RUNNING AMUQ WITH OBSIDIAN

A STUDY ON SUPRA-REGIONAL SOCIO-ECONOMIC RELATIONSHIPS IN THE NEAR EAST AS SEEN THROUGH OBSIDIAN CONSUMPTION PRACTICES IN THE AMUQ VALLEY (S.E. TURKEY) (CA. 6000 – 2400 B.C.E.)

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TITLE: A study on supra-regional socio-economic relationships in the Near East as seen through obsidian consumption practices in the Amuq Valley (S. E. Turkey) (ca. 6000 – 2400 BCE)

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Lay Abstract

This research involved the chemical analysis of 290 artefacts of archaeological obsidian – a naturally occurring substance made of crystallized lava - as a means of studying ancient exchange systems in the Near East. More specifically, this study covers archaeological periods from 6000 B.C.E. (Late Neolithic) to 2400 B.C.E. (Early Bronze Age) in the Amuq Valley region of southern Turkey. These artefacts were procured during excavations under the Oriental Institute Museum (University of Chicago) beginning in the 1930s. All artefacts are exotic to the Amuq Valley from several known obsidian outcrops in Anatolia (Turkey), some over 1000km away. Analysis was conducted using X-ray fluorescence (XRF) to match each artefact to its geological origin thereby identifying the range of exotic materials were exchanged across long-distances. The goal of this research was to uncover social and/or economic dynamics of the Amuq Valley through deep-time with regards to the greater obsidian trade network of the Near East.

Abstract

Southern Turkey's Amuq Valley has been described as a point of convergence bridging distant regions within the ancient Near East. Through an in depth techno-typological and chemical characterization study of 290 obsidian artefacts, this research details changes in deep-time patterns of obsidian use from the Late Neolithic to Early Bronze Age (6000 BCE – 2400 BCE), arguing that shifting traditions of consumption reflect socio-economic developments both within and beyond the Northern Levant. These artefacts come from the three sites of Tell al-Judaidah, Tell Dhahab and Tell Kurdu, the material excavated during the 1930's by the University of Chicago's Oriental Institute. Methodologically raw material sourcing was achieved using energy dispersive X-ray fluorescence spectroscopy (EDXRF) in the well-established McMaster XRF Lab [MAX Lab]. With these artefacts' raw materials all being exotic to the Amuq Valley, originating from various outcrops in Cappadocia, the Lake Van region and Transcaucasia (Turkey and Armenia), over 1000km away, this study not only offers new insight into how Amuq Valley communities engaged in long-distance relations, but also contributes to a larger, deep-time regional study of obsidian consumption as a proxy for understanding significant shifts in Near Eastern socio-economics, from hunter-gatherers to the earliest states. In turn, this study, by employing an Annales school framework to consider practice over deep time at the local and supra-regional level further contributes to an 'archaeology of the long-term'.

Keywords: The Amuq Valley, Near East, obsidian consumption, XRF, chemical characterization, techno-typological analysis, supra-regional connectivity, socio-economic relationships, long distance trade, Northern Levant, deep-time chronology.

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List of Abbreviations

A - Acigöl

A1 – Acigöl Ante-Caldera East

A2 – Acigöl Post-Caldera East

Absl. – Absolute

Archae. – Archaeological

AV – Amuq Valley

Av – average

BA – Bingöl A

BB – Bingöl B

BCE – before common era

B/F – blade-like flake

BL BI – bidirectional blade

BL PD – prismatic blade (*plein debitage*)

BL SEC – secondary series blades

Cappa – Cappadocia(n)

Cent. – century

Chalco – Chacolithic

Chrono – chronology

Chronos – chronologies

Cult. Pr. – Culture Period

EA – East Anatolia(n)

EBA – Early Bronze Age

EGD – East Göllü Dağ

ETA – Early Trans-Caucasia Cultural Complex (and spread)

FMR – First Mixed Range

LNeo – Late Neolithic

Mesop – Mesopotamia

NE – Near East

NMD – Nemrut Dağ

NZD – Nenezi Dağ

Ob. – obsidian

OI – Oriental Institute (of Chicago)

OIM – Oriental Institute (of Chicago) Museum

PAS – Pasinler

Peralk. – Peralkaline(s)

PN – Pottery Neolithic

Pos. – position (on XRF trays)

PPN(A/B) – Pre-Pottery Neolithic (A or B)

REJ – rejuvenated piece

RjB – Rouj Basin

SEAna – South East Anatolia(n)

s.d. – standard deviation

SKS – Sarıkamış

SMR – Second Mixed Range

Unkn – unknown

WGD – West Göllü Dağ

XRF – X-ray fluorescence

Declaration of Academic Achievement

The following is a declaration that the content of the research in this document has been completed by Lauren Rennie and recognizes all contributions of Dr. Tristan Carter, Kathryn Campeau and recommendations of Dr. Aubrey Cannon. The contents of this thesis will be used for on-going investigations by the Oriental Institute of the University of Chicago and future publications in partnership with the MAX Lab at McMaster University.

Chapter 1: Introduction to the thesis

1.0 Introduction

This thesis employs an integrated obsidian characterisation study as a means of documenting the supra-regional socio-economic relations between the Amuq Valley in Northern Levant and communities in surrounding regions from Anatolia, Mesopotamia and Southern Levant. My focus is the analysis of obsidian tool assemblages from three sites in the Amuq Valley (SE Turkey), whose occupations span 6000 – 2400 BCE, i.e. the Late Neolithic to Early Bronze Age. All obsidian samples used in this research are exotic to the communities of the Amuq Valley, deriving from sources in Anatolia hundreds of kilometers away as well as more than 800km apart from one other.

The Amuq Valley has been conceptualised as a point of convergence between three major prehistoric powerhouses: Mesopotamia, Egypt and Anatolia (Yener et al. 2000), a place where "secondary power nodes emerged" becoming "the backdrop of a number of important cultural developments" (Yener 2005:2). With this in mind, it is my intention to employ the results of a chemical and techno-typological analysis of 290 obsidian artefacts from Tell al-Judaidah, Tell Dhahab, and Tell Kurdu. This diachronic analysis will serve to identify socio-economic relationships between the inhabitants of the Amuq Valley and their contemporaries in neighbouring regions through detailing supra-regional patterns in obsidian consumption practices. Beyond this, I establish a better understanding of the Amuq Valley's independence as a region in Northern Levant and its socio-economic importance to the larger obsidian trade network.

Chapter 2: Background to the project

2.0 Introduction

This chapter provides a historical background to the Amuq Valley with particular reference to the three sites that are foundational to my research, namely: Tell al-Judaidah, Tell Kurdu, and Tell Dhahab (see **Figure 2.1**). It commences with a brief historical overview of the Amuq Valley as a region of archaeological interest, followed by a socio-economic characterization of the three sites, then a detailed overview of the Amuq Sequence chronology.

2.1 Historical background to the Amuq Valley as a region of archaeological investigation

The Amuq Valley is situated in the Hatay province of southern Turkey to the east of the Amanus Mountains and along the northern border of Syria (**Figure 2.1**). It is occupied by the upper Orontes River and what was once the Lake of Antioch, and home to the modern city of Antakya among other communities. Since the Neolithic, the Amuq Valley has served as an attractive region for settlement, with archaeological research detailing a total of 346 sites across 535 sq. km (Yener 2005:1-2). Its highland and lowland territories offered diverse ecologies that supported hunting and fishing as well as arable land for early agricultural practices.

Academics from the OI had long been established in the Amuq Valley, with research being conducted there on and off since 1931. Originally, the reasons for excavating here were to uncover first millennium Hittite occupations, hence the name, “Syrian-Hittite Expedition” (Braidwood and Braidwood 1960:1). This work was initiated by James Henry

Breasted (who famously coined the term ‘fertile crescent’) and eventually passed on to Robert J. Braidwood. While the work was focused on Iron Age occupation, the team eventually realized that the stratigraphy at each mound revealed earlier horizons, extending back to settlements of the Aceramic Neolithic period (ca. 8th and 7th millennia BCE) and possibly earlier (Braidwood and Braidwood 1960:1).

The sequences exposed at Tell al-Judaidah, Tell Kurdu, and Tell Dhahab began slightly later in date, around ca. 6000 BCE (Late Neolithic). Braidwood, who had thorough and detailed excavation methods considered advanced for his time, outlined numerous occupation floors which he then assigned to larger temporal blocks which he called Phases. These stratigraphic phases (Phases A-J), comprise the original ‘Amuq Sequence’ chronology, which spanned the later seventh to second millennium BCE (Braidwood and Braidwood 1960:22, 26-27). Each phase was defined on the basis of typological distinctions in the ceramic and lithic assemblages, and/or changes in the stratigraphy (Braidwood and Braidwood 1960:4, 10, & 26). Braidwood and Braidwood (1960) also completed a synthesis of the material culture from each phase, comparing the ceramic assemblages to those from scientific sites in regions of the Levant and beyond. This allowed the authors to accord the Amuq sequence an estimated absolute chronology (Braidwood and Braidwood 1960). From 1995 to 2002, a new OI team led by K. Aslihan Yener, further developed the Amuq sequence by adding Phases K to V, taking it into the Islamic period (Yener et al. 2000:165). Ultimately, the Amuq Valley is perhaps best-known to archaeologists for its region’s deep-time chronological scheme. The Amuq Sequence is often used by Near Eastern archaeologists because of its assistance in clarifying temporal types across regions, matching relative dates to absolute ones.

Today, the Amuq Valley is recognized as “a bridge providing environmental and cultural connectivity” for the rest of the Near East, an important north-south, and east-west route way (Yener 2005:2). The socio-economic significance of the Amuq Valley to the greater Near East, however, is not entirely clear; it is generally accepted that the Amuq Valley communities carried no political influence beyond the region, yet conversely shows no strong evidence of being infiltrated by other cultural complexes. The Amuq Valley consisted of several proto-urban centres by the Late Neolithic, which, over the millennia, developed into a co-dependent unified territory, gaining self-reliance and maintaining some resilience against larger political forces beyond (Yener 2005:2-3). This long lasting independency was likely due to the valley’s surrounding environmental borders with mountain cliffs forming entryways from the north, east, and the Mediterranean coast, which in turn were guarded by marches, lakes and rivers (Yener 2005:3) (**Figure 2.1**). In addition to these, Tell al-Judaidah, among other fortified urban centers, also acted as overseer to foreigners accessing the valley from the east (Yener 2005:196).

2.2 The sample collection

The evidential basis of this thesis is a sample of 290 artefacts from the three aforementioned Amuq Valley sites excavated in the 1930s. The artefacts form part of the collection of the Oriental Institute [OI] of the University of Chicago, where Robert J. Braidwood was employed at the time of undertaking these excavations. Artefact selection of the sample collection was decided based on parameters set by the Oriental Institute

Museum [OIM] which precluded specimens of unique value such as items of personal adornment (beads, pendants, etc.) and exceptionally crafted tools (complete projectile points for example). As it were, these coveted items made up a small percentage of the total obsidian assemblage recovered (the actual percentage unknown). Specimens which were left accessible for testing were all utilitarian in nature and were selected at random yet with hopes of corresponding to a somewhat representational sample based on their visual (colour and luster) and techno-typological indicators.

2.3 The study sites

The three study sites central to this thesis received a certain amount of attention subsequent to the Braidwoods' original work, not least Tell Kurdu which is viewed as a significant community for studying the Halaf-Ubaid transition (cf. Yener et al. 2000; Özbal et al. 2004; Bressy et al. 2005; Özbal 2006; Özbal 2010:293-310; Özbal and Gerritsen 2013:107-115). In particular, excavations in 2001 recovered an additional 600 obsidian artefacts from Tell Kurdu, Phase C, "found in spatially distinct contexts" according to colour (Healey 2007:174-175).

2.3.1 Tell al-Judaidah

This site represents the earliest known occupation in the Amuq Valley beginning around 6000 BCE (Phase A); it also has the longest running occupation, ending in the Late Roman period (Phase S) (Casana and Wilkinson 2005:26). For this study, only the Late Neolithic to Early Bronze Age occupation is of concern (Phase A-H), during which time

Tell al-Judaidah developed from an early village farming community to a proto-urban centre. Upon initial excavations by the Syrian-Hittite Expedition, the tell was measured to be 370m long by 250m wide (Braidwood and Braidwood 1960:5). The obsidian artefact distribution at Tell al-Judaidah can be read in **Tables 2.0** and **2.1**. Unfortunately, this includes five artefacts with no temporal context. Further details on this matter can be found in section 2*.5 Additional notes*… at the end of this chapter.

2.3.2 Tell Dhahab

Tell Dhahab is the smallest of the three sites, a mound measured at only 60m in diameter placed just south of Tell al-Judaidah (Braidwood and Braidwood 1960:14). Excavations began toward the end of Braidwood's time and were hastened by uprising political strife (Braidwood and Braidwood 1960), and alas lacks much recorded detail. By the time the OI returned in 1995, nearly all of the site has been destroyed (Yener et al. 2000). During my time on this project, attempts were made to retrieve past records at the OI, including field notes, to help fill the gaps regarding Tell Dhahab, however no success was had. This means that we do not know the exact date of the 88 Tell Dhahab obsidian artefacts; we can only say they must fall within Phases A, G and H (see **Table 2.0 and 2.1**).

2.3.3 Tell Kurdu

Tell Kurdu is the largest settlement of the Amuq Valley, attaining 15 ha., making it one of the larger Halafian-type sites in the Near East (Özbal et al. 2004:38). It is situated to the east of what was once the Lake of Antioch. Tell Kurdu was an early agricultural-based urban centre first occupied ca. 5700 BCE during the late Halaf (Phase C). After the Halaf period, Tell Kurdu "shrank in size" (Yener 2005:12) and was eventually abandoned around 4300 BCE during the Final Ubaid period (Phase E).

2.4 The Amuq Sequence in detail

While my primary focus is the contexts from which the obsidian artefacts originated, it is necessary to provide some background information on the most significant socio-economic and material cultural features of each phase for later discussions of supra-regional interactions. I focus on Phases A to H, omitting descriptions of the First Mixed Range and the Second Mixed Range for although a small number of obsidian artefacts were recovered from these two levels (two and three samples respectively), they lack sufficient temporal context to interpret any chronological significance. The temporal distribution of obsidian artefacts studied in this project is detailed in **Table 2.0,** while the percentage represented by the sample collection is provided in **Table 2.2**. Finally, **Table 2.3** offers a composite view of all raw and/or cultural materials recovered in each phase with attested supra-regional links.

2.4.1 Phase A

The earliest part of the sequence, Phase A is only represented at Tell al-Judaidah, where it is characterized by a "maturing and stabilized assemblage of the early village-farming type of community" (Braidwood and Braidwood 1960:26), but with little to no architectural features present (*ibid*:47). The cultural material of this phase is mostly defined by its ceramic assemblage, with its most characteristic pottery tradition being the 'dark-faced burnished ware', a type typical of the larger "Syro-Cilician" region, as previously documented at Yümüktepe, Ras Shamra and Gözlükule (**Figure 2.2**) (Braidwood and Braidwood 1960:47). Particularly close relations seem to be shared with the north Levantine coastal community at Ras Shamra, roughly 75 km south of the Amuq Valley (**Figure 2.2**), where de Contenson reported similar if not identical conditions for Halaf-inspired ceramic traditions without any of the true Halaf imports (1963:36). In his report, de Contenson describes Ras Shamra as having more ties to the Amuq Valley than with the Halaf culture itself (1963:36-38).

Over the course of the "Syrian-Hittite Expedition" in the 1930s, an earlier publication (McEwan 1937) of excavation reports presented the Tell al-Judaidah sequence with a separate nomenclature designating 'Period XIV' as what would later become recognized as Phases A and B. As this occurred prior to the development of Braidwood's Amuq Sequence scheme, however, such reports using this period sequencing, inevitably resulted in artifacts from the two earliest phases being analysed and interpreted together. Such was the case for Braidwood and Braidwood's lithic analysis report of flint and obsidian artifacts (1960). For this reason, obsidian from Phases A and B are presented and discussed together.

The recovery of obsidian artefacts provided some of the clearest evidence for the Phase A community's larger scale socio-economic interactions, with cultural similarities – and by extent potential connections – made with the contemporary site of Yümüktepe (**Figure 2.2**) to the west on coastal Cilicia (Braidwood and Braidwood 1960:502-505).

2.4.2 Phase B

The material culture of this phase, again represented solely at Tell al-Judaidah (Ehrich 1992), show a significant degree of continuity from Phase A, the distinction in phasing being based on the *addition* of six new ceramic traditions (Braidwood and Braidwood 1960:26&68). Some of these new ceramics show clear technological and decorative influences from the so-called Halaf and Hassuna cultures of the northern Levant / northern Mesopotamia and central Mesopotamia respectively (**Figure 2.3)**; cultural connections are retained with Yümüktepe, Ras Shamra and the Rouj Basin, as evidenced by common ceramic and architectural traditions (Braidwood and Braidwood 1960:505; de Contenson 1998; Maeda 2003).

2.4.3 Phase C

Phase C is the first occupational phase for Tell Kurdu, a village community that attains proto-urbanization over the course of its occupation. Radiocarbon dates suggest this phase begins around 5800 cal. BCE (Özbal et al. 2004:52-55) and is characterized by the continuation of dark-faced burnished ware with strong Halafian decorative influence alongside a new ceramic tradition: dark-faced *un*burnished ware, plus the appearance of local painted ware (Braidwood and Braidwood 1960:141). While Phase C was claimed to be unique to Tell Kurdu, similar local painted ware and Halafian pottery was also reported from the First Mixed Range at Tell al-Judaidah, suggesting interaction between the two - 15km distant - communities (Braidwood and Braidwood 1960:137-138), while similar ceramics can also be noted at Domuztepe (Yener 2005:11).

Also produced during Phase C is a "completely new" lithic industry which was also discovered in contemporary periods at Yümüktepe and Coba Hüyük in Cilicia (Braidwood and Braidwood 1960:137, 507) (**Figure 2.2**). Lastly, a change in hunting technologies is suggested for this period, with lithic projectiles (spears/arrows) being replaced with clay sling shots (Braidwood and Braidwood 1960:508). According to Özbal et al. (2004:66), while domestic cattle was the primary source of the community's meat, hunting and fishing continued to play a socio-economic role.

2.4.4 Phase D

Phase D is, again, exclusively represented at Tell Kurdu. The ceramic traditions of Phase C all have limited continuity, while four new ceramic industries appear, including the Ubaid-like variants of Amuq origin. This local transition to Ubaid-like pottery production is also reported at Ras Shamra IV (Braidwood and Braidwood 1960:510; de Contenson 1963) At the same time, Phase D reveals the first evidence of interaction with the southern Levant, as attested by connections with the ceramic assemblage of Jericho VIII (Wright 1951:52-55 as cited by Braidwood and Braidwood 1960:157&510). Together, these data indicate that at the very least, members of the Tell Kurdu community were engaging in supra-regional interactions of pottery exchange.

The Phase D lithic assemblage is described as showing continuity from that of Phase C, but again was deemed too small a collection to warrant detailed discussion (Braidwood 1960:157, 168). There is however, reference to obsidian pendants appearing in Phase D (*ibid*: 157).

2.4.5 Phase E

This phase is described as "the stage of full influence of the North Iraq variant of the Ubaid assemblage" in the Amuq Valley (Braidwood and Braidwood describe 1960:175) springing from a "regional readaptation" by the inhabitants of the proto-urbanized Tell Kurdu, the result of consistent supra-regional interactions since Phase C (*ibid*:511; Bressy et al. 2005:1560). In general, the Amuq Valley's relationship with Mesopotamian Ubaid is characteristically different than previous phases, having "much stronger involvement" (Özbal 2010:295) while acting in part to the "oikoumenê" tradition (proto-globalization of sorts) (*ibid*; Braidwood and Braidwood 1960:512). This is primarily viewed through the presence of Ubaid-like monochrome and bichrome painted wares (Braidwood and Braidwood 1960:181&201). Tell Zeidan along the Middle-Euphrates (**Figure 2.2**), for example, was found with comparable material culture to that of Phase E, producing Ubaid-like ceramics (Braidwood and Braidwood 1960:511).

These characteristic sherds were also identified in the First Mixed Range at nearby Tell al-Judaidah (Braidwood and Braidwood 1960:226) allowing all Tell Kurdu occupations, Phases C-E, to fit comfortably between the time line of Phases B and F (*ibid*:175). Contrary to this however, there is no evidence for Phase F showing a material transition out of Phase E anywhere else in the Amuq sequence (Braidwood and Braidwood 1960:26&512). The authors therefore believe that Tell Kurdu's uppermost layers may only represent a beginning stage for Phase E (1960:26). They also express that as occupation at Tell Kurdu terminates at Phase E, however, a proper transition into Phase F may never be recovered (1960:27).

The Phase E assemblage also contains the last of Amuq's dark-faced burnished ware tradition, and provides the first appearance for clay animals and "mother-goddess" figurines (Braidwood and Braidwood 1960:175&512). At the same time, there is indication that true Ubaid imports were arriving to Tell Kurdu by Phase E along with goods from what today is modern Palestine (Özbal 2010).

The lithic industry is described as continuing the traditions of Phase C and D, albeit with a "slight differentiation" that is unfortunately not elaborated upon (Braidwood and Braidwood 1960:175). Taking a longer-term perspective, Braidwood and Braidwood (1960:204) report the chipped stone industries differ greatly between groups Phases A-B and Phases C-E, "mainly in the sickle blades, the blades and blade sections, and the projectile points", with obsidian use seeing a great liking" in Phase E, with beads and a single pendant being fashioned alongside tools (1960:204,220).

2.4.6 Phase F

Phase F occupation was best documented at Tell al-Judaidah, now a proto-urbanized community, though Tell Dhahab, a much smaller village community, did produce pottery of this phase from unstratified contexts (Braidwood and Braidwood 1960:226). The ceramic assemblage was viewed as "a western outlier of … Gawra period of northern Iraq" (1960:513-514), while ongoing connections exist with Ras Shamra based on ceramic ware (de Contenson 1963:40). Radiocarbon dates place these ceramics between 4510-3980 cal. BCE (Yener et al. 2000:181).

Of greater significance is the appearance of the first metal objects at Tell al-Judaidah. The earliest material comes from the First Mixed Range with three small artefacts (two copper drills and a lead based wire), while pins and blades are abundantly represented in Phase F (Braidwood and Braidwood 1960:244-246). Metalwork is also noted at Yümüktepe (Level XVI), which is believed to be contemporary with Tell Kurdu's Phase E (*ibid*:1960:514).

Although it is too early to detect under what circumstances the occupational shift from Tell Kurdu to Tell al-Judaidah occurred, (remembering the former's abrupt end in occupation) it does raise an interesting question for the technological connectivity that may spring from an inter-community relationship with Yümüktepe and Gözlükule which are both situated near Mersin in Cilicia (coastal modern south-central Turkey).

2.4.7 Phase G

It is uncertain whether this Phase can be properly associated with Tell Dhahab on the grounds of its unreliable stratigraphic context (Braidwood and Braidwood 1960:259&263). Fortunately, the ceramic industries of Tell al-Judaidah, still considered a proto-urban site, show consistency on typological grounds, specifically in the pronounced standardization of their production which point to contact with the Uruk Expansion (Braidwood and Braidwood 1960:259&263) as well as the Early Transcaucasian spread (Wilkinson 2014:204). Connections with Ras Shamra, however, appear to largely fade out by the end of the third millennium (~2300-2000 BCE) (de Contenson 1963:40).

