.00	0.007	-0.07	-0.014	0.005	2.1	0.004	-0.001
MM-PMK_7	-3	121.3	-1.06	0.7	-2.9	0.19	-0.21	0.28	0.07	-0.71	10.9	0.14	23.4	-0.142	0.00	0.1	-0.103	0.07	-0.002	1.11	0	-0.009
MM-CFW	-4	123	0.79	1.7	212	-0.116	0.7	0.23	-0.08	-0.01	17.4	0.25	115	0.14	-0.01	-0.014	-0.03	-0.045	0.005	4.37	0.023	0.001
MM-CFW_1	-4	106	-0.47	36	870	0.04	0.2	0.54	-0.13	-0.9	8.6	0	26.6	0.04	0.00	-0.01	-0.035	0.01	-0.001	2.75	0.097	0.009
MM-CFW_2	3	156	-0.65	1.5	8.5	-0.09	1.3	0.26	-0.04	0.3	6	-0.24	157	-0.09	-0.01	-0.04	0.034	0.22	-0.004	6.67	0.004	-0.008
MM-CFW_3	3	154	-1.55	0.9	12.7	-0.093	0.32	0.81	0.19	-0.96	10.1	0.13	181	-0.013	0.01	-0.025	-0.019	-0.1	0.008	11.93	0.003	-0.005
MM-CFW_4	8	233	-1.65	91	5750	3.25	3.5	12.7	1.28	-0.82	28.2	0.14	110	0.04	0.00	0.009	0.035	0.13	-0.001	7.03	0.037	0.001
MM-CFW_5	9	199	0.1	1.71	94	-0.05	0.51	0.46	0.19	-0.3	19.1	0.25	99.1	0	0.00	0.005	-0.075	0.02	-0.001	3.39	0.033	-0.0026
MM-CFW_6	10	196	0.1	1.2	233	0.012	0.02	0.78	0.02	0.65	33.7	0.24	73.1	-0.105	0.00	0.009	-0.08	0.08	0	3.87	0.005	0.006
MM-CFW_7	-3.3	210	0.9	0.7	36.8	0.17	-1.3	0.21	0.15	0	23.6	-0.07	142.7	0.1	0.00	0.029	-0.01	0.15	0.017	7.36	-0.014	-0.006

Appendix B continued

	^{31}P	^{34}S	^{53}Cr	^{55}Mn	^{56}Fe	^{59}Co	^{60}Ni	^{66}Zn	^{71}Ga	^{72}Ge	^{75}As	^{95}Mo	^{107}Ag	^{111}Cd	^{115}In	^{118}Sn	^{121}Sb	^{125}Te	^{197}Au	^{202}Hg	^{208}Pb	^{209}Bi
	MBH 69	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MBH 69*	*MBH 69*	*MASS1*	*MBH 66*	*MBH 69*	*MASS1*	*MBH 69*	*MBH 69*	*MBH 69*	*MBH 72*	*MBH 69*	*MBH 69*	*MBH 66*	*MASS1*	*MBH 66*	*MBH 66*
MM-WPO	-2.8	186	-0.49	0.3	-2.8	0.08	0.5	0.82	-0.04	-0.18	7.7	-0.03	77.3	0.01	-0.01	-0.022	0.53	0.04	-0.003	1.1	0.008	0.074
MM-WPO_1	-0.1	164	-0.04	-0.2	0.1	-0.26	-0.1	0.17	0	-0.28	8.2	-0.34	149	-0.166	-0.01	-0.046	0.306	-0.12	0.004	1.4	0.02	0.005
MM-WPO_2	1.3	147	0.19	-0.7	-0.9	0.06	-1.18	0.26	0.04	-0.27	12.6	0.18	113.2	0.13	-0.01	0.013	0.319	-0.399	0.003	1.74	0.021	0.068
MM-WPO_3	-2	142	0.06	-0.6	-1.8	0	-0.94	0.17	-0.2	0.23	8.6	-0.01	99	0.04	0.00	-0.02	0.226	-0.24	0.007	1.41	0.01	0.016
MM-WPO_4	0.8	150	-0.09	-1.48	-2.3	-0.066	-0.04	-0.19	-0.21	0	6.5	0.14	102	-0.04	0.00	0.021	0.219	-0.11	0.002	1.07	0.008	0.02
MM-WPO_5	1.4	105	-0.35	0	7	0.01	0	-0.21	0.02	-0.42	6.8	-0.08	100	-0.162	-0.01	0.011	0.22	-0.08	-0.002	1.49	0.028	0.004
MM-WPO_6	-3.3	166	-0.16	-0.6	3.5	-0.14	-0.34	0.02	-0.01	0.44	8.9	0.43	100.4	-0.03	0.00	0.006	0.21	-0.05	-0.007	1.48	-0.003	0.006
MM-WPO_7	-5.1	148.4	0.11	1	-3.3	-0.14	0.39	-0.15	0.09	0.89	8.8	0.13	93.8	0.022	0.00	0.04	0.35	0.04	-0.003	1.07	0.014	0.028
MM-OMH	-1.5	124	-0.13	0.4	4.2	0.03	0.5	0.63	0.14	0.29	41.9	0.01	200.4	0.02	0.00	0	0.06	-0.133	-0.001	2.27	0.005	-0.003
MM-OMH_1	-5.2	124	0.06	0.6	-0.2	-0.032	0.1	-0.31	-0.06	0.2	39.5	0.3	202	0.06	-0.01	-0.034	0.08	-0.12	-0.007	1.84	0.012	0.007
MM-OMH_2	1.8	113	-0.02	-0.76	2.6	0.04	-1.1	0.35	-0.06	0.9	31.4	-0.098	211.4	-0.121	0.00	0.035	0.092	0.06	-0.008	1.67	0.016	-0.001
MM-OMH_3	1.9	139	0.28	0.3	4.7	0.26	-0.29	0.15	-0.06	0.26	39.3	0.22	203	0.09	0.00	-0.015	-0.045	0.06	0.005	1.61	0.001	-0.002
MM-OMH_4	-2.7	142	0.01	-0.3	1.3	0.07	-0.73	0.41	0.04	0.08	38	0.03	201	-0.09	0.00	0.016	0.014	-0.12	0.001	1.97	0.01	0.001
MM-OMH_5	-0.8	161	-0.35	-0.27	0.5	0.1	0.11	0.23	0.05	-0.49	28.4	-0.03	142	-0.02	0.00	-0.042	-0.01	0.09	-0.004	2.15	0.002	-0.005
MM-OMH_6	7.2	212	0.14	-0.1	3.3	0.03	-0.5	0.24	-0.035	0.2	49.7	-0.05	177	0	0.00	0.009	-0.048	1.16	0.013	28.6	-0.004	0.005
MM-OMH_7	1	170	0.39	0	-1.9	0.07	1.43	-0.14	0.22	-0.51	49.1	0.04	197	0.2	0.01	0.064	0.03	0.15	-0.002	1.11	-0.002	0.003