The metalwork assemblage shows continuity from Phase F, albeit now augmented by some of the earliest tin-bronze figurines made in the Near East, dating to ca. 3000 BCE

(Yener 2009). A provenience study of the figurines showed that copper and silver came from the Taurus Mountains (Yener et al. 1991:555; Sayre et al. 2001) while gold was brought from sources in the Southern Levant (Lehner and Yener 2014:539). As for lithics, the industries show continuity from Phase F traditions (Braidwood and Braidwood 1960:259).

Artefacts such as reserved-slip ware sherds, cylinder seals, new designs seen in the stamp seals, and particular styles of pendants, all stand as strong evidence for concrete ties with southern Mesopotamia (Braidwood and Braidwood 1960:516) or more specifically, the first city-state of the Fertile Crescent, Uruk. Likewise, connections can be made with Gerzean Egypt based, again, on the cylinder seals and specific styles of pottery décor, but mostly with the show of metal pins (Braidwood and Braidwood 1960:516). Braidwood and Braidwood (1960:516), explain, however, that it is not suggested that these artefacts were imported as final products into Amuq but rather it was the transfer of technology and stylistic influence. This can be exemplified not only by the increased amount of metal objects compared to the previous phase, but the technological advancements recognized in their production and elaboration of style (Braidwood and Braidwood 1960:259).

2.4.8 Phase H

Phase H is found consistently at Tell al-Judaidah, now one of the largest urbanized sites in the Amuq Valley. However, similar to the case from Phases F and G, Phase H is found inconsistently at Tell Dhahab, still only a village community (Braidwood and Braidwood 1960:345). It is predominantly characterized by red-black burnished ware, however, there is also brittle-orange ware, well known at the Early Bronze Age II site

Gözlükule (**Figure 2.2**) (Braidwood and Braidwood 1960:351&518). Unfortunately, the red-black burnished ware does not connect the Amuq Valley to any other regions (Braidwood and Braidwood 1960:518). Due to its uniqueness, Braidwood and Braidwood suggest it to be a regional variant from southwest Anatolia transported by sea to the Orontes delta thereby explaining its absence in mainland Cilicia and eastern Syria (1960:519). They even go as far to suggest it may later give rise to red polished ware found in Cyprus (1960:519).

Once again, lithic industries show techno-typological continuity from Phase F, however consumption falls dramatically (**Table 2.0**). This is the final phase in which the procurement of obsidian is evidenced apart from three artefacts recovered from the Second Mixed Range.

2.5 Additional notes on the Amuq Valley Late Neolithic to Early Bronze Age Occupation Sequence

According to Ehrich (1992), Phases A and B material culture is only known from Tell al-Judaidah. In contrast, Braidwood and Braidwood (1960:46) also report detailed Phase A occupation floors from Tell-Dhahab. It is possible that as Tell al-Judaidah is the only site representing a complete stratigraphy of Phase A and clear material and temporal transition into Phase B, it has become a standard and often solitary reference for those describing Amuq's early phases.

It should be noted that Braidwood and Braidwood (1960:1), disclose that none of the horizons presented in their report contain sufficient amounts of artefacts in their respective material categories, to be used "for an ideally objective quantitative treatment." Keeping this in mind, any comparative analysis of material bulk and/or ratios, will need to be considered with open ended interpretations. For example, Braidwood and Braidwood (1960:23) explain in their report that "it was not until the last season that we realized the value of saving all the flint chips", not to mention the obsidian debitage that must have been overlooked. Nevertheless, **Table 2.1** shows a composite tally of obsidian to chert ratios for each phase according to the total area excavated at one or more of the three study sites (note that these data are only provided by Braidwood and Braidwood 1960).

Lastly, during excavations in the 1930s, field numbers, an early version of the cataloguing system, were given to all items of material culture as it was retrieved from an occupation level or floor from respective sites in the Amuq Valley, with the exception of artefacts from Tell Dhahab. Records speaking to the obsidian assemblage from Tell Dhahab contain no details regarding from which floor level or even which phase any of the artefacts were retrieved (see footnotes to **Table 2.2**) (cf. Braidwood and Braidwood 1960). In later decades, field numbers were replaced by a new cataloguing system which is currently used by the OI and which appears in this thesis. Other than all of the obsidian artefacts from Tell Dhahab, there were a small number of obsidian artefacts from Tell al-Judaidah and Tell Kurdu which also could not be stratigraphically located because their original field number and strata no longer existed. In these cases, such artefacts which could not be associated to a temporal phase were recorded in **Table 2.0** as "Unknown".

In all cases where obsidian artefacts had their strata recorded, it was possible to ascribe them to an Amuq Phase by matching it to its occupational level or floor using

Braidwood and Braidwood's (1960:21-22) table detailing the depth of each excavation level per site. With this process completed, a proper representation of the distribution of obsidian artefacts between sites and across temporal phases could be created. As can be read in **Table 2.0**, artefacts recovered from Tell al-Judaidah were distributed to temporal phases A-B and F-H while artefacts recovered from Tell Kurdu were distributed between temporal phases C-E. Based on Braidwood and Braidwood's (1960:21-22) report, we also know that artefacts from Tell Dhahab are associated to similar temporal occupations as Tell al-Judaidah, however, the exact distribution of this in unknown.

From the results of this temporal distribution, the majority of artefacts from Tell al-Judaidah corresponded to Phase G (70 artefacts) followed by Phase A (41 artefacts) while most artefacts from Tell Kurdu came from Phase E (52 artefacts). It should also be noted that this temporal distribution of the collection is not representative of the total obsidian assemblage from either of these sites. Rather, the collection of Amuq Valley obsidian which my research entails is merely a portion of the actual volume recovered (see **Table 2.2**). According to the largest counts recorded by Braidwood and Braidwood (1960:213) Phase A sites (Tell al-Judaidah, Tell Dhahab and a third site in the Amuq Valley Wadi al-Hamman) produced an assemblage of 422 obsidian artefacts followed by Phase E at Tell Kurdu with 230 obsidian artefacts.

2.6 Chapter 2 Tables and Figures

Table 2.0: Chronological sequence of Amuq Valley with distribution of artefacts across the three study sites.

Phase	Period	Absolute Date (BCE)	Culture Period	Tell al-Judaidah	Tell Kurdu	Tell Dhahab	Total artefacts per Phase
SMR	Early Bronze Age	Unknown	Early Dynastic	3	0		3
J		Unknown		0	0		0
I		Unknown		0	0		0
H		2900-2400	Uruk Expansion	3	0		3
G		3500-2700	Early Transcaucasia Uruk Expansion	70	0		70
F	Late Chalco./ Early Bronze Age	4500-3500	Early Uruk	6	0		6
E	Early Chalcolithic	4800-4300	Ubaid	0	52		52
D		5200-4800	Halaf-Ubaid	0	6		6
C		5700-5200	Halaf	0	14		14
FMR	Late Neolithic	Unknown		2	0		2
B		5500-5000		0	0		0
A		6000-5500	Halaf-ish /Hassuna	41	0		41
Uncon-firmed				5	0	88	93
Total number of obsidian artefacts per site				130	72	88	Total number of artefacts in collection 290

Table 2.1: Tally of lithic artefacts for each phase according to the area excavated at Tell al-Judaidah, Tell Dhahab and Tell Kurdu, reported by Braidwood and Braidwood (1960).

Amuq Phase	N= chert	N= obsidian	Obsidian ratio	Tell al-Judaidah	Tell Dhahab	Tell Kurdu
SMR	No tally	No tally	Unknown	No record	n/a	n/a
Phase H	No tally	No tally	Unknown	116.2 m^2	No record	n/a
Phase G	279	63	18%	167 m^2	No record	n/a
Phase F	134	32	19%	121.2 m^2	No record	n/a
Phase E	469	230	33%	n/a	n/a	153.3 m^2
Phase D	53	17	24%	n/a	n/a	20 m^2
Phase C	78	44	36%	n/a	n/a	43 m^2
FMR	267	60	18%	110 m^2	n/a	n/a
Phase A/B	1320	422	24%	72.25 m^2	130 m^2	n/a

Table 2.2: Representation in percentage of the sample collection per phase in comparison with the total obsidian collection reported by Braidwood and Braidwood (1960).

Amuq Phase	N=obsidian reported (Table 2.1)	N= obsidian in sample collection	Sample representation	Possible distribution of Dhahab's 88 artefacts
Unconfirmed	-	5	n/a	n/a
2nd Mixed Range	9	3	33%	n/a
Phase J	0	0	n/a	n/a
Phase I	0	0	n/a	n/a
Phase H	21	3	14%	possible
Phase G	63	70	111%	possible
Phase F	32	6	19%	possible
Phase E	230	52	23%	n/a
Phase D	17	6	35%	n/a
Phase C	44	14	32%	n/a
1st Mixed Range	60	2	3%	n/a
Phase B	see Phase A	0	0%	see Phase A
Phase A	422	41	10%	likely

Table 2.3: Composite of raw and cultural materials found at the three study sites in the Amuq Valley and their attested links to other regions or settlements.

Phase	Period	Absolute Date (BCE)	Culture Period	Materials	Attested Link
SMR	Early Bronze Age	Unknown	Early Dynastic Uruk Expansion		
J		Unknown			
I		Unknown			
H		2900-2400		Ceramic traditions	Gözlukule
G		3500-2700	Early Transcaucasia Uruk Expansion	Cylinder seals Copper, silver, gold (bronze figurines)	Southern Mesopotamia Taurus Mtns, Southern Levant,
F	Late Chalco/ Early Bronze Age	4500-3500	Early Uruk	Ceramic traditions Metal pins, blades, copper drills, lead wires	Gawra Period of northern Mesopotamia Yümüktepe
E	Early Chalco	4800-4300	Ubaid	Ceramic and Oikoumenê tradition, Other goods	Northern Ubaid Palestine
D		5200-4800	Halaf-Ubaid	Ceramic traditions	Ubaid, Jericho VIII
C		5700-5200	Halaf	Ceramic decorative traditions Lithic traditions	Halaf culture Yümüktepe, Coba Hüyük
FMR	Late Neo-lithic	Unknown			
B		5500-5000		More Halaf-like ceramic traditions	Yümüktepe, Ras Shamra, Mesopotamia
A		6000-5500	Halaf-like /Hassuna	Halaf-like ceramic (dark-faced burnished ware)	Yümükktepe, Gözlukule, Ras Shamra

Figure 2.1: The Amuq Valley in the Hatay province of southern Turkey.

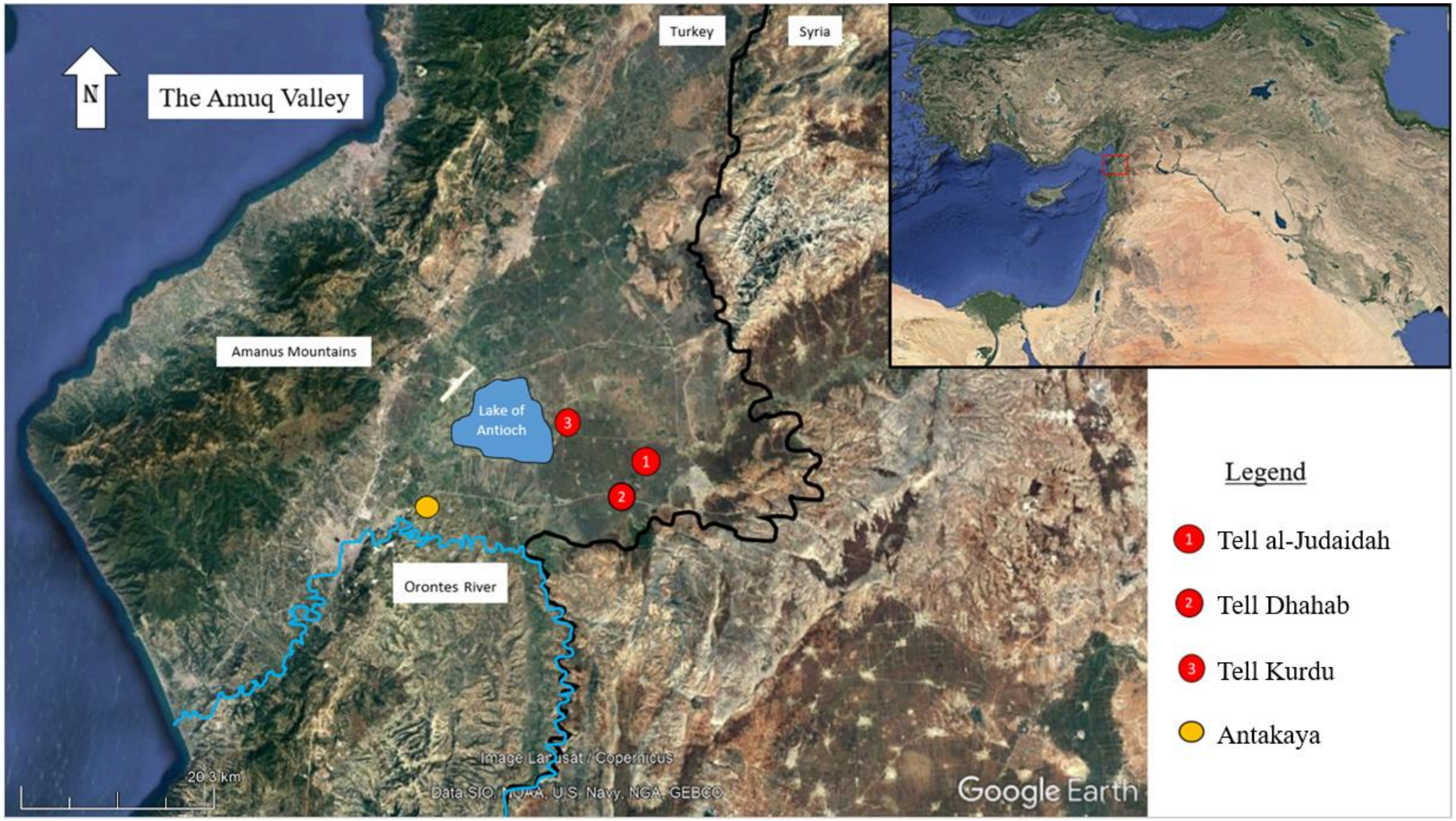
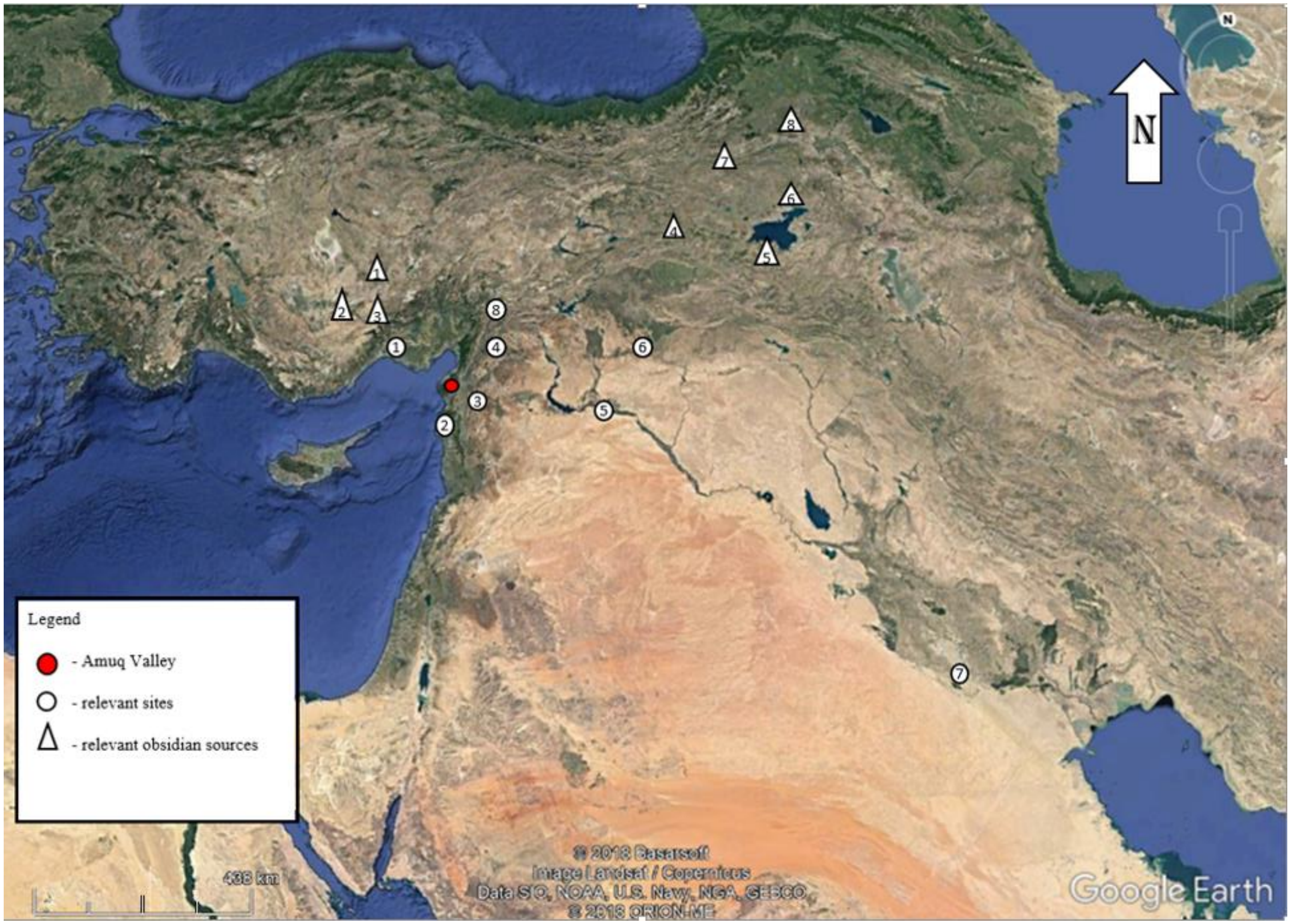
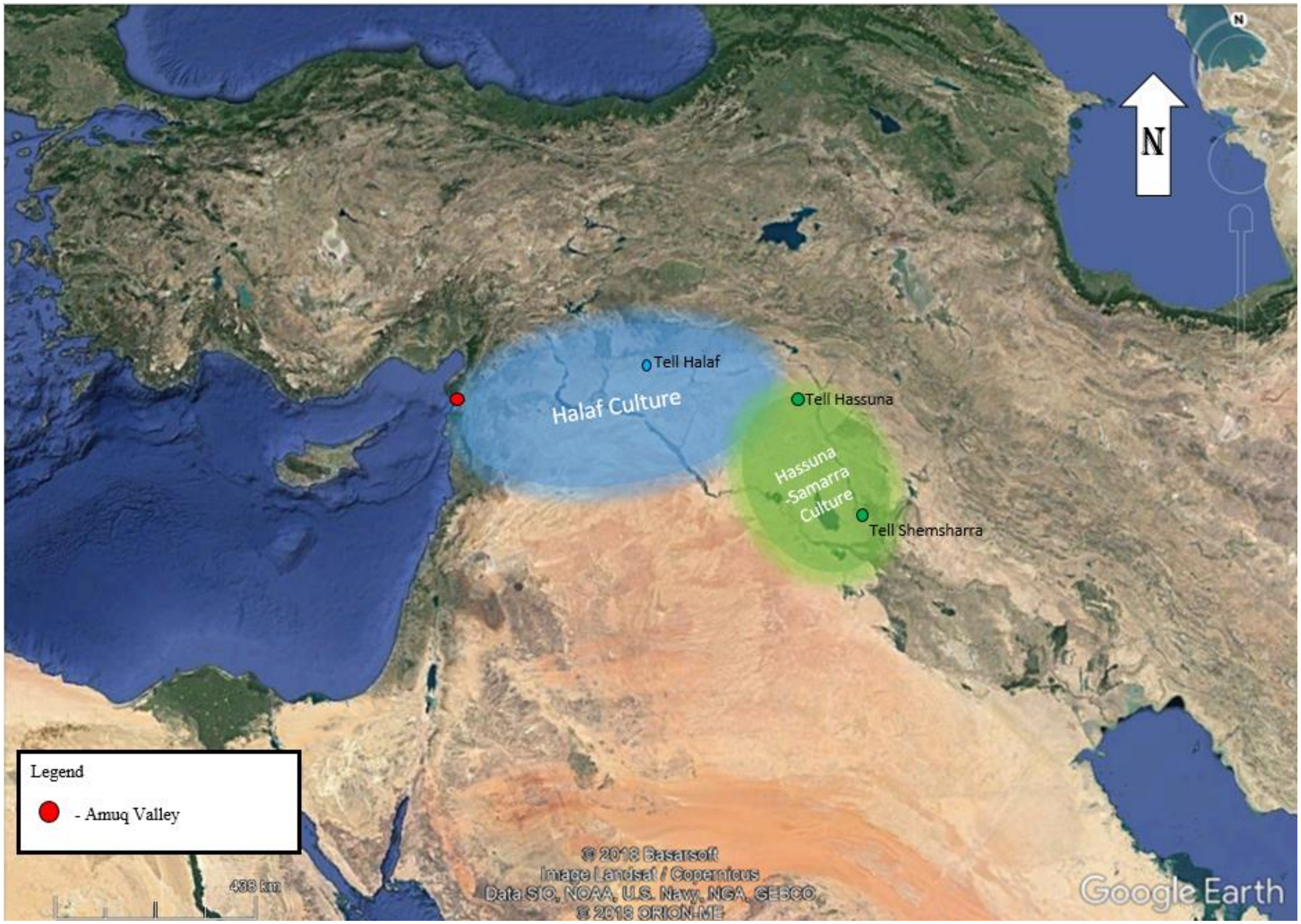


Figure 2.2: The Amuq Valley in the Near East.



Relevant sites: 1-Yümüktepe and Gözlukule; 2-Ras Shamra; 3-Rouj Basin; 4-Domuztepe; 5-Tell Zeidan; 6-Tell Halaf; 7-Uruk City State; 8-Coba Hüyük.**Relevant obsidian sources:** 1- Acigöl; 2-Göllü Dağ; 3-Nenezi Dağ; 4- Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

Figure 2.3: The Halaf and Hassuna cultures in the Near East.



Chapter 3: An overview of X-ray fluorescence as application for obsidian sourcing

3.i Foreword

As stated at the outset of this thesis, the primary data employed in this study as a means of reconstructing supra-regional socio-economic relations, derives from a characterisation study of 290 obsidian artefacts excavated as detailed in the previous Chapters during the 1930s. More specifically, this chapter will address characterization using energy dispersive X-ray fluorescence spectrometry as a tool for archaeological research, specifically its use for sourcing obsidian. I will demonstrate how XRF works on a chemical and physical basis and how archaeologists use this technique to source materials, that is, to trace an obsidian sample back to its geological origin. Finally, I will explain the process of interpreting XRF data for sourcing studies. Throughout this chapter I will reference several geological and anthropological perspectives on obsidian as a volcanic product and cultural material, respectively.

This chapter should not to be read as a background to my area of study (for a background, see **Chapter 2**), but rather as an informative session to prepare the reader for discussions surrounding the archaeological uses of X-ray fluorescence spectrometry. More specifically to this point, this chapter will focus on XRF as an efficient and appropriate means for sourcing obsidian, not only within my own study, but in archaeometric characterization studies more generally.-

3.0 Introduction

Archaeologists source the obsidian used to make artefacts as a means of understanding consumption practices, including acquisition/mining, trade, production, use, and discard (Freund 2014:45-51). Ultimately, these consumption practices, when looked at as pattern through time, can aid in recreating social and economic structures. My specific aim in using the technique of obsidian sourcing is to explore socio-economic relations by comparing the consumption patterns from three sites in the Amuq Valley (Tell al-Judaidah, Tell Kurdu, and Tell Dhahab), occupied from the Late Neolithic to Early Bronze Age (ca. 6000 BCE – 2400 BCE), with consumption patterns seen supra-regionally with the Near East obsidian trade network. It is the hope that finding similar consumption patterns occurring at contemporaneous sites beyond the Amuq Valley will offer a new perspective for the region's supra-regional connectivity, or, in another sense, its contributions to the obsidian trade network of the Near East as a whole.

This chapter is divided into six parts. Part I discusses the logical and methodological underpinnings of materials' characterization and its relationship to archaeological sourcing studies. Part II, focuses on obsidian as a geological material and as a cultural resource for prehistoric populations, including details on how obsidian forms, its elemental composition, and its varied uses culturally. Part III examines how archaeologists have characterized obsidian archaeometrically. In Part IV, I provide a brief historical background of XRF spectrometry, with specific reference to its use in archaeological sourcing studies. Part V describes how desktop ED-XRF works. Finally, Part VI summarizes the archaeological intent behind conducting obsidian analysis studies.

Part I

3.1 Sourcing versus characterization

According to Trigger (1989:348-357), the study of sourcing – *provenance* – has existed as an archaeological concept for well over two hundred years. Interestingly, the term *provenance* was defined by Harbottle (1982 as cited by Pollard et al. 2007:14) as a point of origin only when applied to studies of characterization. Thus, the term provenance, and by extension, any study that entails sourcing an artefact to its point of origin, is often assumed to be addressing the process of characterization as well. To characterize an object, however, is only to describe its traits including those that are unique to any given source. Meanwhile, it is these traits – common and unique – that are eventually used as a means for finding an object's provenance. For example, describing obsidian traits will characterize a specimen or artefact by material, whereas to *use* the characterization of said obsidian material is to source the specimen or artefact back to its geological origin.

Part II

3.2 Obsidian

In this section, I will describe obsidian's geological occurrence, including its physical appearance and elemental composition as a mineraloid. Then, I will elaborate to include a socio-cultural perspective of obsidian by explaining its relevance throughout human history and how it has come to carry archaeological significance. My geological and archaeological references are drawn primarily from the Mediterranean and Anatolian regions.

3.2.1 What is obsidian?

Colloquially known as volcanic glass, obsidian is an igneous mineralization considered more glass than rock. Geologically speaking, however, obsidian is neither lithic (a rock) nor a natural glass but a mineraloid. Rocks are composed of various minerals whereas obsidian is composed of only one mineral, SiO_2. The most common appearance of obsidian is a homogenous, dark translucent vitreous material, although other colour and texture variations exist. For example, obsidian from Monte Arci, Sardinia can be opaque and range in colours from grey to red-brown (Tykot 2002), while in Eurasia significantly rarer green-tinged obsidian is known from only a handful of locales, including Pantelleria (Central Mediterranean), and the Bingöl A and Nemrut Dağ sources of the Lake Van region, South-East Turkey (Carter et al. 2008). Obsidian can also possess *spherulites*, small white crystalline inclusions, sometimes called the "snowflake" variety. This distinctive obsidian type is perhaps best known commonly recognized from outcrops on Lipari in the Central Mediterranean (Clay et al. 2013), and Giali in the Dodecanese islands of the Eastern Aegean (Carter et al. 2016).

Obsidian can only be produced during a volcanic eruption when a silica rich lava flow solidifies in a rapid cooling process (Pollard and Heron 1996:75). This sudden cooling process guarantees only micro-crystallization, invisible to the naked eye, or no crystallization at all takes place, hence obsidian's isotropic, glass-like appearance. The infrequency of this occurrence is also because obsidian formation requires volcanic activity where the magma has a high silica content.

Concerning my region of study, obsidian recovered from archaeological sites in the Northern Levant have hitherto been shown to be made of raw materials sourced to volcanic outcrops in Turkey from Central Anatolia (Cappadocia), East Anatolia (Lake Van), and North-East Anatolia (Transcaucasia). Lastly, because of its mineraloid (isotropic) structure, obsidian has an excellent conchoidal fracture habit.

3.2.2 Obsidian's mineral composition

For the most part, obsidian can be classified as a homogenous material (Kilikoglou et al. 1997). At the elemental level, however, the composition of obsidian varies with impurities that are unique to its place and process of geological origin. This makes obsidian heterogeneous enough at the (trace) elemental level to distinguish between geological outcrops. This subtle geochemical heterogeneity is what sourcing specialists refer to as a geochemical fingerprint (Tykot 2002:618). This ability to carry a distinct geochemical fingerprint, is possible because each obsidian outcrop is composed of unique ratios of elements present. That is to say, for each eruption, lava flows emitted from a single volcano have a different mineral composition than lava flows from the next volcanic eruption. Thus, each obsidian outcrop, possesses its own unique geochemical fingerprint as defined by its elemental composition. This fingerprint is what archaeologists use to determine provenance, or the volcanic source, of an obsidian artefact.

Aside from silica (Si), which makes up anywhere from 65-75% of obsidian's composition (Pollard and Heron 1996:83), major elements, in order of prevalence are as follows: aluminum (Al), sodium (Na), potassium (K), calcium (Ca), and iron (Fe). Common trace elements, which are represented as considerably low values (less than 1% each, measured in parts per million [ppm]) include: zinc (Zn), rubidium (Rb), strontium (Sr), barium (Ba), thorium (Th), zirconium (Zr), titanium (Ti), and magnesium (Mg) (Orange 2012:8). These trace elements – amongst others - are key to my own studies detailed below.

Various types and sub-types of obsidian can be distinguished based upon the elemental ratio and presence of major elements in unique lava flows. When obsidian has higher quantities of Sodium (Na) and Potassium (K) in relationship to Aluminium (Al), it is called *peralkaline*, while obsidian with a higher ratio of Al to Na and K, are termed *subalcaline*. Within the *peralkaline* group, (most recognizable for the green hue of its matrix) obsidian can then be placed on a spectrum from being *alkaline* (highest Na and K ratios), *calcic* (highest Ca ratios), or *cal-alkaline* (when Na and K ratios are equal to those of Ca) (Pollard and Heron 1996:86). As for the *subalcaline* group, placed on a different spectrum, obsidian can range from being *metaluminous* (higher content of Ca to Al), or *peraluminous* (higher content of Al to Ca) (McDonald, Smith and Thomas 1992 as cited by Orange 2012:8). For a visual representation of these types and sub-types, refer to **Figure 3.1**.

3.2.3 Obsidian's cultural relevance throughout human history

Due to its efficient knapping quality (a product of its homogeneity), forming sharp and clean edges, obsidian's primary use has been utilitarian, used worldwide to make simple cutting tools, blades, scrapers, projectiles and other tools (Glascock et al. 2007:523). The earliest evidence of obsidian use is associated with *Homo habilis* in Olduvai George, ca. 1.9-1.7 million years ago (Leakey 1971 as cited by Carter 2014:25). More rarely, and only in later prehistory onwards, was obsidian worked to make beads, pendants, vessels, mirrors, and statuettes (Renfrew and Bahn 1996:355). In these latter instances, these artefacts are often viewed as having been ascribed with social and cultural values associated with the material's aesthetic value, the raw material being cross-culturally regarded as a symbol of power, animacy, and spirituality, as well as an agent to the supernatural world (Aufrère 1991; Clark 2015; Saunders 2001).

Most recently, obsidian has been utilized for modern medical practices due to its fracturing quality making its edges sharper than hospital grade steel scalpels (Scott and Scott 1994). French lithic specialist François Bordes was the first to undergo a surgical operation using obsidian blades by his request (Pollard and Herron 1996:82). Meanwhile, experimental archaeologist Don Crabtree became widely known for producing obsidian surgical tools used by medical professionals for major operations (Buck 1982:268).

3.2.4 Obsidian's archaeological significance

Archaeological specialists regard obsidian as the exemplary raw material for sourcing studies (Binder et al. 2012:189, Speakman et al. 2007:278). Its unique geochemical makeup, as well as its homogenous nature, provide tighter data clouds than other lithic materials such as chert, allowing for precise and reliable results while its prehistoric use and geological rarity make it an exemplary marker for tracing deep-time history of people and places.

Part III

3.3 How to characterize obsidian

In this section, I will review the many techniques by which obsidian has be characterized over time (**Figure 3.2**). It should be noted that as methodological developments occurred, newer techniques retired previous ones, with the exception of visual and haptic techniques which are still used today. All techniques apart from chemical characterization are listed for comparison in **Table 3.1**. As a more in depth discussion has been reserved for comparing the various techniques *within* chemical characterization, a second chart to present this is shown in **Table 3.2**.

As was partly introduced in Part I of this chapter, characterization is the practice of describing features or traits that sets something (the material of an object or a device) apart. Archaeologists characterize by quantitatively and qualitatively distinguishing raw materials, often through the physical and chemical properties of the artefact. For archaeologists, studying either one or both aspects allows the raw material used to make an artefact to be traced back to its volcanic origin.

3.3.1 Visual and haptic techniques

The earliest means of characterizing obsidian employed visual and haptic markers, specifically: colour, lustre, cortex, texture, inclusions and translucency (Pollard and Herron 1996:90, Cann and Renfrew 1964). Today, archaeologists continue using visual and haptic techniques as they are cost-effective, can be conducted without laboratory equipment, preserve the artefact's integrity and are useful for training students, though only in a few contexts can they be relied upon to successfully source a raw material (Braswell et al 2000).

3.3.2 Density and refractive index

Obsidian's density and refractive index have also been used a means by which scholars have attempted to discriminate source products (Tykot 2004). Density relates to the viscosity of the lava while the refractive index refers to the angle at which light penetrates glass formations which, for obsidian, is also dependent on the consistency of the lava prior to the cooling process. Ultimately these methods have limited utility compared to geo-chemical characterization techniques (Liritzis and Zacharias 2011).

3.3.3 Crystalline and mineral structures

In exceptional cases, it is possible to visually characterize obsidian based on the crystalline structure, normally for distinctions between specimens with and without spherulithic inclusions. If there are no visual inclusions, another means of mineral characterization for obsidian is *back-scattered electron imaging* (BSE imaging). In the sourcing study performed by Burton and Krinsley (1987), the surface of obsidian artefacts were examined directly rather than preparing thin cross sections like most petrographic studies require. This demonstrates how BSE imaging can be adapted as a non-destructive technique. However, the most common challenge encountered for this characterization technique is its inability to target specific elements and ratios. As obsidian is a relatively homogenous material, BSE imaging often proves to be an insufficient means for sourcing to specific outcrops within a region where differentiation is based on targeting trace-elements.

Another technique under this category is Raman spectroscopy which, also non-destructive, examines the microstructural features of molecules. The main challenge with it, however, is the overlapping energy feeds with the Reyleigh scattering that can mask the true values of Raman scattering.

3.3.4 Dating techniques

Dating obsidian can be used as a means for characterization when the relative date or geological age of a potential obsidian outcrop is previously known and can be used for comparison to retrace origin. One method is through isotopic analysis to measure decay rates of radioactive inclusions. The most common technique to do this uses fission track dating and examines the replacement of uranium by thorium (U^{238}/Th^{234}), potassium by argon ($^{40}Ar/^{39}Ar$) or rubidium by strontium ($^{87}Sr/^{86}Sr$) (Pollard and Heron 1996:94). Chataigner et al. (2003) used fission track dating on Transcaucasian obsidian as an alternative to the more common chemical techniques. They sourced obsidian artefacts with some success, however, fission track dating could not distinguish distinct outcrops created by a single volcano. In addition, this is a destructive method of analysis requiring test surfaces to be prepared with hydrochloric acid. Other issues with this technique are it being costly and time consuming.

Another means of characterizing obsidian using dating techniques with magnetic properties. This is possible due to the content of iron in a lava flow that orientates itself to the planet's magnetic field prior to solidification as an obsidian outcrop. While the earth's magnetic field has a pattern of continually reversing itself over time, the iron striations, now static within an obsidian outcrop, will remain the same. Tracking the trends of these iron striations have allowed geologists to generate a paleo-magnetic history of our planet.

In turn, archaeologists can use this relative dating scheme to match an obsidian artefact back to its volcanic outcrop. This technique can be cost-efficient and non-destructive, however, it has been pointed out in several case studies that distinguishing obsidian based on magnetic properties is not as precise as geochemical characterization (Frahm et al. 2016a; McDougal et al. 1983).

3.3.5 Chemical

Chemical characterization of obsidian has a history extending back over two hundred years. Martin Heinrich Klaproth, a German chemist who experimented with *gravimetry* – the measurement of elemental weight, pioneered chemical-based research (Pollard et al. 2007:3). In the mid-nineteenth century, J. E. Wocel from Austria was the first to suggest using the chemical composition of archaeological materials to identify provenance and determine relative dates of manufacture (Pollard and Herron 1996: 5). Since this time, numerous techniques for chemical characterization have been developed and the approach remains the primary means today by which archaeologists characterize and source obsidian. The four most commonly referred to and used methods for obsidian characterization and sourcing, are *neutron activation analysis* (NAA), *inductively coupled plasma emission spectroscopy* (ICP), *X-ray fluorescence spectroscopy* (XRF), and finally, *proton induced X-ray emission* (PIXE).

For the remainder of this section, I will describe the four above methods with their advantages and disadvantages for sourcing and they will be approached in the chronological order in which they were developed. In the next section, XRF's use in archaeology will be given a more thorough investigation.

3.3.5i Neutron activation analysis (NAA): was first employed in the 1950s and has remained one of the most preferred techniques today (Pollard and Heron 1996:55). NAA can detect the widest range of elements over all other characterization techniques, doing so with higher precision, tracing even the lowest levels of elemental presence. Its restrictions lie in being time consuming, the most expensive of the four chemical techniques, and also highly destructive. In most cases, to prepare a specimen, the sample, in this instance obsidian, must be pulverized, permanently destroying the artefact.

3.3.5ii Inductively coupled plasma emission (ICP): was created as a technique through a series of developments originating with *optical emission spectroscopy* (OES), later developed into *atomic absorption spectrometry* (AAS) (Pollard and Herron 1996:61). In today's form, ICP is often used with mass spectrometry (ICP-MS), and even more recently, with laser ablation (LA-ICP-MS). Together, these create an efficient and sensitive means for detecting trace element signatures. On the other hand, they are destructive to specimens and are more expensive than XRF.

3.3.5iii X-ray fluorescence (XRF): can be used in multiple forms such as EDXRF, WDXRF and pXRF, which will be elaborated upon in Part IV *en suite*. All forms are similar in their advantages and disadvantages. Firstly, XRF is a non-destructive technique. Preservation of the specimen has always been a priority in archaeology and XRF can test obsidian artefacts with little to no modification required. When modification is required, it does not permanently damage or alter the integrity of the artefact. With the machine's rapid running time, XRF is also a time efficient technique that can be completed in a matter of minutes

(Shackley 2011:vii). Furthermore, the bench top EDXRF model, which will be employed for my study, can process several samples in one analytical run, a level of automation that again saves time. Lastly, XRF machines can be purchased at a reasonably low cost compared to most other forms of geo-chemical instrumentation. The only significant disadvantage to using XRF is that it does not have as wide a range of detectable trace elements as NAA. Despite this, XRF is still considered by many archaeologists to be a reliable technique for sourcing obsidian (Shackley 2011:vii). This last point will be brought up again with greater detail in Part IV.

3.3.5iv Proton induced X-ray emission (PIXE): is the most recently developed of the chemical techniques listed here and has been used in several obsidian sourcing studies with equal success to XRF. It is a non-destructive technique (Poupeau et al. 2010), however, is significantly more expensive to use than XRF.

Part IV

3.4 Choosing X-ray Fluorescence

Here, I focus on XRF techniques as a preferential means of undertaking obsidian characterization. I begin by briefing the historical development of XRF as an instrument then compare it to its leading archaeometric competitor, NAA.

3.4.1 History and development of XRF

X-rays were first discovered by German physicist Röntgen at the end of the nineteenth century, however, it is chemist Moseley, who is considered the father of XRF (Guthrie and Ferguson 2015). Moseley's work involved observing electron transitions of atoms under exposure to microwave radiation. While doing so, Moseley discovered, in 1912, the relationship between an element's fluorescent radiation and its atomic number (Guthrie and Ferguson 2015). This connection laid the groundwork for XRF use as an analytical instrument to distinguish materials based on their elemental composition (Shackley 2011:7). Initially, XRF focused on three elements – rubidium (Rb), strontium (Sr), and zirconium (Zr) – and their relative intensities for the distinction between sources. As more obsidian sources and volcanic regions joined the database, however, these three elements alone were not enough (Hughes 1998:106-107). Today, most XRF machines will measure all elements above sodium (Na) on the periodic table.

As XRF continued to develop, two variations were created. There is energy dispersive (EDXRF), or wavelength dispersive (WDXRF). The difference is WDXRF can detect lighter elements (elements with a smaller atomic number) more easily than EDXRF. Despite this, most archaeologists use EDXRF because is it more time efficient and, overall, the trace elements most significant for obsidian characterization are still detectable (Pollard and Heron 1996:46). In addition to these two varieties, a third method, portable XRF (pXRF) has been introduced into both laboratory and field settings. This instrument still primarily employs EDXRF, however, its approach is different then the usual laboratory bench top instrument as it can be brought into the field to test artefacts *in situ*. In the past decade, pXRF has seen significant growth in its application by archaeologists due to these conveniences (Nazaroff et al. 2010). PXRF instruments have also been referred to as 'handheld XRF' (hhXRF) by certain specialists who wish to clarify on the relative portability between models (Frahm and Doonan 2013).

3.4.2 A major comparative

Of all the chemical characterization techniques, XRF and NAA are the most common to be used in comparison to one another for testing results on accuracy and efficiency. These tests' main objectives are to determine at what level of elemental resolution an obsidian outcrop can be distinguished. While NAA is precise and can target a larger sequence of trace elements, it is expensive, time consuming and in most cases, destructive. While XRF is affordable, time efficient and preserves specimens, its range in detecting trace elements is limited. Yet, in many comparative studies, this limitation of XRF has not deterred it from producing successful and reliable matches between obsidian artefacts and their volcanic outcrops. For example, Smith et al. (2007) found XRF results tested on obsidian from Yautepec Valley, Mexico, were similar in reliability and accuracy to NAA. As third party observers, Hancock and Carter (2010) compared results from two respective studies, one XRF, the other NAA, demonstrating their equal success in distinguishing obsidian outcrops in western Göllü Dağ, Turkey. In a third region, a sourcing study on Kenyan obsidian by Ferguson (2011:407) also found XRF to have comparable results to NAA.

Eventually, these examinations for competency turned into ventures for collaboration. Johnson (2011), interested in characterizing basalt outcrops from American Samoa island, performed two sequential studies, the first using XRF and his second NAA, to compare results and argue that these two techniques be used in conjunction with one another. In Glascock's (2011) collaborative study, he analysed Central Mexican obsidian sources with XRF and NAA, achieving equal success in collecting accurate data. Khazaee et al. (2014) also conducted a collaborative study using both XRF and NAA side by side to achieve optimal results on sourcing obsidian artefacts to Lake Van, Turkey.

Part V

3.5

In this section, I detail how XRF functions instrumentally by covering the major processes that occur when in operation. The processes mentioned below are not exclusive to the testing of obsidian specimens. In archaeology alone other specimens used for testing include a variety of lithic materials as well as ceramics. I, however, have selected obsidian as the example for these discussions. It should also be noted that the level of detail provided for these processes is limited to my personal expertise in physics and chemistry.

3.5.1 How XRF works

After the obsidian specimen has been prepared and inserted into the XRF machine, the procedure begins with an emittance of X-ray radiation. This X-ray beam strikes the surface of the obsidian sample at a pre-set angle between 45-90˚ (Speakman and Shackley 2013). Anything outside this range causes refraction and scattering effects that interrupts the reading of real values. The purpose of striking the sample with an X-ray beam is to bombard the atomic matrix of the obsidian and generate a fluorescence of radiation (**Step 1 in Figure 3.3**). This happens when the X-ray beam passes through the first few nanometres, no more than 1mm in depth (Shackley 2011:24), into the obsidian sample and excites electron particles of the atoms it encounters (**Step 2 of Figure 3.3**). This atomic activity in the matrix, called the *excitation process*, is the ionization of individual atoms caused by the disruption of their electron covalence (Shackley 2011:16).

In chemistry, electron covalence, otherwise known as atomic energy levels or orbitals, are labelled by numbers. When using X-ray fluorescence, however, these covalencies are labelled beginning with K (the most inner energy level), followed by L, M, N and so on. When the excitation process, or ionization, occurs, an electron from an inner orbit (example: K orbit) will be removed, thus altering the atom to an unstable state. To compensate, an electron from a higher energy level (in keeping with the same example, this time an electron from the L orbit) will displace itself to fill the lower energy level vacancy. During this entire process, there will be an emission from the atom itself of equal energy to that which was absorbed by the atom from the X-ray beam. This emission will be in the form of an X-ray photon or a third electron unit, known as a *photoelectron*, from another outer orbit (continuing with the same example: M orbit) (Pollard and Heron 1996:52). At the same time as the photoelectron is ejected, the element's altered atomic energy has now changed again and emits its own form of radiation known as fluorescence. For a visual of the entire excitation process, see **Step 3 in Figure 3.3**. This fluorescent energy is unique for each element and is the major measurement of interest for XRF analysis.

Fluorescent signatures are gathered by the XRF machine when their emitted energies are detected by a vacuum tube called an anode. Inside the anode is a coiled metal wire, usually made of tungsten (W), but can also be of rhodium (Rh) or silver (Ag) (Shackley 2011:24). The purpose of this metal wire is to separate the reading of certain elements from others (more on this below). The captured energy waves then pass through the detector to be transmuted into measurements of elemental parts per million (ppm) and ratios of each element's presence or absence. This information is presented to the analyst in a digital form calibrated through a designated computer software program that converts the ppm and ratios into a visual spectrum. As targeted trace elements from the sampled obsidian are detected and placed on the spectrum, their ratios are what makes distinctions between source types possible by cross referencing their differences and similarities.

Unfortunately, the range of energy waves that the detector anode collects is not as simple as that described above. There are numerous other processes that occur during the entry of an X-ray beam into a sample that generate additional emissions of energy that are not directly used for characterization. To mention a few, there is scattering which is excess ricochet energy that escapes the sample matrix. This scattering is measured as either unchanging energy levels, called coherent *Reyleigh scattering*, or as random amounts of energy lost called incoherent, *Compton peaks* (Guthrie and Ferguson 2015). Together, these scattering processes are part of the background radiation that will always occur, but can be corrected in calibration so that they can be read separately in the spectrum. Other activities during X-ray bombardment are, *primary absorption*, which is affected by the density of other elements present in the sample matrix, and *secondary absorption*, which is relative to the escape depth – the proportion of energy that goes undetected. These are referred to as *mass absorption effects* (Shackley 2011:164).

Lastly, another important process to note that demands for further corrected calibration is *Bremsstrahlung* radiation. This radiation is the continuous stream of excess electron radiation that decelerates inside the detector thereby being read as repeating individual energy emissions. The Bremsstrahlung is generated by the presence of the coiled wire inside the anode and creates a region of rationing on the spectrum that segregates heavier elements not of interest for sourcing (Shackley 2011:24). When these activities of background radiation, mass absorption effects and Bremsstrahlung, coincide, the result is known as the *matrix effect* (Shackley 2011:18). If not accounted for and corrected with proper calibration the matrix effect can skew the true values of element concentrations of interest, ultimately compromising interpretations.

At a later point in time, I will state what calibrations and software is employed in the MAX Lab that overcomes the matrix effect so as not to interfere with the results.

Part VI

3.6 Summary

As was stated earlier in this chapter, archaeologists rely on sourcing the obsidian used in making an artefact to a geological origin as a means of answering a variety of socio-economic questions. The purpose in uncovering these patterns of consumption, however, will stem from a larger area of interest particular to the time period of the study but also particular to the researcher's goals. In the end, obsidian consumption patterns are generated for the purpose of lending the archaeologist a perspective of human development. The angle of human development then depends on the specifics of the research questions in mind.

Interestingly, for all the research that follows this procedure of using obsidian characterization for generating consumption patterns in order to recreate past social, economic and political structures, there is no one model for how to actually apply the data to the research question, only that it is essential for the two processes to work together

(Cauvin et al. 1998:267-268). Therefore, using obsidian analysis in archaeological research functions on a case by case basis. Because of this, using XRF as an analytical technique has essentially become comparable to performing obsidian trade studies, meaning archaeologists wishing to investigate the socio-economic importance of obsidian as a cultural material, will inevitably turn to this technique of characterization (Pollard and Heron 2008:87; Frahm 2016b). Freund, on the other hand, has argued against this, saying the relationship between the two processes only limits the potential of how XRF analysis on archaeological obsidian can be used; for example, discourses that explore beyond questions of long-distance exploitation towards questions of cultural contact, cultural identity and movement of peoples (2013).

3.7 Chapter 3 Tables and Figures

Table 3.1: Comparative chart of advantages and disadvantages for characterization techniques used by archaeologists for sourcing obsidian, excluding chemical techniques.

		Pros	Cons
Visual and haptic		• cost-effective • non-destructive • good for training purposes	• cannot distinguish differences beyond external physical appearance • possibility that expertise fails to replicate
Density and refractive index			• was eventually proven insufficient compared to other techniques (primary due to advancements in chemical characterization)
Crystalline and mineral structures		• can be adapted to be non-destructive	• cannot target specific elements and their ratios
Dating techniques	-Magnetic properties	• cost-effective • non-destructive	• not as precise as geochemical characterization
	-Fission track dating	• relative success in distinguishing between volcanoes	• destructive • costly • time consuming • cannot distinguish between outcrops of a single volcano

Table 3.2: Comparative chart of advantages and disadvantages of four chemical characterization techniques used by archaeologists for sourcing obsidian.

	Pros	Cons
NAA	• detects the greatest range of trace elements • high precision • detects lowest levels of element ratios	• destructive • time consuming • most expensive of all chemical characterization techniques
ICP/-MS	• sensitive detection system for trace elements	• destructive • more expensive than XRF
XRF	• non-destructive • no/minimal preparation • time efficient • low cost to purchase and operate	• does not have as wide of a detection range to NAA for trace elements
PIXE	• non-destructive • equal success rates in accuracy to XRF	• significantly more expensive than XRF

Figure 3.1: Model for obsidian types and sub-types based on chemical ratios of aluminium (Al), sodium and potassium (Na + K), and calcium (Ca).

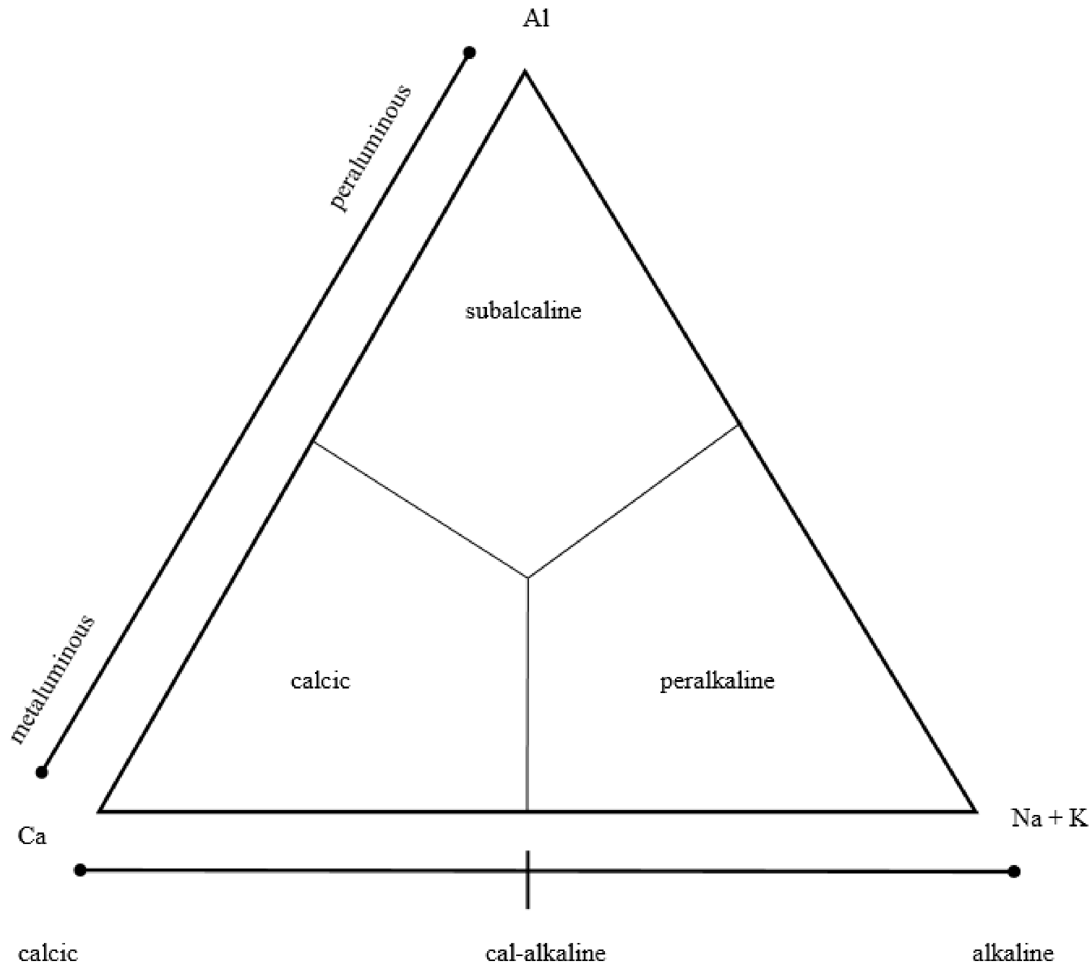


Figure 3.2: Flow chart showing placement of XRF machine used for this research in relation to other characterization techniques employed on obsidian for sourcing studies. The XRF machine described is facilitated by the MAX Lab at McMaster University.

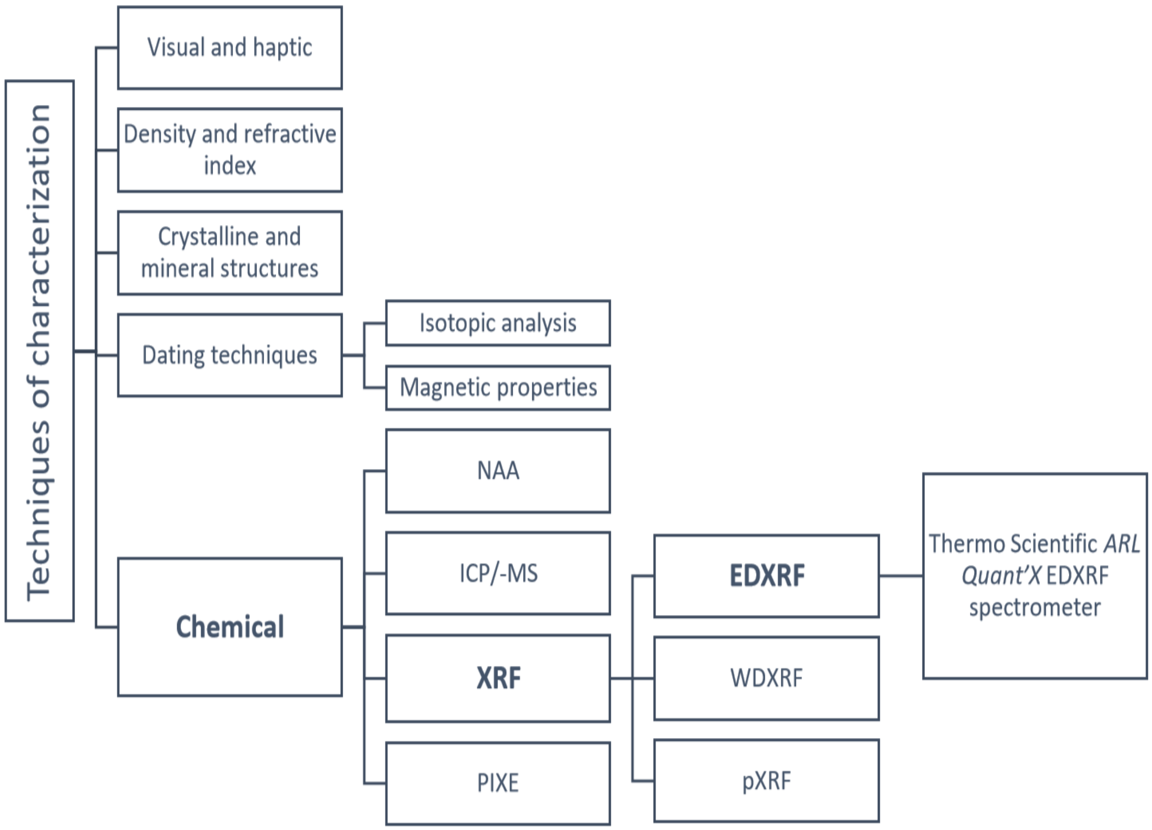
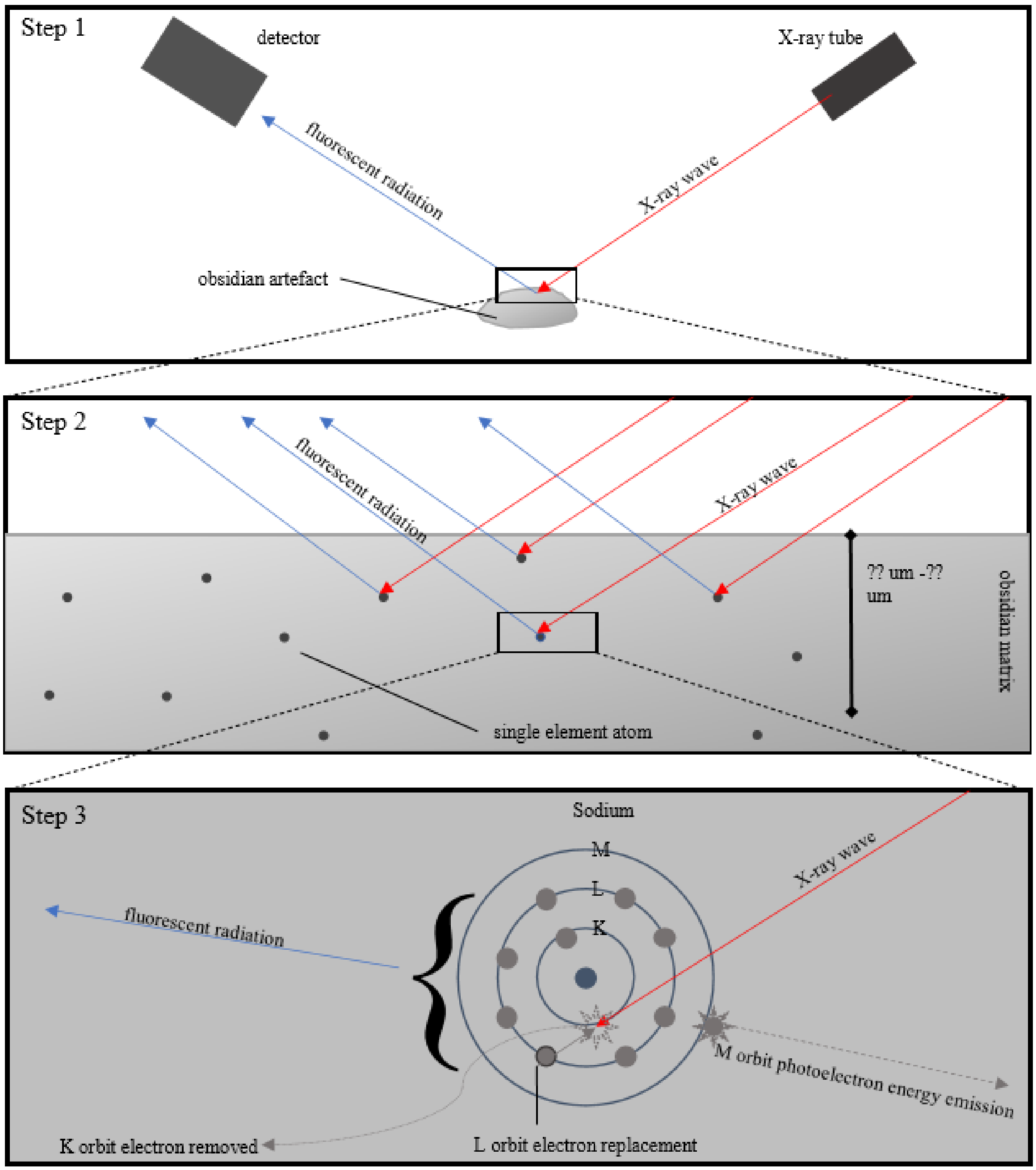


Figure 3.3: A general description of the XRF process.
Step 1: An X-ray beam is emitted from the machine to strike the surface of an obsidian artefact and bombard the atomic matric and generate a fluorescent radiation.
Step 2: The X-ray passes into the obsidian matrix and excites electron particles of the atoms it encounters.
Step 3: Excitation process disrupts the atom's covalence causing electron displacement, photoelectron energy emission and finally fluorescent ration as the signature for that element.



Chapter 4: Theoretical Temporal Methodology

4.0 Introduction

In this chapter I present my theoretical methodology which is a multi-scalar temporal perspective of deep-time archaeology. As part of my discussion on the chemical sourcing and techno-typological analyses, which will be presented in Chapter 8, I will be considering multi-scalar temporalities for interpreting and putting into perspective deep-time prehistoric archaeology. In turn, this methodology will assist me for discussing the relative significance of socio-economic relationships in obsidian consumption between the Amuq Valley and neighbouring regions as they are formed, are maintained, and eventually replaced, throughout a 3600 year period.

The first section to this chapter will offer a brief introduction to the Annales historical approach and how, broadly speaking, this has influenced archaeological history. The proceeding section will then present the Braudelian paradigm, specifically how I have repurposed Braudel's three units of measured time for the nature of my investigation. Then, I explain my intentions for applying Braudel's multi-scalar device using examples from my area of research to demonstrate how my theoretical methodology will unravel the discussion of my data (Chapter 8) in a chronological order.

4.1 The Annales school of history and archaeology

To break away from the tradition of history telling from important individual figures, the Annales overarching goal was to compose a 'total history' that considered the "physical, intellectual and moral universe of each preceding generation" (Bintliff 1991:12). The school's focus was also "to produce human science by interweaving historical and social-science approaches to the past" (Knapp 1993:3). On top of that Braudel, a leading scholar in the Annales school, devised a three tiered framework that allowed different processes of sociocultural change to be observed and understood at different levels or durations of time (Smith 1992:69).

Eventually, many archaeologists turned to the Annales approach to history. It not only disentangled the discipline from the confines of strict narratives inspired solely by historical figures, but it was also malleable, applicable to the many theoretical and methodological shifts underway (Knapp 1992:9,16; Snodgrass 1991:59). No longer were a trend of archaeologists excavating sites after literary records, but were now being guided toward discoveries of undocumented prehistories such as Le Roy Ladurie's 'People without history' (Bintliff 1991; Snodgrass 1991:61).

4.2 An adapted methodology

My temporal methodology will follow, in principle, Braudelian time (1972&1982), that is, *l'histoire événementielle* (the event), *l'histoire conjuncturelle* (alternatively known as mid-range or mediohistory), and *l'histoire de la longue-durée* (deep time). This multi-scalar time perspective will also benefit from a multi-directional geographical perspective that interchanges focus from local (i.e. the Amuq Valley) to regional, in order to grasp the relativity of obsidian consumption patterns as representations of inter-regional socio-economic relationships. Taking this spacio-temporal approach is an inherent aspect of archaeological study as observations of temporality require a fixated space within which such processes occurred (Bailey 1983:171).

For my purposes, however, I have re-interpreted Braudel's three units of measured time to fit within a perspective of obsidian consumption in the Near East during the Late Neolithic to Early Bronze Age. In accordance with Braudel's views, as time is not linear, the historian cannot view the past as linear (Clark 1985:180). Therefore, these three temporalities are to be used interchangeably and on an as needed basis, yet, will function in consideration of one another.

It is also my intention to simplify and reduce the subjectivity of my interpretations by acknowledging that patterns may appear and disappear depending on what temporal perspectives are applied to the data at any given time. Using only deep-time as an interpretive perspective would inevitably limit observation to only understanding long-term processes of obsidian consumption. This strategy thus prevents the identification of other possible forms of socio-economic processes (i.e. supra-regional relationships) occurring within shorter time perspectives. In the end, the multi-scalar temporal methodology will interpolate socio-economic developments occurring at different levels of observable time, enhancing discussions of deep-time obsidian consumption patterns in the Amuq Valley.

4.3 Braudelian time, repurposed

4.3.1 The event

The *event* can be described most simply as a short term perspective of relative time. These moments were "little more than a concession to narrative political history" (Knapp 1992:6). It was, in keeping with classical literature, the underpinning for writing histories, including archaeological ones. That is, however, until it was transformed by the Annales to replace "great men" with the narratives of the common populous, the everyday people (Knapp 1992:9).

According to Sahlins (1982) and Giddens (1986), the event is created when a collective of actions and reflexive actions is performed by many actors. Sewell goes farther to claim that the event must bring change to structures and to human conduct (2005:218). An opinion shared by all, however, is that the event is a micro-history record of action relative to the other sociocultural processes (Knapp 1992:6).

My own take on the event is to combine these views to describe it as a collective of actions that instills a shift which then becomes acknowledged by the society itself. For Braudel, events typically unfold in a matter of years, and are indeed a micro-history within the mosaic of time. That said, the duration of the event will be manipulated to match the relativity of deep-time that my study requires. Therefore, the duration of my archaeological events will occupy a period of 500 years.

For my purposes, an event in obsidian consumption will be the measure of time represented by a noticeable shift in obsidian consumption in the Amuq Valley. For convenience, I will be following the Amuq Sequence as described by Braidwood and Braidwood (1960) based on the cultural material belonging to the stratigraphy. With the addition of this information, my obsidian characterization study will be used not only to enrich our knowledge of the Amuq Sequence, but also as the unit of duration for marking events in obsidian consumption.

I will now elaborate on my definition of an event in obsidian consumption and how I plan to identify them. As preferences and accessibility change and new sources are put into circulation, patterns of obsidian consumption manifest. Each change in obsidian consumption is a response to the collective of actions and reflexive actions by various actors (the elites, the merchants, the consumers, etc.). In other words, shifts in obsidian consumption are historical events for my purposes. They are socio-economic processes as it requires the collective of a community or more to effect a change. This change will appear as a shift in the ongoing consumption of obsidian for the Amuq Valley. It could be as simple as the appearance of a new source type into the Amuq Valley or as complex as a technological change with aesthetic preferences and reasons for production.

When interpreting an event as a socio-economic process, or more specifically, a socio-economic relationship, this unit of time, which will present itself in the archaeological record as a change in obsidian ratios, will be reflecting local socio-economic dynamics of obsidian consumption. Therefore, the Amuq Valley, being a local level for a geographical perspective, is temporally measurable at the scale of the event.

4.3.2 Mid-range history

Originally referred to as the conjuncture, this unit of time is now better understood as mid-range duration and considers broad strokes of time that make up multiple facets of a culture: namely growth of economy, settlement change, demographic cycles and so on (Snodgrass 1991:63). These are then organized in a way which represent a historical movement. Clark describes this measurement of time as “rhythms and phases of demographic technological and social change” (1985:182). Originally, these processes were meant to be observed over a period of a single generation, “a score or so of years”, however, prehistorical archaeologists have often used it to consider thousands of years (Barker 1991:39).

I have interpreted this time measurement as an overlapping of systems that together characterize a socio-economic phenomenon for an extended duration. In this sense, mid-range duration not only represents a temporal measurement, but also represents a socio-economic system in operation. Mid-range duration, like a system at play, must be stable and considered a constant by any extant actors. The system, or time unit, will continue moving linearly until something – an event – off sets the trajectory of development and the system transforms, taking on a new direction.

In my situation, mid-range duration in obsidian consumption will be the recognition of shared obsidian consumption practices in a region. That is, the overlapping of similar obsidian consumption patterns between two different localities within the greater system of operation. This greater system of operation will be, for example, known cultural traditions or political forces, limited to the geographical landscape of the Near East. These middle-range obsidian consumption patterns represent socio-economic processes – relationships – that the Amuq Valley shares with other regions within the obsidian trade network.

Upon an initial examination of this, it may appear to the reader that a cultural period of the Near East and an Amuq Phase are too similar both in definition of cultural material as well as temporal occupation. There is one important difference to recognize; while an Amuq Phase is tied to local time – meaning time is observed as it transpires in the Amuq Valley – a cultural period requires observations from more than one locality. This I have termed, regional time. For example, the Halaf cultural period may have initiated as an event in its local setting, however, as it expanded and spread geographically, it engulfed other communities transforming into ‘regional time’. In this way, the cultural expansion operates as a social system, characterizing multiple communities as ‘Halaf’ based on similar social attributes.

Another reason for distinguishing local from regional is due the intermittent and gradual growth of regional time. As **Table 4.1** and **Table 2.0a** of Chapter 2 show, each phase in the Amuq Sequence has been identified to a cultural period (these were assigned by Braidwood and Braidwood [1960] based on material culture). The absolute dates for these periods, however, do not match with those assigned to the rest of the Near East. For example, as **Table 4.1** shows, the first cultural period of the Ubaid began around 5800 BCE while the ‘Ubaid’ cultural period does not appear in the Amuq Valley until at least 4800 BCE.

All this returns to my explanation of how recognizing shared obsidian consumption patterns between localities can still identify mid-ranges in obsidian consumption even if they did not happen contemporaneously. Basically, if two or more localities express similar patterns of obsidian consumption, they likely will belong to the same regional system in operation because the system itself is in constant development. In other words, mid-range time (‘regional time”) will last for as long as it can maintain geographical expansion. Once this system expires, it will collapse and so too that unit of mid-range time until both are replaced with a new system of operation. Consequently, this also means that the obsidian trade network of the Near East is, in fact, made up of multiple systems operating at a regional level. From here, we can also assume then, that each of these regional systems is being governed by their regional cultural powerhouse.

In the end, these regional mid-range systems, represent a continuity of an obsidian trade agreement between communities, and therefore, a socio-economic relationship. As long as there is a system of trade, there is a relationship. If there is a transformation in the regional operation of the obsidian trade network such as the termination or replacement of a trading circuit, then this would reflect a change in the socio-economic relationship between the distributing community and the recipient community. Considering that trade networks can continue for thousands of years, these mid-range units of duration will be taking on a unique meaning of the term socio-economic system.

4.3.3 Deep-time

Deep-time, or the *longue-durée*, is the perspective that encompasses the longest duration of relative time. It recognizes transformations in "the domain of man's biological, geographical and climatic circumstances" (Clark 1985:183). Archaeology came to achieve the *longue-durée* with geographical expenditure through field survey and regard for the rural rather than urban landscapes (Snodgrass 1991:67). In this way, archaeologists furthered the meaning of deep-time to include several millennia unlike Braudel's original perspective (Knapp 1992:13). In addition, archaeologists have used deep-time by attaching social processes to past landscapes, thereby making cultural inferences from long-term observations of a changing environments. This kind of use of deep-time duration has led to archaeological descriptions of important observations in human history. Examples of this include the Neolithic revolution which brought sedentary living and the beginning of agriculture and animal husbandry, as well as the Bronze Age which marked the eventual replacement of lithic and obsidian tools with the advent of metallurgy.

As for literary examples of the archaeological deep-time, the Biferno Valley in the Mediterranean written by Barker (1995) has been famously recognized for this feat. In Barker's narrative history, he uses the Mediterranean environment to observe deep-time socio-cultural developments of populations who share the coastal landscape. Another example is by Freund (2014) whose dissertation also studies the Mediterranean environment but instead uses the political landscape to observe deep-time transformations in obsidian consumption.

My intentions, will be similar to Freund's in the sense that my interests are in observing not biological or geological transformations of the landscape, but socio-economic ones. More accurately, the 'landscape' I intend to observe is the obsidian trade network as it extends across the Near East. Using this as my temporal frame, I will associate the obsidian consumption of the Amuq sequence with my deep-time observations of the Near East obsidian trade network.

As a unit of measured time, deep-time will be following the archaeological periods of the Neolithic, the Chalcolithic, and the Bronze Age (**Table 4.1**). Although the main focus of my thesis will be between the Late Neolithic to the Early Bronze Age, I will be referencing earlier and later archaeological periods in order to gain a proper large-scale perspective of the obsidian trade network in the Near East. Such observations in deep-time as they relate to obsidian consumption will be to draw macro-level comparisons in obsidian trade operations across the landscape, encapsulating the Amuq phases pertaining to my study. That is, I will make inferences on the Near East obsidian trade network by dividing it into three stages, 1) prior to the beginning of the Amuq sequence (prior to Phase A = before 6000 BCE), 2) during the Amuq sequence of my study (Phases A-H = 6000 BCE – 2400 BCE), and 3) after the final Amuq phase of my study (after Phase H = beyond 2400 BCE).

4.4 Using a multi-scalar time perspective

In the previous section, I presented Braudel's three units of measured time, modifying each to play a particular function in my interpretations for socio-economic relationships in obsidian consumption. In this section, I will now combine all three components of Braudelian time under Sewell's structural theory to construct what I refer to now as my temporal methodology.

4.4.1 From the conjuncture to the event

As Sewell argues that seeing structures as overlapping and vagarious is critical for determining how a historical event is to be considered as such (2005:205), then the temporal scale must be interpreted deductively, by first acknowledging a structure or system in place. Once this system is interrupted with change, it can lead to further development or even a transformation to something new. To put it simply, one must recognize what structures are at play in a society before it is possible to identify historical events within that society. In other words, a historical event can only be such if it marks a transition of change from one social structure to another. Therefore, in keeping with Sahlin's original description:

“historical events should be understood as happenings that transform structures” (Sewell 2005:218), I will go further to say that structural time is in fact mid-range time in that societal structures are representations of temporal mid-range systems, triggered by historical events.

For example, imagine the obsidian trade of the Amuq Valley as a pre-existing structure within the larger network that makes up obsidian trade in the Near East. This smaller, Amuq obsidian trade has been in place for generations and is a facet of a structural history for a particular region, in this case, Northern Levant. The societal structure encompasses the obsidian trade from the Amuq Valley within the rest of the Near East and is understood by the remaining populations in the Near East as a locality that is on-going and stable for as long as the Amuq Valley participates in regional obsidian trade. The event then comes about when there is a socio-economic shift developed at the local level. For example, an event may be represented by the start of a decrease in overall obsidian consumption in the Amuq Valley. It may also be represented by the appearance of a new obsidian source or a consumption increase of a previously acquired source.

At this point I should alert the reader that the *reason* for a socio-economic shift does not need to originate within the Amuq Valley. That is, recognizable events in the obsidian consumption of the Amuq Valley, may not have been originally caused by the local population. It is perfectly possible that the shift began elsewhere in the Near East. As an event, this external socio-economic shift reverberates through the obsidian trade network, eventually causing a reactive shift to occur at the local level of socio-economic relations in the Amuq Valley. For example, imagine obsidian consumers in the Amuq Valley have created a shift due to their increased demand for a previously acquired obsidian source. What cannot be seen, however, from the local perspective, is why this increased demand occurred. Only by changing temporal scales to include a regional perspective of the obsidian trade network can we identify that the event in the Amuq Valley was a result of an event elsewhere in the Near East. It is also possible that the Amuq Valley's event will reverberate back into the Near East obsidian trade network, leading to a new event at a third locality. (Note that in the case of this study, a shift does not automatically equate to an event if the shift does not lead to overall socio-economic transformation.)

In the end, the outcome of the chain reaction of events is an eventual transformation of the obsidian trade network – the mid-range time perspective as it were – as the trade circuit is no longer made up of the same structural components as before. The new mid-range time becomes recognizable only when it is able to characterize the obsidian consumption of an entire region.

4.4.2 From mid-range history to deep-time history

So far, I have demonstrated a hypothetical methodological application, beginning with recognizing the mid-range, identifying the event, and returning to the regional level to recognize a new mid-range system at play. This process can be repeated as often as necessary depending on the number of events represented in the obsidian consumption of the Amuq Valley. What we have not done thus far, however, is continue to expand our temporal perspective to deep-time in a methodological manner. To do this, I will again apply structural theory, but this time I will be transitioning from the mid-range perspective, to the deep-time perspective. Whereas events are triggers for change seen in mid-range time, new mid-range systems will be triggers for change seen in deep-time. In obsidian consumption terms, how the obsidian trade network is seen to operate at the regional level will correspond to what socio-economic transformations are taking place which are notable in archaeological periods. And from these large-scale observations of obsidian consumption during archaeological periods in the Near East, a deep-time history of obsidian socio-economic relations between the Amuq Valley and the Near East obsidian trade network is formed.

To provide a brief example of what this may look like, I will refer to the transition of the Late Neolithic to Early Bronze Age. Metallurgy replaced obsidian – as it did eventually all lithics in trade – during the Bronze Age, hence the reason why we have named our archaeological periods as such. However, the transition between technological materials occurred several different times throughout the socio-economic landscape of the Near East. Each time there was a replacement, there was a change (at the regional level) in the structure of the obsidian trade network as a whole. Once multiple regions begin to see the same replacement, the obsidian trade network is no longer the same network it once was. The network might continue to exist (arguably surviving on the back of a metal trade network), however, the socio-economic landscape is forever changed. What we will see in turn is a clear distinction in characteristic of the obsidian trade network from one archaeological period to the next. Noting these deep-time changes creates a historical narrative of obsidian consumption within a deep-time perspective.

4.5 Summary and prelude to the discussion

Whilst presenting the XRF results, the data, as each artefact is sourced, will be discussed in relation to their temporal distribution in the Amuq sequence. For an understanding of the order of Amuq phases and how the Amuq Valley is situated temporally, please refer back to Table 4.1. Temporal distribution of the archaeological data (artefacts distributed across Amuq Phases A-H), will be presented in **Table 6.0.1**, from *Chapter 6 Results*. In summary, the results after analysis will be discussed chronologically from the earliest local time period, Phase A, to the final phase of obsidian presence, Phase H and the Second Mixed Range.

Following the information provided from analysis, I will form interpretations, on an as needed basis, by using my multi-scalar temporal methodology described herein. In doing so, I will be using the mid-range level as the leading point for contracting or expanding my temporal perspective. My reason for following this method is to help make the Amuq Valley more relatable to other archaeological studies in the Near East with regards to obsidian consumption and/or socio-economic processes, harmonizing the Amuq sequence with the narrative of the obsidian trade network in the Near East. Finally, the last point I would like to include is a potential benefit to the practice of my temporal methodology. I believe that by interchanging the temporal scale in consecutive turns as each Amuq phase is presented will enable me to gain repetitive re-evaluation and appreciation for a historical narrative as I form my interpretations. For now, the proceeding three chapters of analysis and results will be presented until at which point the data can be interpreted for a discussion in Chapter 8.

4.6 Chapter 4 Tables and Figures

Table 4.1 Chronology of the Amuq Valley in context with Near Eastern chronology using Braudelian measurements of time.

Time in absolute dates (BCE)	Longue-durée – Time of the Ancient Near East	Mid-range – Regional Time	Event – Local Time	
	ASPRO Chronology (cal. BCE) with archaeological periods	Cultural Periods of the Near East and absolute dates (BCE)	Cultural Periods of the Near East as they appeared in the Amuq Valley*	Amuq Chronology with absolute dates
1000 BCE				
1500 BCE				
2000 BCE			Early Dynastic III	20..end Phase J
-				Phase I SMR
-	Bronze Age	24-- Early Dynastic Period I		24--
2500 BCE				
-			Early Dynastic I	Phase H
-				27--
-		--29		--29
3000 BCE		30-- Early Trans-Caucasian Spread; 31-- Uruk Expansion		
-			Uruk	Phase G
3500 BCE				35-- --35
-		--36		
-		--37		
-		38-- Final Ubaid; 38-- Early Uruk		
-			Early Uruk	Phase F
4000 BCE				
-		-42- Ubaid 5		
-				43--
4500 BCE	45--		Ubaid	--45 Phase E
-	Period 9 Chalcolithic			
-				FMR --48--
5000 BCE	--50-- Period 8		Halaf-Ubaid	50-- Phase D
-		51-- Halaf		
-		-52- Ubaid 4 -53- Ubaid 3		Phase B --52--
-	--54-- Late Neolithic		Halaf	--55-- Phase C
5500 BCE		-55- Ubaid 2		
-	Period 7 56--			
-		-57- Ubaid 1	Halaf-ish with Dark Faced Burnish Ware	Phase A --57
-	--58			
6000 BCE	60-- Period 6			--60
-		--61		
-	--64 Late Pre-Pottery Neolithic B			
6500 BCE		65-- Ubaid 0 (Dark Faced		

-		Burnished Ware)		
-	Period 5/ Period 4			
-		~Early 6^{th} mil.		
-		Proto Hassuna		
7000 BCE	Late Pre-Pottery Neolithic B			
-				
-				
-				
-				
7500 BCE				
-	--76			
-				
-	Middle Pre-Pottery Neolithic B			
-				
8000 BCE				
-				
-				
-	83-- 83--			
-				
8500 BCE				
-	Early Pre-Pottery Neolithic B			
-	Period 3			
-				
-				
9000 BCE				
-				
-				
-	--93			
-				
9500 BCE	95-- Period 2			
-	Pre-Pottery Neolithic A			
-				
-				
-				
10,000 BCE				
-				
-		10,2--		
-				
-				
10,500 BCE	--10,5			
-				
-				
-				
-	Period 1 Epi-Paleolithic			
11,000 BCE				
-				
-		Natufian		
-				
-				
11,500 BCE				
-				
-				
-				
-				
12,000 BCE	--12			
-				
-				
-	Upper Paleolithic			
-				
12,500 BCE		--12,5		

*as described by Braidwood and Braidwood (1960) based on of cultural material.

Chapter 5: Laboratory Methods and Analyses

5.i Foreword

The laboratory methods and analyses described herein were made possible through the supervision of Dr. Tristan Carter, director of the McMaster Archaeological XRF Lab [MAX Lab]. While all sample preparation, analyses and initial data interrogation were undertaken by the author, the entire process was carefully overseen by Dr. Carter. In addition, special acknowledgement goes to Kathryn Campeau (ex-MAX Lab RA, now PhD candidate and lab user) who developed and tested a new protocol for discriminating Bingöl A and Nemrut Dağ peralkaline sources, a crucial method for distinguishing them in my project.

5.0 Introduction

The focus of this chapter will be to introduce the sampling of those obsidian artefacts analysed in this research project. As stated in a previous chapter, these artefacts were loaned to Dr. Carter by the Oriental Institute Museum [OIM] of the University of Chicago. The material was excavated in the 1930s from three sites in the Amuq Valley: Tell al-Judaidah, Tell Kurdu, and Tell Dhahab. For more details, please refer back to Chapter 2.

In keeping with the previous organizational procedure of ascribing temporal context to each artefact in the sample collection described in Chapter 2, I will continue with an explanation on how samples were then grouped for analysis. Next, I will detail how the artefacts were prepared for analysis following MAX Lab protocols for elementally characterising obsidian artefacts. Following this, I will describe the analytical protocols employed on the EDXRF instrument for my analyses. Finally, I will provide some insight into how we critically reflected upon data integrity.

5.1 Organizing the sample collection

Prior to laboratory preparation for chemical characterization, the artefacts needed to be grouped by site and chronology. Although these two steps were not essential to the success of artefact preparation and analysis, they did reduce time and effort with regard to interpreting the data afterward in an orderly fashion. For a review of the organizational procedures regarding temporal context, artefact distribution between sites and across Amuq Phases, as well as the sample collection's total proportional assemblage representation according to Braidwood and Braidwood (1960), please refer to Chapter 2.

Once the artefacts were satisfactorily organized, they were then grouped into sets of 19 as each analytical run was undertaken on a sample tray with 20 stages, the 20th being taken by an international standard (RGM-2) that was included in each analytical run. All artefacts from a single site were tested before moving on to another site, with seven groups for Tell al-Judaidah, four runs for Tell Kurdu, and five runs for Tell Dhahab. Over the course of the analyses, it was noticed that some of the elemental data was problematic, leading us to re-run a number of the pieces (some more than once) whereby we eventually ran a total of 26 sample trays. For a list of all sample runs in the order which artefacts were analysed and/or re-analysed, please refer to **Tables 5.1-5.5**.

5.2 Sample preparation for EDXRF analysis

Prior to analysis, each artefact was cleaned so that the X-rays, when emitted, were only detailing the obsidian, rather than any extraneous surface materials. For reasons detailed in Chapter 3, our artefact target area for analysis was the flattest/widest surface possible. In the case of the Amuq Valley artefacts, this was usually the ventral surface (underside) of a blade, or flake. Unfortunately this tended to be the surface upon which the OIM inventory number had been marked with a zinc-based white ink protected with varnish. Having a clean surface for XRF analysis is essential for successful obsidian sourcing, i.e. we need the elemental data to pertain solely to raw material composition. While each artefact was cleaned prior to analysis following MAX Lab protocols (under running tap water with light brushing, followed by 10 minutes in distilled water in an ultrasonic tank) this did not always remove all traces of ink. At the end of running each tray of artefacts we systematically reviewed the XRF results to identify any possible discrepancies in the data before continuing with the next group of material. As mentioned in the section above, it was at this stage when we noted immediately that some artefacts had anomalously high levels of titanium (Ti), zinc (Zn), and to a lesser extent, iron (Fe) and barium (Ba) as represented in **Table 5.6**. Our working hypothesis – given that the published record by Bressy et al. (2005) provided no obsidian sources with such high levels of the aforementioned elements – was that the aberrant results were due to residual traces of ink influencing the elemental signature for these artefacts. Indeed, after some investigation, it was confirmed that the white ink marking the artefacts was the likely culprit (cf. Miyoshi 1982).

With regards to our concern over the problematic results, and in keeping with our findings from the literature, we concurrently designed and conducted a series of experimental runs to test our hypothesis, so that we might ultimately correct any false ppm values due to contamination. A full report of this experiment has been included in the Appendix of this document. In brief, the results of our experiments confirmed that the ink did indeed raise values of titanium and zinc significantly while the varnish used to seal the ink would slightly mask these same elements.

In response to this discovery, a more intensive cleaning method was used, albeit one that would still not damage the artefact. In order to ensure complete removal of ink and varnish, acetone was rubbed on all possible testing surfaces using a cotton pad. Then the artefact was rinsed under tap water, after which each piece was placed in distilled water within individual glass beakers that were then gently agitated for 10 minutes in an ultrasonic tank.

Once the artefacts had dried in open air, they were mounted to the sample tray using adhesive tape (**Figure 5.1**). During the contamination experiments we also considered the potential impact of such adhesive tape on the resultant elemental data (see Appendix). It was found that where the adhesive tape was in the path of the X-ray beam it would mask (diminish) the values of iron (Fe), and raise the values of titanium (Ti). Thus we were careful to make sure that the adhesive tape was only used on surfaces of the artefact that would not come into contact with the X-ray beam.

5.3 Analytical procedures

Once the samples had been prepared we were able to run the analyses. The elemental characterisation of the 290 Amuq Valley obsidian artefacts was undertaken in the MAX Lab using the facility's Thermo Scientific *ARL Quant'X* EDXRF spectrometer (**Figure 5.2**). The specific analytical protocols employed by the lab correspond to those devised by Shackley (2011, appendix; Poupeau et al., 2010:2711). The following text detailing the protocol is taken from recent lab publications (cf. Carter et al. 2018).

The spectrometer is equipped with an end window Bremsstrahlung, air cooled, Rh target, 50 watt, X-ray tube with a ≤7.6 micron (0.3 mil) beryllium (Be) window, an X-ray generator that operates from 4 to 50 kV in 1 kV increments (current range, 0 – 1.98 mA in 0.02 mA increments), and an Edwards RV8 vacuum pump for the analysis of elements below titanium (Ti). Data are acquired with a pulse processor and analogue to digital converter.

In the study, we ran the artefacts under two analytical conditions. The pieces were first run under a Mid Zb analysis condition, with the X-ray tube operated at 30 kV using a 0.05 mm (medium) Pd filter in an air path for 200 seconds livetime, to generate X-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (Fe), zinc (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb) and thorium (Th). The second is a High Zb analysis condition, with the X-ray tube operated at 50 kv using a 0.63 mm (thick) Cu filter in an air path, to detect the element barium (Ba).

Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards. These comprise AGV-2 (andesite), BCR-2 (basalt), BHVO-2 (hawaiite), BIR-1a (basalt), GSP-2 (granodiorite), QLO-1 (quartz latite), RGM-2 (rhyolite), SDC-1 (mica schist), STM-2 (syenite), TLM-1 (tonalite), and W-2a (diabase) from the US Geological Service [USGS], plus JR-1 and JR-2 (both obsidian) from the Geological Survey of Japan. The USGS standard RGM-2 is analysed on each tray of samples to verify machine calibration and accuracy, with a maximum of 19 artefacts, plus standard, per analysis. The data are then translated directly into Excel for Windows software for manipulation and analysis.

Once in Excel form, the data are normalized to the standard reference sample, RGM-2, prior to further analysis and plotting. This process consists of determining the relative error in the standard sample's concentration measurements and applying this difference to the individual artefacts analysed for each tray processed by the instrument. This procedure ensures source and artefact data results are consistently based on the reference, thus providing a more accurate match between chemical fingerprints.

5.4 Critical reflections on data-integrity

As noted above, after a tray of artefacts had been analysed, the results were reviewed by myself and Dr. Carter to discern any possible aberrations in the data that would necessitate re-analysing a particular artefact. These 'aberrations' were in the form of unexpectedly elevated or diminished numbers for a particular element. As we continued with our work we came to appreciate that such data might be the result of four different factors: (a) the effects of residual ink, varnish, tape, or dirt on the artefact ('surface contamination'), (b) poor setting of the artefact on the tray leading to the x-ray beam missing the target, (c) instrumental error (rare), (d) the raw material being one not included in the lab's geo-chemical database whereby the elemental values were unfamiliar to us.

Most of the artefacts (n=44) that were re-analysed was due to contamination from residual ink/acetone from the OIM labelling. After re-cleaning and re-running the analyses these problematic data were resolved. The rest of the retested artefacts (n=16) were selected for reanalysis on the basis of elevated, or diminished element values that placed them on the fringes, or significantly beyond, recognized source variation (as represented by data generated in the MAX Lab from geological samples from Anatolian sources). An example of this can be viewed in **Figure 5.3** where three artefacts lay on the fringe of the Meydan Dağ source values on a standard Zr by Sr bivariate plot. These three artefacts were retested to ensure all ppm values could be considered accurate enough before proceeding to the next step of analysis. In the end, these three artefacts remain in the fringe area of the Meydan Dağ source values, results which will be discussed more in the proceeding chapter. For now, it can be confirmed that the final results were not affected by sample size (see artefacts photos in proceeding chapter).

While the MAX Lab's established obsidian analysis protocol produced high-quality data (see **Tables 5.7** and **5.8** for reference to RGM-2 and RGM-2A data matching within boundaries of expected values) that allowed us to assign immediately a unique source for most of the artefacts' raw materials, it was necessary to reanalyse a small proportion of the assemblage (n=25, 9% of the sample collection) using a second protocol to discriminate between certain sources. This was specifically required when dealing with peralkaline types, i.e. the products of the Bingöl A and Nemrut Dağ sources. Despite being 150km from one another (**Figure 2.2**), the raw materials from these sources have long been appreciated as having very similar chemical signatures (Poidevin 1998). Indeed, many labs have been unable to distinguish these products leading to 'Bingöl A/Nemrut Dağ' source assignations in a number of publications (e.g. Bressy et al 2005). Discriminating these raw materials elementally is however possible, as first detailed by Chataigner (1998) using combinations of niobium (Nb), zirconium (Zr), and lanthanum (La). Subsequent work has demonstrated the utility of iron (Fe), aluminium (Al), and titanium (Ti) to achieve the same ends (Frahm 2012). The MAX Lab has previously been successful in distinguishing these peralkaline products using a bivariate ratio plot of Rb/Zr vs. Fe/Mn (Carter et al 2013a:563, Fig. 5), yet the same graph failed to achieve source discrimination for all of the Amuq Valley artefacts made of peralkaline obsidian (see **Figures 5.4-5.5** for comparison).

It was thus necessary to develop a new analytical protocol, as devised by Kathryn Campeau, that uses the major elemental data best-suited to achieving Bingöl A / Nemrut Dağ discrimination, as expressed through oxidized elemental weight percentages. These oxides were: Na_2O, Al_2O_3, K_2O, CaO, TiO_2, MnO_2, and Fe_2O_3. As of late, peralkaline discrimination has gained importance as recent studies by other labs have begun detailing important differences in these two sources' exploitation history across time and space (cf. Abbès et al. 2003). The results of these analyses, along with the main body of data from the initial MAX Lab analytical protocol are detailed and discussed in the following chapter.

5.5 Conclusion

EDXRF is a relatively easy and efficient method of elemental characterization, and one well-established for obsidian sourcing in general, and within a SW Asian context specifically (see Chapter 3 for references). Each run can be completed in a matter of hours (our regular RGM-2 protocol taking under four hours on average while our peralkaline RGM-2A protocol was a little faster) meaning multiple runs can be conducted in a single day, with the process fully automatic once the analysis has been initiated. With the laboratory stage of this research complete, I now move forward to the following chapter where the XRF results and their analyses are discussed.

5.6 Chapter 5 Tables and Figures

Table 5.1: Sequence list of runs for testing obsidian artefacts, Runs 1-5.

Run No.	Run 1	Run 2	Run 3	Run 4	Run 5
Date	10/04/17	17/04/17	17/04/17	19/04/17	19/04/17
Details	Tell Judaidah	Rerun	Tell Judaidah	Tell Judaidah	Rerun
Pos. 1	A45462	A45472	A59845	A59873	A59883
Pos. 2	A45466	A45476A	A59846	A59874	A59889
Pos. 3	A45470	A45478A	A59847	A59875	RGM-2
Pos. 4	A45471	A45481B	A59849	A59877	
Pos. 5	A45472	RGM-2	A59850	A59878	
Pos. 6	A45476A		A59851	A59881	
Pos. 7	A45476B		A59852	A59882	
Pos. 8	A45478A		A59853	A59883	
Pos. 9	A45481A		A59854	A59886	
Pos. 10	A45481B		A59856	A59889	
Pos. 11	A45482		A59860	A59892	
Pos. 12	A45487		A59862	A59895	
Pos. 13	A45488		A59863	A59897	
Pos. 14	A45490		A59864	A59899	
Pos. 15	A45491		A59865	A59901	
Pos. 16	A45494		A59867	A59904	
Pos. 17	A58942		A59868	A59905	
Pos. 18	A59011		A59870	A59907	
Pos. 19	A59027		A59871	A59909	
Pos. 20	RGM-2		RGM-2	RGM-2	

Table 5.2: Sequence list of runs for testing obsidian artefacts, Runs 6-10.

Run No.	Run 6	Run 7	Run 8	Run 9	Run 10
Date	21/04/17	21/04/17	21/04/17	24/04/17	26/04/17
Details	Tell Judaidah	Tell Judaidah	Tell Judaidah	Rerun	Tell Judaidah
Pos. 1	A59910	A59962C	A59977D	A59962D	A60003
Pos. 2	A59913	A59962D	A59977I	A59962E	A60004
Pos. 3	A59914	A59962E	A59977J	A59962F	A60005
Pos. 4	A59919	A59962F	A59977K	A59962G	A60006
Pos. 5	A59923	A59962G	A59977L	A59962H	A60007
Pos. 6	A59924	A59962H	A59977M	A59962I	A60008
Pos. 7	A59928	A59962I	A59977N	A59962J	A60009
Pos. 8	A59930	A59962J	A59977O	A59962K	A60010
Pos. 9	A59935	A59962J	A59982A	A59976H	A60014
Pos. 10	A59937	A59962K	A59982B	A59977A	A60018
Pos. 11	A59938	A59963A	A59982C	A59982C	A60019
Pos. 12	A59947	A59963B	A59982D	A59938	A60021
Pos. 13	A59951	A59963C	A59996	A59977J	A60027
Pos. 14	A59957	A59963D	A59997	A59977O	A60028
Pos. 15	A59959	A59976F	A59998	A59982A	A60029
Pos. 16	A59960B	A59976H	A59999	A59982C	A60030
Pos. 17	A59961B	A59977A	A60000	A59982D	RGM-2
Pos. 18	A59962A	A59977B	A60001	A59998	
Pos. 19	A59962B	A59977C	A60002	RGM-2	
Pos. 20	RGM-2	RGM-2	RGM-2		

Table 5.3: Sequence list of runs for testing obsidian artefacts, Runs 11-15.

Run No.	Run 11	Run 12	Run 13	Run 14	Run 15
Date	26/04/17	28/04/17	28/04/17	29/04/17	01/05/17
Details	Tell Kurdu	Tell Kurdu	Tell Kurdu	Tell Kurdu	Tell Dhahab + mixed reruns
Pos. 1	A59099	A59256	A59505	A59411	A48074P
Pos. 2	A59102	A59344	A59508	A59417	A48074Q
Pos. 3	A59103	A59347	A59510	A59426	A48074R
Pos. 4	A59106	A59352	A59511	A59429	A48074S
Pos. 5	A59108	A59355	A59518	A59437	A48074T
Pos. 6	A59109	A59365	A59521	A59439	A48075L
Pos. 7	A59113	A59367	A59529	A59440	A48081
Pos. 8	A59114	A59372	A59533	A59443	A48082
Pos. 9	A59118	A59373	A59539	A59446	A48083
Pos. 10	A59119	A59379	A59540	A59458	A48085
Pos. 11	A59120	A59387	A59542	A59463	A48086
Pos. 12	A59127	A59391	A59545	A59468	A59089
Pos. 13	A59128	A59392	A59547	A59469	A59387
Pos. 14	A59132	A59393	A59550	A59472	A59402
Pos. 15	A59245	A59398	A59553	A59482	A59550
Pos. 16	A59246	A59400	A48063Y	A59490	A59411
Pos. 17	A59248	A59402	RGM-2	A59496	A59873
Pos. 18	A59249	A59403		A59498	A59437
Pos. 19	A59252	A59404		A59501	A59403
Pos. 20	RGM-2	RGM-2		RGM-2	RGM-2

Table 5.4: Sequence list of runs for testing obsidian artefacts, Runs 16-20.

Run No.	Run 16	Run 17	Run 18	Run 19	Run 20
Date	01/05/17	03/05/17	03/05/17	05/05/17	08/05/17
Details	Tell Dhahab	Tell Dhahab	Tell Dhahab	Tell Dhahab	Reruns + Jordan and Israel
Pos. 1	A48070U	A48070A	A48065H	A45770	A48065I
Pos. 2	A48070W	A48070B	A48065I	A45771	A48065K
Pos. 3	A48070X	A48070C	A48065J	A45772	A48065M
Pos. 4	A48070Y	A48070D	A48065K	A48063C	A48065N
Pos. 5	A48074A	A48070E	A48065L	A48063E	A48065O
Pos. 6	A48074B	A48070F	A48065M	A48063O	A48065Q
Pos. 7	A48074C	A48070G	A48065N	A48063P	A48065U
Pos. 8	A48074D	A48070H	A48065O	A48063Q	A48065W
Pos. 9	A48074E	A48070I	A48065P	A48063U	A48065X
Pos. 10	A48074F	A48070J	A48065Q	A48063V	A48070N
Pos. 11	A48074G	A48070K	A48065R	A48063Z	A48070P
Pos. 12	A48074H	A48070L	A48065S	A48065A	A48065F
Pos. 13	A48074I	A48070M	A48065T	A48065B	008/99-M7
Pos. 14	A48074J	A48070N	A48065U	A48065C	011/102-M7
Pos. 15	A48074K	A48070O	A48065V	A48065D	029/98-M7
Pos. 16	A48074L	A48070P	A48065W	A48065E	43/1051-MjRb
Pos. 17	A48074M	A48070Q	A48065X	A48065F	W571C/4473-MjRb
Pos. 18	A48074N	A48070R	A48065Y	A48065G	616/4023-MjRb
Pos. 19	A48074O	A48070S	A48065Z	RGM-2	RGM-2
Pos. 20	RGM-2	RGM-2	RGM-2		

Table 5.5: Sequence list of runs for testing obsidian artefacts, Runs 21-25.

Run No.	Run 21	Run 22	Run 23	Run 24	Run 25	Run 26
Date	25/08/17	26/01/18	26/01/18	26/04/18	21/09/18	21/09/18
Details	Rerun	AV Peralk.	AV Peralk.	Run 11 Rerun	Protocol 2, Peralk.	Protocol 2, Peralk.
Pos. 1	A59550	A48063Z	A59889	A59099	A59889	A48063Z
Pos. 2	A59411	A59854	A60003	A59102	A60003	A59854
Pos. 3	A59437	A59545	A45490	A59103	A45490	A59545
Pos. 4	A59365	A59862	A59114	A59106	A59114	A59862
Pos. 5	A59510	A59883	A59521	A59108	A59521	A59883
Pos. 6	A59392	A59998	A48075L	A59109	A48075L	A59998
Pos. 7	A59482	A59468	A59403	A59113	A59403	A59468
Pos. 8	A59962D	A59128	A59404	A59114	A59404	A59128
Pos. 9	A59924	A59846	A59446	A59118	A59446	A59846
Pos. 10	A59905	A45476A	A59914	A59119	A59914	A45476A
Pos. 11	A59899	A48074P	A59505	A59120	A59505	A48074P
Pos. 12	A59883	A59120	A59429	A59127	A59429	A59120
Pos. 13	A59889	RGM-2	A59440	A59128	A59440	RGM-2A
Pos. 14	A59845		RGM-2	A59132	RGM-2A	
Pos. 15	A59938			A59245		
Pos. 16	A48065I			A59246		
Pos. 17	RGM-2			A59248		
Pos. 18				A59249		
Pos. 19				A59252		
Pos. 20				RGM-2		

Table 5.6: Example set of contaminated artefacts from museum labelling presenting in elements Ti, Fe, Zn, and Ba, and their corrected values after re-cleaning and re-testing.

Artefact	Run Sequence	Site	Tray	**Ti**	**Fe**	**Zn**	**Ba**
A59962H	original	Tell Judaidah	Run 7 Pos. 06	**1031**	**15434**	**233**	**565**
A59962H	rerun	Tell Judaidah	Run 9 Pos. 05	**931**	**14306**	**163**	**513**
A59962I	original	Tell Judaidah	Run 7 Pos. 07	**506**	**14777**	**212**	**460**
A59962I	rerun	Tell Judaidah	Run 9 Pos. 06	**341**	**10601**	**100**	**291**
A59962J	original	Tell Judaidah	Run 7 Pos. 08	**876**	**13695**	**257**	**763**
A59962J	rerun	Tell Judaidah	Run 9 Pos. 07	**595**	**11714**	**172**	**604**

Table 5.7: Expected RGM-2 values for high quality data matching.

Element	Expected Values	+/- (s.d)
Ti	0.15 Wt %	0.014
Mn	273 mg/g	8
Fe	1.30 Wt %	0.03
Ni	4 mg/g	
Cu	9.8 mg/g	0.8
Zn	33 mg/g	2
Rb	147 mg/g	5
Sr	108 mg/g	5
Y	24 mg/g	2
Zr	222 mg/g	17
Nb	9 mg/g	
Ba	842 mg/g	35
Pb	20 mg/g	1
Th	15 mg/g	1

Table 5.8: Expected RGM-2A values for high quality data matching.

Oxide	Expected Value	+/- (s.d)
Na2O	4.14 Wt %	0.12
Al2O3	14.0 Wt %	0.30
K2O	4.35 Wt %	0.16
CaO	1.23 Wt %	0.03
TiO2	0.25 Wt %	0.023
MnO2	0.035 Wt %	
Fe2O3	1.86 Wt %	0.04

Figure 5.1: Obsidian artefacts mounted to sample tray with adhesive tape. Ready for XRF testing.

Figure 5.2: Sample tray placed inside the MAX Lab EDXRF instrument.

Figure 5.3: Zr vs Sr plot showing three example artefacts that lay in the fringes of the Meydan Dağ source according to data generated in the MAX Lab from geological samples from Anatolian sources.

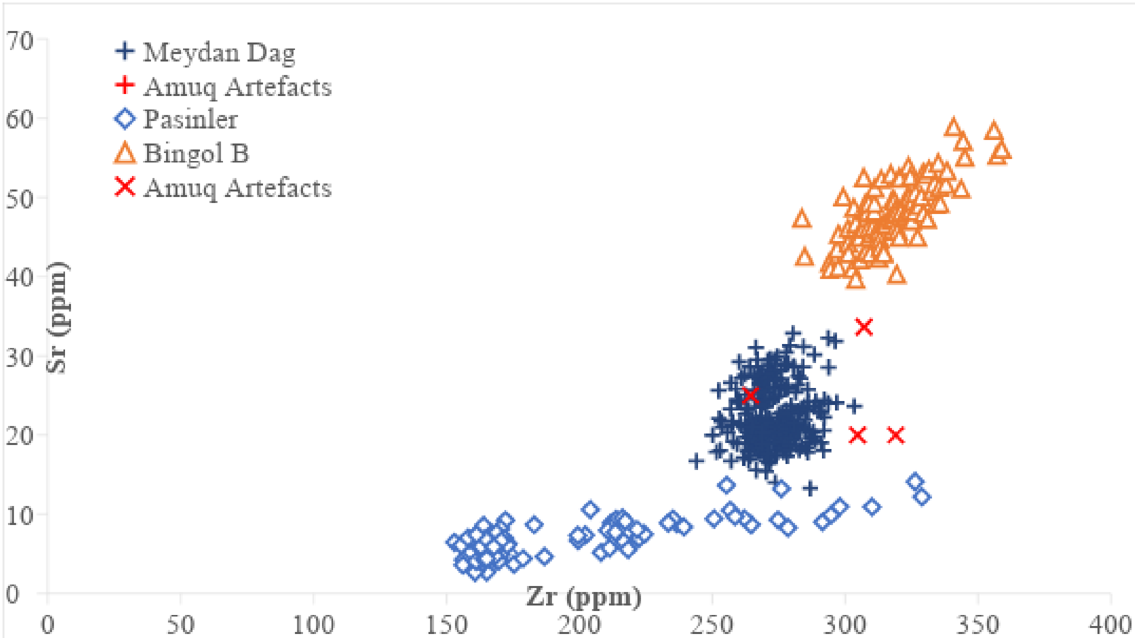


Figure 5.4: Fe/Mn vs Rb/Zr bivariate plot separating Bingöl A and Nemrut Dağ A obsidian peralkalines according to data generated in the MAX Lab from geological samples from Anatolian sources.

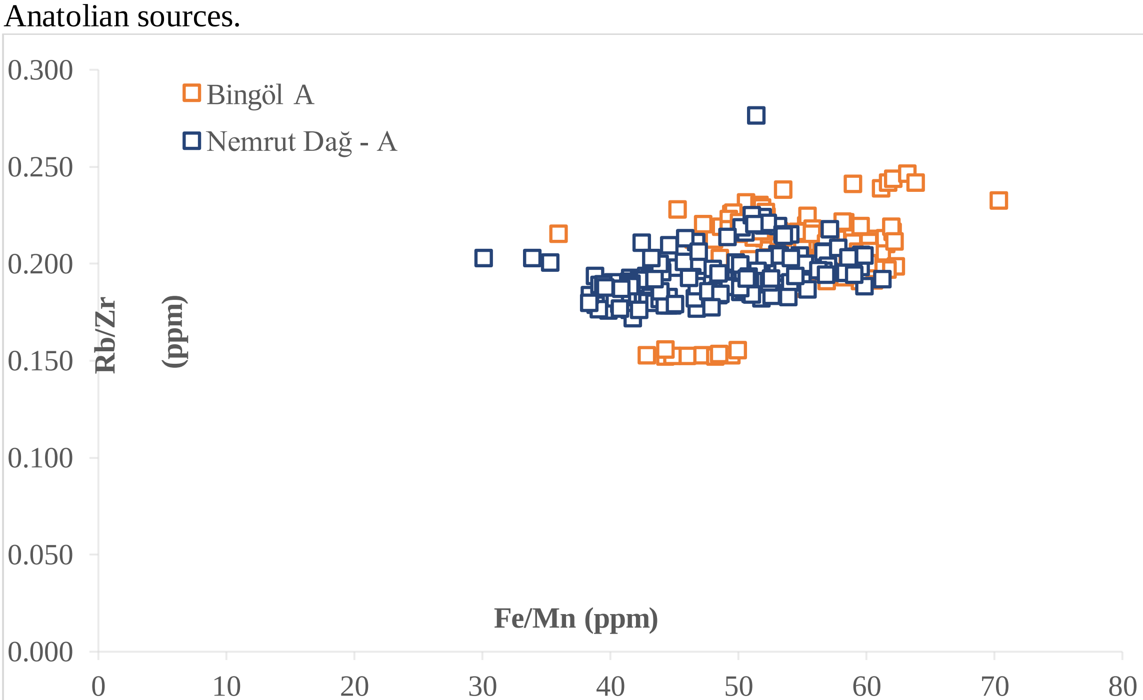
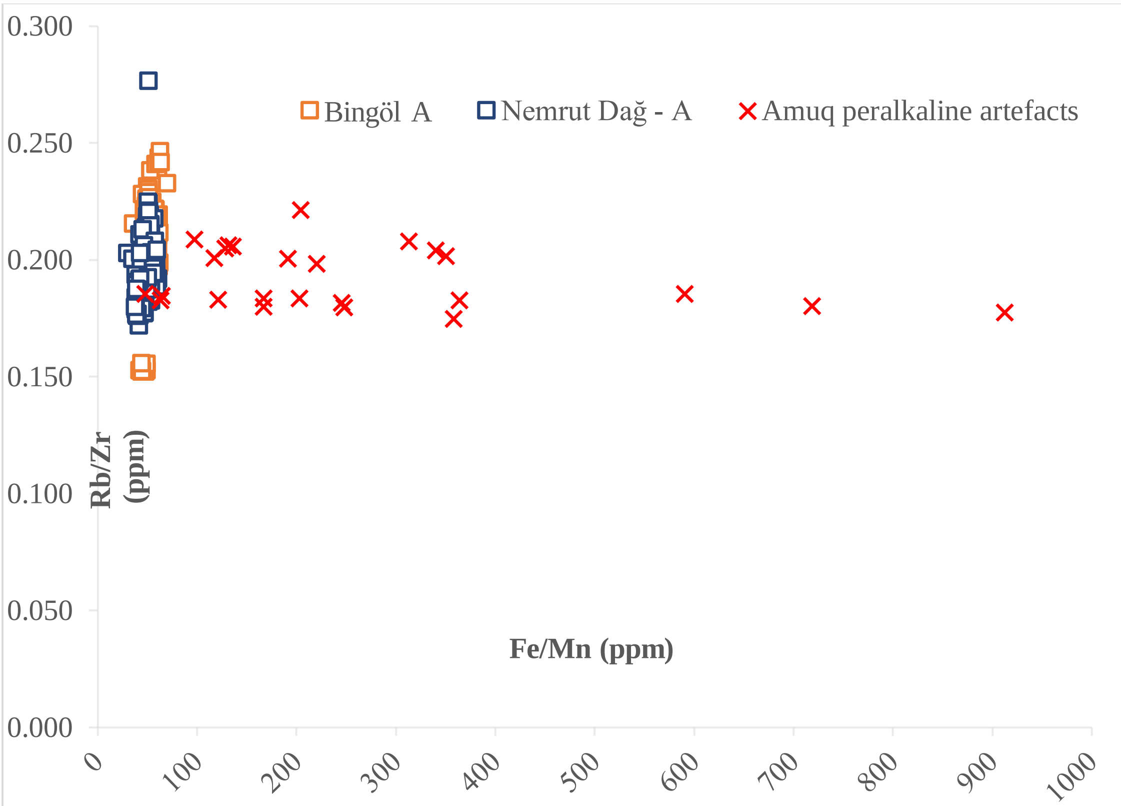


Figure 5.5: The same bivariate plot as Figure 5.4 with Amuq Valley peralkaline data inserted, now distorting the separation between Bingöl A and Nemrut Dağ A obsidian peralkalines.



Chapter 6: Results

6.0 Introduction

In this chapter, I present the results from the EDXRF analyses described in the previous chapter. All final results have been compounded into **Figure 6.0.0** and **Table 6.0.0a**, with source assignments based upon matching the chemical fingerprint of an artefact's raw material with that of a unique geological source. That said, this list of geological assignment follows our first protocol (RGM-2) meaning the peralkaline artefacts, at this stage, are labelled *Nemrut Dağ/Bingöl A*. For a final list detailing the discrimination of the peralkaline obsidians following our second protocol (RGM-2A), see **Table 6.0.0b.** While these final attribution lists has been organized by obsidian source, the results presented below are given in a chronological order, by site. The quantitative results of the chronological distribution of obsidian artefacts and their sources from Phases A-H are presented in **Table 6.0.1**.

Firstly, Part I will provide the reader with a general overview of the major Anatolian obsidian sources pertinent to this study. This is accompanied by photos of representative samples of Amuq Valley obsidian artefacts organised by raw material source. Following this, Part II provides the results of the Tell al-Judaidah artefact analyses, while Parts III and IV details those from Tell Kurdu and Tell Dhahab respectively.

Part I

6.1 Obsidian source descriptions

The major Anatolian obsidian sources can be grouped geographically into three major regions (**Figure 6.1.1**), namely: Cappadocia (central Anatolia), the Lake Van region (eastern Anatolia, towards the Iranian border), and Northeast Anatolia (close to the borders with Georgia and Armenia).

6.1.1 Sources from the Cappadocian Region

6.1.1.i Göllü Dağ: The major volcanic massif of Göllü Dağ of southern Cappadocia (**Figure 6.1.1**) has numerous obsidian outcrops, many of excellent tool-making quality. Detailed geo-chemical studies have separated these raw materials into seven chemically distinct sub-types, of which, Kayirli and Kömürcü, are known to be the most significant archaeologically (Binder et al. 2011; Chataigner 1998:525-526; Poupeau et al. 2010:2718). From a deep-time perspective, Göllü Dağ obsidian was exploited from the Lower Palaeolithic (Balkan-Atlı et al. 2010), and consumed at distance from at least the earlier Epi-Palaeolithic (as far as 380 km to the south-west [Carter et al. 2011]) until the Late Bronze Age, c. 1250-1000 BCE (Chataigner et al. 1998:525; Renfrew, Dixon and Cann 1966). It was from the later Epi-Palaeolithic (Natufian) period that we first witness this raw material's circulation amongst hunter-gatherer communities of the Middle-Euphrates and Levant up to 1000km away (Cauvin 1994 as cited by Chataigner et al. 1998:525; Delerue 2007). During the Neolithic (10, 300 – 9600 BP [~8300-7600 BCE]), Göllü Dağ obsidian was the main Cappadocian obsidian circulating at distance, being procured by farmers of central Anatolia, northern Mesopotamia, the Levant and even Cyprus (Chataigner 1998:525; Delerue 2007).

Amongst the Amuq Valley obsidian detailed in this study, two of the Göllü Dağ sub-source products were detected. Located together near the village of Kömürcü are two main sub-sources (**Figure 6.1.2**). The first, and most common, comes from 'East Göllü Dağ', made up of three separate flows: Kömürcü, Kayırlı-East, and East-Bözköy (Chataigner 1998:525. Obsidian from these outcrops are typically a high-quality translucent grey raw material (Binder et al. 2011), examples of which are shown in **Plates 6.1.1-2**. Chemically, East Göllü Dağ obsidian is distinctive on the basis of its low values of Sr and Zr relative to other Anatolian obsidian types, save for certain varieties of Acigöl obsidian of northern Cappadocia (see **Figure 6.0.0**). In total, our analysis demonstrated that 170 of the Amuq Valley artefacts (59%) were made of East Göllü Dağ obsidian, the material recovered from nearly all phases (**Table 6.0.1**). Details of the distribution are presented in Parts II-IV.

The second raw material from this volcano detected in the Amuq Valley material comes from the 'West Göllü Dağ' sub-source, deriving from two flows: Kayırlı-village and North-Bözköy (Chataigner 1998:525). These raw materials were less commonly exploited during prehistory, the obsidian being of blackish colour with little to no translucency (**Plates 6.1.3-4**). Only one artefact made from this raw material was recognised from the Amuq Valley collection, from Tell al-Judaidah, dating to Phase A (**Table 6.0.1**).

6.1.1.ii Acigöl: Studies have shown that the Acigöl volcano, located in northern Cappadocia, can be spatially separated according to outcrop into sub-sources, namely: Acigöl West, Acigöl Post-Caldera East – both which are considered of poor knapping quality (Chataigner et al. 1998:523) – and Acigöl Ante-Caldera East (**Figure 6.1.3**). According to Chataigner et al. (1998:523) the history of Acigöl (ante-caldera East) obsidian exploitation is relatively limited, commencing only in the Late Neolithic (c. 8th millenium), and being procured by only a handful of communities, as far as El Kowm 2 in the Middle-Euphrates (**Figure 6.1.1**).

Only two artefacts from the Amuq Valley collection were sourced to Acigöl, both from Phase A contexts at Tell al-Judaidah (**Table 6.0.1**); one from Ante-Caldera East, A59976H, which is blackish and opaque with brownish edges, while the other, A59962I, is from Post-Caldera East and is blackish with dark grey translucency (**Plates 6.1.5-6**). Chemically, Acigöl obsidian falls into several locations on the Anatolian source plot (**Figure 6.0.0**), with distinctions separating the three sub-sources based predominantly on differential Sr levels.

6.1.1.iii Nenezi Dağ: The smaller volcano of Nenezi Dağ is located in southern Cappadocia, only a few kilometres north of Göllü Dağ (**Figure 6.1.1**). Currently, the earliest evidence for this obsidian's use at distance comes from an Epi-Palaeolithic context (19th millennium cal. BCE) at the Öküzini Cave (**Figure 6.1.1**), 380km to the south-west near the Mediterranean coast (Carter et al. 2011). It is not until the PPNB that we witness a marked increase of this raw material in circulation, reaching a number of sites in the Southern

Levant (Carter et al. 2011:142; Chataigner 1998:525; Delerue 2007). While initially Nenezi Dağ obsidian was less commonly used and travelled over shorter distances compared to the raw materials of neighbouring Göllü Dağ (Altınbilek-Algül 2011), it eventually came to have equal role with Göllü Dağ obsidian at Çatalhöyük by the mid-7th millennium BCE, after a "radical shift" (Carter et al. 2006:906) in consumption practices toward the end of the Early Neolithic (Cauvin and Chatainger 1998; Poupeau et al. 2010).

By appearance, Nenezi Dağ obsidian is blackish with or without light coloured amygdules (Renfrew, Dixon and Cann 1966:38), which all of the Amuq Valley obsidian matches to. Also seen in the Nenezi Dağ obsidian of the Amuq Valley, is a general opacity with some degree of dark greyish translucency (**Plates 6.1.7-8**). Chemically, Nenezi Dağ can have some overlap with some of the obsidian from the North-East Anatolian source of Pasinler, however, these products can be discriminated using Rb values. In total, there were forty-three artefacts whose obsidian was sourced to Nenezi Dağ (15% of the total collection), this material appearing intermittently across the Amuq Sequence in Phases A, D, G and H, from Tell al-Judaidah (n=29), Tell Kurdu (n=1), and Tell Dhahab (n=9) (**Table 6.0.1**). More details on the artefacts made of Nenezi Dağ obsidian are presented in Parts II-IV.

6.1.2 Sources from the Lake Van Region

6.1.2.i Bingöl A and Nemrut Dağ A: Arguably, the most visually and chemically distinctive obsidian from the study is that from the Bingöl A and/or Nemrut Dağ sources. These raw materials are peralkaline products, and are unique for their green colour which can be seen in translucent specimens when held before a light. At other times, when a specimen is too thick for light to pass through it, the distinct green can only be recognized along its edges. Examples of these descriptions can be viewed in **Plates 6.1.9-10.** Such raw materials are also highly distinctive in having greatly elevated Zr values (>1000ppm) and correspondingly low Sr values (≤5ppm).

The Bingöl A and/or Nemrut Dağ raw materials are the Eastern Mediterranean's only peralkaline obsidians, the nearest other examples come from the Yemen to the south-east, and the insular source of Pantellaria in the central Mediterranean (Khalidi 2010; Francaviglia 1988). Bingöl is a very old volcanic region, with numerous outcrops of high-quality obsidian (**Figure 6.1.4**); broadly speaking these products can be separated into two groups. 'Bingöl A' is the green peralkaline material, known from Orta Düz and Çavuşlar (Poidevin 1998:137-138), while the raw materials from Alatepe and Çatak are the more traditional calk-alkaline, with a black/brown hue, and are referred to as deriving from the 'Bingöl B' source (Poidevin 1998:137-138). Thecaldera volcano of Nemrut Dağ is situated on the western shores of Lake Van (**Figure 6.1.5**). Here obsidian outcrops around its rim, within its caldera and on its western flanks; all of these raw materials are peralkaline (Poidevin 1998:139-140). Most of the obsidian from Nemrut Dağ is highly spherulitic and of poor knapping-quality; the best raw material derives from the Sıcaksu and Kayacık outcrops on the volcano's western flanks (Robin et al 2016).

Despite being ~150km apart from each other, the peralkaline products of Bingöl A and Nemrut Dağ have striking similarities" chemically, they were originally referred to as a single source 'type 4c' by Renfrew et al (1966: 40). It was not until the 1990s that these raw materials could be distinguished elementally through reference to major elemental Al2O3 and Fe2O3 percentages (Cauvin et al 1996; Poidevin 1998:141-142; see also Frahm 2012). This discrimination was not always possible for every obsidian sourcing lab, with Al values relatively difficult to determine for XRF techniques, leading to many reports continuing to attribute peralkaline products to a combined Bingöl A/Nemrut Dağ source (e.g. Abbès et al. 2003; Campbell and Healey 2016). For this study a new analytical protocol was devised by Kathryn Campeau to discriminate our peralkaline raw materials.

These peralkaline sources were exploited since the Late Palaeolithic (33 000 – 17 000 BP; ~31 000-15000 BCE) as evidenced by artefacts from Level C of the Shanidar Cave in northern Iraq (Renfrew, Dixon and Cann 1966:39). They remained the dominant obsidian from the Lake Van region to be exploited throughout the Epi-Palaeolithic (Wright 1969:25; Carter et al. 2013b:568) and into the Early Neolithic (PPNA) when their distributions change. While Nemrut Dağ obsidian was circulated southward into the Zagros mountain area (Renfrew, Dixon and Cann 1966:39), Bingöl A, seems to have a more limited distribution, keeping within the Middle-Euphrates region similar to Bingöl B (Chataigner et al. 1998:530). The distribution of Nemrut Dağ obsidian eventually expanded into the Levant, albeit not until the Late Neolithic, around 6500 BP (~4500 BCE) (Chataigner et al. 1998:533).

A total of twenty-five peralkaline obsidian artefacts (9%) is included in the Amuq Valley obsidian collection. Using three different bivariate plots (Fe2O3 vs MnO, Fe2O3/CaO vs Na2O/MnO2, and Na2O/Fe2O3 vs Na2O/MnO2), these sources appeared intermittently throughout the Amuq Sequence from the Chalcolithic to the Early Bronze

Age (5700-2700 BCE). Nemrut Dağ appears first at tell Kurdu in Phase C (n=3), then reappears with Bingöl A at the same site in Phase E (n+8, n=1 respectively). Finally, at Tell al-Judaidah, Phase G, the two reappear a last time with Nemrut Dağ still the more abundant (n=9 and n=1). Unfortunately, there are three remaining Nemrut Dağ artefacts from Tell Dhahab with no temporal context (**Table 6.0.1**). More details of the distribution of peralkalines is presented in Parts II-IV.

6.1.2.ii Bingöl B: Bingöl B is the source name given to the massif's various calcalkaline products (**Figure 6.1.4**). Bingöl B obsidian has been exploited since 10, 600 BP (~8600 BCE), roughly the transition from PPNA to PPNB, starting in the upper Tigris basin, eventually appearing westward in the Middle Euphrates (Chataigner 1998:530). A second distribution course descended the Zagros mountains by 9600 BP (~7600 BCE), well into the PPNB (Wright 1969:26). These movements continued until the Halaf period when Bingöl B obsidian tended to be replaced by products from Meydan Dağ (Wright and Gordus 1969b:76; Chataigner et al. 1998:530). Bingöl B appears to have been first accessed by Levantine populations sometime after 6500 BP (~4500 BCE), before making a reappearance in the Euphrates and southern Mesopotamia during the Uruk (Chataigner et al 1998:530).

Bingöl B obsidian is recognizable by its brownish to blackish colouring with varying degrees of translucency and opacity (Healey 2007:175), examples of which are shown in **Plates 6.1.11-12**. In the Amuq Valley obsidian collection, forty-one artefacts (14%) were made of Bingöl B material, recovered throughout the Amuq Sequence since the Late Neolithic. At Tell al-Judaidah, this is during Phase A (n=1), Phase G (n=12), Phase H (n=2) and Second Mixed Range (n=1), while it appears in all phases of Tell Kurdu (Phase C=6; Phase D=2; Phase E=14), leaving three unstratified artefacts from Tell Dhahab (see **Table 6.0.1**). More details are provided in Parts II-IV.

Interestingly, the Phase A appearance is roughly two thousand years earlier than expected based on Chataigner's (1998) report. Also not in keeping with usual observations (reported above by Wright 1969 and Carter et al. 2013b), Bingöl B is the most dominant obsidian type from the Lake Van region to be exploited in the Amuq Valley both in quantity and consistency, rather than peralkaline obsidian.

6.1.2.iii Meydan Dağ: The volcano of Meydan Dağ is situated on the north shore of Lake Van (**Figure 6.1.5**). As with other Lake Van raw materials, Meydan Dağ obsidian was first circulated along communities of the Zagros region as early as the PPNB (Renfrew, Dixon and Cann 1966:40) before making an appearance in Northern Mesopotamia in the Late Neolithic to Chalcolithic periods (8^{th} to 5^{th} millennia) (Renfrew, Dixon and Cann 1966:40). It then enters the Middle-Euphrates (Chataigner et al. 1998:534) and southern Levant (Renfrew, Dixon and Cann 1966:40; Wright and Gordus 1969b:77) by the Late Chalcolithic (ca. 4500-3500). Thereafter, its presence is mostly known in association with other obsidian types, completing the image of "cosmopolitism" as described by Renfrew (Renfrew, Dixon and Cann 1966:40).

In the Amuq Valley collection, Meydan Dağ obsidian is only present at Tell Kurdu in Phase E (4800-4300 BCE) of the Late Chalcolithic (**Table 6.0.1**). Chemically, only one artefact can be confidently confirmed as such while the other three artefacts can only be described as Meydan Dağ-like based on their Sr and Zr levels (see **Table 6.0.0a**). Its appearance is dark grey to black in colour with varying translucency, typically with cloudy inclusions (see **Plates 6.1.13-16**).

6.1.3 Sources from North-East Anatolia

6.1.3.i Sarıkamış: The Sarıkamış obsidian source is situated in what today is the far north-eastern quadrant of Turkey, and is the most distant source represented in the Amuq Valley obsidian analysed in this study (**Figure 6.1.6**). Despite its excellent knapping quality, there is very little evidence for Sarıkamış obsidian being used at distance (certainly to the south). Thus far it has been documented from the Halaf period site of Domuztepe (Frahm, Campbell and Healey 2016b) in the Northern Levant, plus Ubaid period at Surezha and Tell Nader (Iraq) (T. Carter pers. comm.; Gratuze and Boucetta 2013) (**Figure 6.1.1**).

Chemically, the volcano's raw materials can be separated into two sub-types, the Sarıkamış South and the Sarıkamış North, which are chemically distinguishable by opposing ratios of barium and yttrium content (Chataigner et al. 2014:367). Only a single artefact from the Amuq Valley sample collection has been attributed to Sarıkamış (**Table 6.0.1**), though four other artefacts of this material type have been mentioned from Tell Kurdu by Delerue (2007:459). This artefact, from Phase G at Tell al-Judaidah, is dark grey with light grey to colourless translucency (**Plates 6.1.17-18**).

6.1.3.ii Pasinler: The Pasinler obsidian source is located in North-Eastern Anatolia (**Figure 6.1.6**) by the Büyükdere River in Turkey (Chataigner et al. 2013:5). At present, obsidian sourcing studies suggest that Pasinler obsidian was mainly used during the Early Bronze Age (by the 4th millennium BCE) by relatively local communities of Trans-Caucasia (Chataigner et al. 2014). Geo-chemical analyses indicate that there are at least two sub-sources, termed: Pasinler South, and Pasinler North (Brennan 2005)**.**

The results of the EDXRF analysis suggested that two of the Amuq Valley artefacts, both from Tell Kurdu, were made of obsidian from Pasinler (**Table 6.0.1**). The first, A59118, from Phase C is translucent grey, while A59463, from Phase E is black, nearly fully opaque, with no inclusions (**Plates 6.1.19-20**). Pasinler North obsidian has been described as "black with red inclusions" (Healey 2007:175) or red and black "mottled" (Chataigner et al. 2014:357). Chataigner et al. (2014:357), however, also describe another Pasinler obsidian type as "black, uniform, opaque, shiny" and Belli (2001) provides a similar description, both of which A59463 fits. Chemically, as observed by Cauvin et al. (1998:186), Pasinler obsidian typically contains relatively low strontium levels with zirconium levels in the high one hundreds. Unfortunately, this does not provide the Amuq Valley Pasinler artefacts with enough detail to confirm which sub-source they might belong to.

Part II

6.2 Tell al-Judaidah obsidian source distribution

Tell al-Judaidah has the earliest – Phase A – occupation levels of the Amuq Sequence. In this study, we included Tell al-Judaidah artefacts from the following periods: Phase A, First Mixed Range (intermediate between Phase B and Phase F), Phase F, Phase G, Phase H and finally, the Second Mixed Range (contemporary to Phases I and J) (**Table 6.2.0**). The sources of these artefacts' raw materials is detailed in the Zr versus Sr plot of **Figure 6.2.0**.

6.2.1 Phase A

There are five different obsidian sources represented in the forty-one obsidian artefacts from Tell al-Judaidah. These sources are Acigöl, East Göllü Dağ, West Göllü Dağ, and Nenezi Dağ from Cappadocia, and Bingöl B from the Lake Van region (**Figure 6.2.1**).

6.2.1.i East Göllü Dağ products: The majority of the artefacts (twenty-seven in total) were sourced to East Göllü Dağ. As a close up of **Figure 6.2.0**, **Figure 6.2.2** shows four of these artefacts with slightly lower Zr levels compared to the MAX Lab's East Göllü Dağ source data. These four artefacts (A59977B, A59962K, A59977O and A59977I) appear to the left of the East Göllü Dağ database grouping (**Figure 6.2.2**). To ensure their proper allocation to the East Göllü Dağ source, these artefacts were cross-referenced using other elemental values. Individually, each artefact was placed on a line graph to detail this analysis which can be viewed in **Figures 6.2.3-6.2.6** and **Tables 6.2.2-6.2.5**.

To perform a proper comparison of the four artefacts deviating on the Zr versus Sr plot in **Figure 6.2.2**, the next closest obsidian source based on chemical composition was used for contrast. In this case, the Acigöl West source database proved to the closest chemical comparison for the four artefacts. An average of ppm values for eight elements: Rb, Sr, Y, Zr, Nb, Ba, Pb, and Th were taken from the MAX Lab source data for East Göllü Dağ and Acigöl West. Then, the exact ppm value for the same eight elements were taken for each of the four straying artefacts mentioned above.

As can be seen from the line graphs (**Figures 6.2.3-6.2.7**), all four artefacts show greater compatibility, on an individual basis, to the East Göllü Dağ source data due to their Ba levels, for which the Acigöl West source data average is dramatically lower. For the sake of consistency in using the average ppm value of the eight elements, the four artefacts have also been summed together for an average ppm values for use in a fifth line graph. From the results of **Figure 6.2.7** and **Table 6.2.6**, the same conclusion can be made that artefacts A59977B, A59962K, A59977O and A59977I can be sourced to East Göllü Dağ.

6.2.1.ii Nenezi Dağ products: The next largest grouping of Amuq artefacts in **Figure 6.2.1** was sourced to Nenezi Dağ with ten artefacts. Two of these artefacts, however, A59976F and A60019, land in the chemical spectrum that overlaps with Pasinler (north or south). [LR11] By looking at the same Zr versus Sr plot of **Figure 6.2.1**, however, scaled accordingly in order to see the detail of artefact distribution across the sources of Nenezi Dağ, Acigöl East, Pasinler (north or south) [LR12] and West Göllü Dağ, it is possible to detect where this overlap between Nenezi Dağ and Pasinler arises (see **Figure 6.2.8**). Note the two points circled in pink that indicate the two Amuq artefacts which fall within the overlapping range of Zr and Sr ppm levels.

In order to prove that the raw materials of A59976F and A60019 originate from the Nenezi Dağ source, the same ten artefacts were plotted with MAX Lab source data from Nenezi Dağ, West Göllü Dağ and Pasinler (north or south) [LR13] on a Rb/Zr versus Y plot (see **Figure 6.2.9**). This plot, taken after Carter et al. (2017), was used specifically to distinguish Pasinler from Nenezi Dağ. As can be seen in **Figure 6.2.9**, this plot allows for a clear chemical distinction to emerge between the sources, firmly separating A59976F and A60019 from Pasinler and assigning them to Nenezi Dağ.

6.2.1.iii Other source materials: The remaining artefacts from Tell al-Judaidah Phase A are easier to associate to a source. Referring back to **Figure 6.2.1**, there is one artefact, A59982B, whose raw material can be assigned to Bingöl B, and one artefact, A59962D made of West Göllü Dağ obsidian. This latter artefact can also be seen in a second plot, **Figure 6.2.10**. Finally, the two additional artefacts, A59962I and A59976H assigned to Acigöl can be further differentiated into two different sub-sources. To demonstrate this, an additional Zr versus Sr plot (**Figure 6.2.11**) was created with a modified scale, showing how the sub-sources, Ante Caldera East (circled in purple), Post Caldera East, and Acigöl West, are chemically distinct. This allows us to demonstrate that Amuq A59976H was made of obsidian from the Ante Caldera East sources, while A59962I was fashioned from Post Caldera East raw material.

6.2.2 First Mixed Range

Skipping over Phase B as there are no obsidian artefacts to discuss, Tell al-Judaidah resumes with The First Mixed Range. This occupation layer is the only one of its kind across all of the Amuq Valley (Braidwood and Braidwood 1960:21). This level was described by Braidwood and Braidwood as an inconsistent assemblage based on its disorderly mixture of cultural material pertaining to Phases B through F (1960:100). In total, 60 obsidian artefacts were recovered from the First Mixed Range, however, is only represented by two (3%) in the study collection (**Table 2.0.1**).

Plot **Figures 6.1.12-6.1.13** shows that the obsidian of these two artefacts (A59960B and A59961B) can sourced to East Göllü Dağ.

6.2.3 Phase F

From the study collection, all six obsidian artefacts were sourced to East Göllü Dağ (**Figures 6.2.14 and 6.2.15**). It is important to note that in **Figure 6.2.15**, only five red dashes are visible rather than six. This is because two obsidian artefacts, A60021 and A60009 have the same Zr and Sr ppm values and thus occupy the same place on the plot.

6.2.4 Phase G

The 70 artefacts from Phase G are shown to be made of obsidian from over six different sources (**Figure 6.2.16**).

6.2.4.i East Göllü Dağ products: The largest source group from Phase G is East Göllü Dağ with twenty-nine artefacts (**Figure 6.2.17**). Five of these lie in the outskirts of the source data, similar to what was previously seen in Phase A. To verify that these outlier artefacts belonged to the East Göllü Dağ source, the same procedure used in Phase A was performed again (see above section *6.2.1.i*). The results seen in **Figure 6.2.18** accompanied by **Table 6.2.7** show that these five artefacts match closer to East Göllü Dağ than they do to the West Acigöl source.

6.2.4.ii Nenezi Dağ products: The next largest source group represented in Phase G is Nenezi Dağ to which eighteen artefacts were sourced. As can be seen in **Figure 6.2.19**, however, several artefacts appear in overlapping areas to other sources on the Zr versus Sr plot. Three, A59907, A59873 and A59930 overlap with source data from Pasinler. As this overlap occurred before with artefacts from Phase A, the same Rb/Zr ratio versus Y plot taken after Carter et al. 2017 was used again to separate Nenezi Dağ from Pasinler. Again, the results presented in this plot, **Figure 6.2.20**, show that the three artefacts A59907, A59873 and A59930 can be properly sourced to Nenezi Dağ.

The two remaining artefacts, A59849 and A6000 land in between the source data range for Nenezi Dağ and West Göllü Dağ. So far, alternative bivariate plots and line charts have not been able to convincingly prove that these artefacts do indeed belong to Nenezi Dağ (**Figure 6.2.21-23; Table 6.2.8**). For the time being, however, they have been tentively assigned to Nenezi Dağ (see Final List **Tables 6.0.0a&b**).

6.2.4.iii Other source materials: Phase G's third largest grouping with twelve artefacts belongs to Bingöl B as seen in **Figure 6.2.24**. The next most frequent obsidian type were peralkalines (n=10). Using three different bivariate plots (Fe2O3 vs MnO, Fe2O3/Ca vs Na2O/MnO2, and Na2O/Fe2O3 vs Na2O/MnO2), only one, A59998, was matched to Bingöl A while the remaining nine could be matched to Nemrut Dağ. These results can be seen in **Figures 6.2.25-6.2.27**. One of the artefacts, A59854, from Tell al-Judaidah Phase G, has the issue of drifting away from the database grouping on two of the plots: Fe2O3/CaO vs Na2O/MnO2 (**Figure.6.2.26**), and Na2O/Fe2O3 vs Na2O/MnO2 (**Figure 6.2.27**). In the first plot (**Figure 6.2.25**), however, this artefact falls comfortably amongst the Nemrut Dağ source data points. It is also important to mention that a second artefact, A59846, while still considered Nemrut Dağ, falls within the overlap of Bingöl A and Nemrut Dağ source data points on the second plot (**Figure 6.2.27**). This issue, however, does not occur in any other plot.

Finally, one obsidian artefact from Phase G was sourced to Sarıkamış (**Figure 6.2.28**). As mentioned earlier, the North-East Anatolian Sarıkamış sub-sources North and South can be distinguished from one another following yttrium and barium ppm levels (Chataigner et al. 2014:367). When plotting the Sarıkamış MAX Lab source data under the same conditions, the single Amuq artefact, A59845, has stronger association to the Sarıkamış South group with 539ppm barium and 28ppm yttrium (**Figure 6.2.29**).

6.2.5 Phase H

Only three of the twenty-one obsidian artefacts (14%) were included in the study collection (**Table 2.0.1**). One of these, A45482, has been sourced to Nenezi Dağ, while the other two, A45462, and A45472, have been sourced to Bingöl B (**Figures 6.2.30; 6.2.31** and **6.2.32**).

6.2.6 Second Mixed Range

The Second Mixed Range is represented by three artefacts from Tell al-Judaidah. The raw materials of two, A45470 and A45471, were sourced to East Göllü Dağ, while that of A59001, was sourced to Bingöl B (**Figures 6.2.33, 6.2.34** and **6.2.35**).

6.2.7 Unconfirmed Phase

In the end, there were five obsidian artefacts that could not be properly associated to a specific phase. These artefacts' raw materials were all sourced to East Göllü Dağ (**Figures 6.2.36** and **6.2.37**).

6.2.8 Summary of obsidian source consumption at Tell al-Judaidah

Members of the Tell al-Judaidah proto-urban community used obsidian tools for the nearly 4000 years of its largely uninterrupted occupation. The largest quantities of obsidian we have from the site derive from its earliest – Phase A – occupation; thereafter we witness a diminished number of artefacts, suggesting a decrease in access to / desire for these distant resources, with fluctuating amounts in Phases F-H until finally dissipating in the Early Bronze Age (**Table 2.0.1**). Our sample suggests that East Göllü Dağ obsidian was the staple and preferred raw material imported to the site, followed by Bingöl B, which is, again, documented consistently through the Tell al-Judaidah sequence (**Table 6.0.1**). The latter fact is interesting because it means that this study has provided evidence for Lake Van obsidian being transported into the Northern Levant significantly earlier than was previously documented (see section above in Part I regarding the Bingöl B source for more details and references). This suggests that a supra-regional relation between the Northern Levant and the Middle-Euphrates or even Northern Mesopotamia existed prior to the Chalcolithic Period. Lesser quantities of Nenezi Dag obsidian are also recorded from Tell al-Judaidah (**Table 6.0.1**) from Phase A-H, while North-East Anatolian obsidian makes its first appearance in Phase G at the site in context with the spread of the Early Trans-Caucasian Cultural Complex dated to the 4th millennium BCE (**Table 6.0.1**).

Part III

6.3 Tell Kurdu obsidian source distribution

Tell Kurdu was occupied throughout the Chalcolithic period, beginning with Phase C ca. 5700 BCE and extending to around 4300 BCE in Phase E. Obsidian artefacts were recovered from all occupational phases (**Table 6.3.0**), 72 of which are represented in the sample collection. East Göllü Dağ and Bingöl B raw materials appear in all three phases while peralkaline obsidian, Meydan Dağ, Nenezi Dağ, and Pasinler are present at various other times (**Figure 6.3.0**).

6.3.2 Phase C

Following the results from the Zr versus Sr plots (**Figures 6.3.1** and **6.3.2**), we can see that the 14 Tell Kurdu Phase C artefacts were made of four different obsidians from both central and eastern Anatolian sources. While four of the artefacts' raw materials were sourced to East Göllü Dağ in Cappadocia, most items were made of Lake Van region products. This included six artefacts corresponding to Bingöl B raw materials and three from Nemrut Dağ (the latter seen in **Figures 6.2.25-27**). There was also one artefact made of Pasinler obsidian (sub-source type unknown) from North-Eastern Anatolia.

6.3.3 Phase D

Of Tell Kurdu's six Phase D artefacts, three were made of East Göllü Dağ obsidian (**Figure 6.3.3**), one of Nenezi Dağ obsidian (**Figure 6.3.4**), while the elemental fingerprint of two items matched those of Bingöl B source products (**Figure 6.3.5**).

6.3.4 Phase E

This phase witnessed an increase of obsidian consumption since Phases C and D with a total of 52 artefacts (**Figure 6.3.6**). Twenty-four of these are Cappadocian products made from East Göllü Dağ obsidian (**Figure 6.3.7**). The remaining 27 artefacts were made of Lake Van region raw materials, nine of which were peralkaline products (**Figure 6.3.8**), fourteen from Bingöl B (**Figure 6.3.9**), and four from Meydan Dağ (also **Figure 6.3.9**). Of the peralkalines, only one, A59404 is sourced to Bingöl A while the rest have chemical profiles that match Nemrut Dağ (**Figures 6.2.25-27**). Finally, from North East Anatolia, one artefact was sourced to Pasinler, sub-source type unknown (**Figure 6.3.10**).

Looking at the close up plots for East Göllü Dağ (**Figure 6.3.7**), Meydan Dağ (**Figure 6.3.9**), and Pasinler (low Sr type) (**Figure 6.3.10**), one can see that several Phase

E artefacts lie amongst the fringes of the MAX Lab source data. For instance, in **Figure 6.3.7**, three were plotted with lower Zr levels than the average East Göllü Dağ database source. In **Figure 6.3.9**, three artefacts appear next to the Meydan Dağ source but have higher Zr levels than the average sample in the Meydan Dağ database. Lastly, in, **Figure 6.3.10**, the artefact is situated between the two groups of the Pasinler (low Sr type) source data. To assign all these artefacts to an individual source it was necessary to consider additional elements and data plots, the results of which are presented in the proceeding sections.

6.3.4.i East Göllü Dağ products: As can be seen in **Figure 6.3.7**, three Tell Kurdu Phase E artefacts' raw materials sourced to East Göllü Dağ appear as outliers on the Zr versus Sr plot. From top to bottom of the plot these artefacts are A59437, A59365 and A59496. To confirm that their raw materials indeed originated from this source, further data analysis was undertaken.

Chemically, the closest source to East Göllü Dağ on the Zr versus Sr plot is Acigöl West. Therefore, average ppm values were collected from the East Göllü Dağ database and the Acigöl West database in order to compare the trends of ppm levels across eight elements: Rb, Sr, Y, Zr, Nb, Ba, Pb and Th. Then, each artefact was compared to the two source databases using line graphs to determine which source is the closest match according to overall trend in elemental values (**Figures 6.3.11-6.3.13**). **Table 6.3.2** compiles all the values used for displaying the line graph results.

After examining the results, all three artefacts are a clear match to East Göllü Dağ rather than to Acigöl West. The line graphs show visible similarities between the Amuq artefacts and the East Göllü Dağ source based on trends across the eight elements. The most obvious element that prevents these artefacts from matching with West Göllü Dağ is barium.

6.3.4.ii Pasinler products: A single artefact (A59463) from Tell Kurdu Phase E was sourced to Pasinler, however, on the Zr versus Sr plot, it does not clearly land within the expected range for this source (**Figure 6.3.10**). Aside from Pasinler, the two closest sources to A59496 in elemental value are Sarakımış and Muş. **Table 6.3.3** shows the average ppm values of the MAX Lab geological data for these three sources alongside the ppm values of A59463 for eight elements: Rb, Sr, Y, Zr, Nb, Ba, Ph, and Th. A line graph displaying these results show A59463 to have more similarity of elemental ppm value trends with the Pasinler database then the other two sources (**Figure 6.3.14**).

6.3.4.iii Meydan Dağ products: The plot in **Figure 6.3.9** shows three artefacts A59387, A54902, and A59550, appearing as outliers to the Meydan Dağ source data. To ascertain that these artefacts could not also be potential outliers to Bingöl B - the chemically closest source on the Zr versus Sr plot – further analysis using alternative bivariate plots was performed.

According to Khalidi et al. (2009:888-889), Meydan Dağ and Bingöl B obsidian can be distinguished from one another based on two bivariate plots: Zr versus Y levels and

Ba versus Zr levels. Although the Khalidi et al. team performed this analysis using LA-ICP-MS data, the same plots were created with the EDXRF data generated for this project. When replicating these plots with the Meydan Dağ and Bingöl B source data from the MAX Lab the same separation occurred (see **Figure 6.3.15** and **6.3.16**). In addition, the Zr versus Y and the Ba versus Zr plots shows there is a clear tendency of the artefacts A59387, A54902 and A59550 toward the Meydan Dağ source grouping than to the Bingöl B source grouping.

The second step in furthering the analysis of these outlier artefacts was to find patterns or a divide in the values of particular elements within the Meydan Dağ source data and cross-reference these patterns with the Amuq artefacts A59387, A54902 and A59550. It was found that aside from Y and Ba (used for the Khalidi et al.'s 2009 bivariates), Rb could also be a good element to use as indicator of Meydan Dağ variants with higher Zr levels than previously recorded in the MAX Lab database.

Because these three Tell Kurdu Phase E artefacts differed from the Meydan Dağ source data through having higher Zr levels, it was decided that the initial bivariate plot using Rb should be compared with Sr (see **Figure 6.3.17**). Then, a second bivariate comparing Rb to the ratio of Sr/Zr was used (see **Figure 6.3.18**). In both cases, the three Amuq artefacts A59387, A54902 and A59550 could be properly matched with the Meydan Dağ reference source data.

6.3.5 Summary of obsidian source consumption at Tell Kurdu

To summarize the consumption of obsidian at Tell Kurdu during the Chalcolithic, between Phases C to E, one can note a pattern across a span of approximately 1400 years of procuring raw materials and/or finished products from Cappadocia, the Lake Van region and North-Eastern Anatolia. Most of the Cappadocian obsidian came from East Göllü Dağ (n=31), while a single artefact was made of Nenezi Dağ raw materials. A wider range of the raw materials used is represented from Eastern and North-Eastern Anatolia, of which the Lake Van region products from Bingöl B (n=22) and Nemrut Dağ (n=11) were the most abundant, followed by a single Bingöl A specimen. Interestingly, Tell Kurdu is the only site to source artefacts to Pasinler (n=2) and Meydan Dağ (n=4) from the entire Amuq Valley collection studied for this thesis.

Part IV

6.4 Tell Dhahab obsidian source distribution

The obsidian artefacts excavated from Tell Dhahab were documented without stratigraphical context and therefore, they have no temporal context. Within our study collection eighty-eight obsidian artefacts came from Tell Dhahab, whose sourcing is detailed in **Figure 6.4.0**.

Starting with the Cappadocian products, some twenty artefacts' elemental values (on a Zr versus Sr plot) are situated to the left of the East Göllü Dağ source data due to their lower Zr levels (**Figure 6.4.1**). This data 'drift' was also seen for some of the Tell al-Judaidah and Tell Kurdu artefacts. To verify that these artefacts *were* made of East Göllü Dağ obsidian we repeated the process of comparing the average ppm values of select elements: Rb, Sr, Y, Zr, Nb, Ba, Ph, and Th, from the East Göllü Dağ source data, to the closest chemically similar database group, Acigöl West, and the outlier artefacts themselves. The results of this process are presented in a line graph (**Figure 6.4.2; Table 6.4.1**). In addition to this, another outlying artefact, A48065K was compared with the source data groups as well. This particular artefact, however, appeared in a different area on the Zr versus Sr plot. As can be seen in **Figure 6.4.1**, A48065K sits in between the source data for East Göllü Dağ and Acigöl West.

The results from the line graph show that each of these artefacts' raw materials have greater similarity to the East Göllü Dağ source data than they do with geological samples from Acigöl West. In the end, sixty-eight artefacts from the Tell Dhahab collection have been sourced to East Göllü Dağ.

The next largest grouping of artefacts have elemental signatures that match those of source materials from Nenezi Dağ (n=9), as detailed in the Zr versus Sr plots of **Figure 6.4.0** and **Figure 6.4.3**. In the latter plot, there are two artefacts which land in the overlapping area of Nenezi Dağ and Pasinler and four additional artefacts that stray with lower Sr levels in between Nenezi Dağ and West Göllü Dağ source data. The first two artefacts, A48070N and A48070P, have been sourced to Nenezi Dağ based on the Ba levels after completing the line graph comparing average elemental ppm values of Nenezi Dağ and Pasinler (**Figure 6.4.4; Table 6.4.2**). The other four artefacts with lower Sr levels, however, are more challenging to source (**Figure 6.4.3**). After re-running these artefacts a number of times, we eventually assigned their raw materials to Nenezi Dağ.

As can be seen in the next plot, **Figure 6.4.5**, two artefacts were easily sourced to Bingöl B while one, A48065I strays to the far left with lower Zr levels. This artefact is also of near equal distance on the plot to Meydan Dağ. In order to determine which source A48065I belongs too, two discrepancy plots taken after Khalidi et al. (2009) were used. In both plots, Zr versus Y (**Figure 6.4.6**), and Ba versus Zr (**Figure 6.4.7**), A48065I remains unaffiliated with a particular group from the MAX Lab source data, has more in common to the Bingöl B source data.

The final three obsidian artefacts from Tell Dhahab have been sourced to Nemrut Dağ. These have been plotted to scale in **Figure 6.4.8** following original Zr vs Sr plotting, however, their discrimination from Bingöl A can be seen with more accuracy in the elemental oxides plots of **Figures 6.2.25-27**.

Part V

6.5 Conclusion

In this chapter, all results from EDXRF testing of the Amuq Valley obsidian sample collection from Tell al-Judaidah, Tell Kurdu and Tell Dhahab, were presented according to source type in chronological order. In the next chapter, the techno-typological analysis of these artefacts will be presented.

6.6 Chapter 6 Part I Tables and Figures

Table 6.0.0a: Final list of XRF runs on all artefacts using RGM-2. (See abbreviation key below.)

No.	Artefact	Site	Phase	Tray	Ti-Norm	Mn-Norm	Fe-Norm	Ni-Norm	Cu-Norm	Zn-Norm	Rb-Norm	Sr-Norm	Y-Norm	Zr-Norm	Nb-Norm	Ba-Norm	Pb-Norm	Th-Norm	Source
1	A45462	J	H	Run 1,01	1227	236	24468	5	8	72	244	49	29	323	12	414	38	32	BB
2	A45466	J	G	Run 1,02	273	44	9810	8	5	55	212	11	24	78	4	132	30	26	EGD
3	A45470	J	SMR	Run 1,03	264	225	7997	1	3	26	191	10	22	72	14	143	25	24	EGD
4	A45471	J	SMR	Run 1,04	248	102	8819	4	4	35	207	11	24	78	8	126	28	24	EGD
5	A45472	J	H	Run 2,01	1016	200	18510	5	4	67	208	41	27	293	13	396	31	30	BB B
6	A45476A	J	G	Run 2,02	1423	255	51983	6	4	289	281	2	144	1271	22	0	69	36	BA/NMD
7	A45476B	J	?	Run 1,07	354	10	10855	8	6	62	207	11	19	72	3	166	31	27	EGD
8	A45478A	J	G	Run 2,03	1256	49	26048	4	9	82	261	53	34	354	5	405	40	38	BB
9	A45481A	J	?	Run 1,09	258	132	6707	3	4	33	169	12	21	69	11	252	23	22	EGD
10	A45481B	J	?	Run 2,04	254	186	9980	2	5	42	158	12	16	67	11	121	23	21	EGD
11	A45482	J	H	Run 1,11	714	263	11464	3	4	50	169	102	20	142	11	736	30	29	NZD
12	A45487	J	?	Run 1,12	359	238	6612	3	4	30	181	12	20	73	14	205	24	23	EGD
13	A45488	J	G	Run 1,13	1097	130	11528	6	7	51	212	44	28	306	8	468	31	26	BB
14	A45490	J	G	Run 1,14	956	405	25988	7	0	228	247	7	137	1339	50	1	53	30	BA/NMD
15	A45491	J	G	Run 1,15	209	81	6146	5	3	45	163	10	21	65	9	155	23	20	EGD
16	A45494	J	?	Run 1,16	428	242	6956	4	4	143	193	10	22	76	14	114	26	23	EGD
17	A58942	J	G	Run 1,17	518	74	7939	4	5	60	149	90	19	126	5	638	26	25	NZD
18	A59011	J	SMR	Run 1,18	1187	260	14459	4	3	61	238	50	31	337	15	539	33	30	BB
19	A59027	J	G	Run 1,19	204	46	5692	3	3	38	149	11	19	63	6	224	22	20	EGD
20	A59845	J	G	Run 3,01	559	84	9879	4	4	10	157	26	28	91	5	539	31	23	SKS
21	A59846	J	G	Run 3,02	1253	211	46591	8	2	327	255	2	152	1288	21	27	66	35	BA/NMD
22	A59847	J	G	Run 3,03	260	68	8001	4	3	36	175	13	22	71	7	192	24	24	EGD
23	A59849	J	G	Run 3,04	601	178	7292	3	5	44	143	86	19	122	10	789	25	27	NZD
24	A59850	J	G	Run 3,05	255	-16	6423	5	5	74	145	9	18	67	2	193	19	22	EGD
25	A59851	J	G	Run 3,06	289	209	9201	3	3	31	197	11	24	73	13	134	27	26	EGD
26	A59852	J	G	Run 3,07	1233	75	19322	5	6	122	237	48	32	330	6	465	35	33	BB
27	A59853	J	G	Run 3,08	428	251	8757	3	3	33	199	14	23	81	15	241	29	28	EGD

28	A59854	J	G	Run 3,09	857	180	23139	4	2	268	262	1	147	1278	29	10	66	40	BA/NMD
29	A59856	J	G	Run 3,10	296	376	8691	1	2	27	215	12	26	78	23	157	30	29	EGD
30	A59860	J	G	Run 3,11	319	107	9612	3	6	96	195	13	24	86	8	259	27	27	EGD
31	A59862	J	G	Run 3,12	1271	218	36386	5	2	248	227	1	135	1262	20	4	50	31	BA/NMD
32	A59863	J	G	Run 3,13	1369	178	17661	5	4	83	241	49	33	337	12	489	36	33	BB
33	A59864	J	G	Run 3,14	264	282	7471	2	3	24	192	10	24	74	17	118	25	24	EGD
34	A59865	J	G	Run 3,15	279	274	8327	2	2	26	200	11	26	77	16	129	27	25	EGD
35	A59867	J	G	Run 3,16	1303	238	15769	4	3	61	245	50	33	340	14	484	36	33	BB
36	A59868	J	G	Run 3,17	931	28	11030	4	5	92	157	91	17	128	3	581	30	27	NZD
37	A59870	J	G	Run 3,18	316	109	9032	3	3	70	196	14	24	84	8	184	27	27	EGD
38	A59871	J	G	Run 3,19	1035	40	18221	3	5	61	228	46	33	325	5	460	35	33	BB
39	A59873	J	G	Run 4,01	781	272	12426	5	2	52	180	109	21	144	11	653	34	34	NZD
40	A59874	J	G	Run 4,02	378	51	8878	5	3	48	190	14	22	77	5	158	27	25	EGD
41	A59875	J	G	Run 4,03	274	283	9745	1	2	31	208	10	24	76	16	134	28	28	EGD
42	A59877	J	G	Run 4,04	644	111	10943	3	2	52	169	103	20	140	6	598	31	31	NZD
43	A59878	J	G	Run 4,05	214	-4	8032	5	6	52	176	13	21	72	3	136	25	28	EGD
44	A59881	J	G	Run 4,06	1032	68	17330	7	4	81	227	47	32	326	6	448	34	35	BB
45	A59882	J	G	Run 4,07	593	98	10111	4	4	54	159	96	19	132	6	648	28	30	NZD
46	A59883	J	G	R. 22,12	1067	227	30916	8	3	213	225	1	126	1092	20	47	52	33	BA/NMD
47	A59886	J	G	Run 4,09	264	33	9189	7	5	72	194	15	22	74	5	169	28	27	EGD
48	A59889	J	G	Run 5,10	1036	87	29424	10	5	282	211	1	115	1037	11	9	49	31	BA/NMD
49	A59892	J	G	Run 4,11	1016	95	13355	5	4	95	210	45	30	311	6	472	31	28	BB
50	A59895	J	G	Run 4,12	1086	138	18699	5	4	59	232	47	31	330	8	476	36	34	BB
51	A59897	J	G	Run 4,13	312	178	10112	5	3	45	200	15	23	80	11	169	28	7	EGD
52	A59899	J	G	Run 4,14	572	73	10619	8	4	180	165	99	20	136	5	662	29	31	NZD
53	A59901	J	G	Run 4,15	764	333	12640	5	3	52	176	106	20	143	13	739	32	32	NZD
54	A59904	J	G	Run 4,16	618	105	12051	5	4	86	170	102	18	142	6	603	34	33	NZD
55	A59905	J	G	Run 4,17	1205	227	20293	3	4	165	219	43	28	297	12	416	34	29	BB
56	A59907	J	G	Run 4,18	913	632	10772	1	4	51	186	112	22	148	20	799	33	33	NZD
57	A59909	J	G	Run 4,19	351	388	9543	3	2	46	207	14	24	85	20	224	31	28	EGD

58	A59910	J	G	Run 6,01	726	46	12650	11	6	94	177	106	21	140	3	502	34	30	NZD
59	A59913	J	G	Run 6,02	775	273	11884	5	3	95	173	103	21	143	12	701	32	29	NZD
60	A59914	J	G	Run 6,03	915	267	35001	10	3	355	294	1	165	1423	36	9	80	41	BA/NMD
61	A59919	J	G	Run 6,04	333	185	9249	4	3	75	197	15	23	89	11	210	30	26	EGD
62	A59923	J	G	Run 6,05	355	271	6527	4	2	35	162	11	19	65	16	221	25	20	EGD
63	A59924	J	G	Run 6,06	1083	66	17357	9	5	187	224	46	32	324	6	446	33	30	BB
64	A59928	J	G	Run 6,07	358	470	8935	3	3	40	201	15	24	85	23	261	28	25	EGD
65	A59930	J	G	Run 6,08	780	235	14668	3	5	78	182	108	21	147	10	738	33	30	NZD
66	A59935	J	G	Run 6,09	725	232	10745	5	3	63	168	101	21	139	10	670	31	28	NZD
67	A59937	J	G	Run 6,10	685	198	11573	7	3	104	165	102	21	139	8	670	30	27	NZD
68	A59938	J	G	Run 9,12	611	37	10521	8	3	71	155	95	18	133	3	588	30	29	NZD
69	A59947	J	G	Run 6,12	1121	77	21522	6	7	81	247	50	33	346	6	421	37	32	BB
70	A59951	J	G	Run 6,13	593	118	8056	5	4	62	155	95	19	128	8	683	28	25	NZD
71	A59957	J	F	Run 6,14	248	-5	7760	15	4	91	173	13	22	68	3	237	30	21	EGD
72	A59959	J	F	Run 6,15	233	161	9805	7	4	32	211	11	26	78	12	111	30	26	EGD
73	A59960B	J	FMR	Run 6,16	374	407	7458	4	1	29	205	14	24	80	20	218	32	27	EGD
74	A59961B	J	FMR	Run 6,17	283	95	8290	10	4	40	188	13	22	81	8	201	28	24	EGD
75	A59962A	J	A	Run 6,18	267	18	6707	8	3	49	165	11	19	78	4	138	24	21	EGD
76	A59962B	J	A	Run 6,19	331	194	10548	5	3	31	205	15	23	81	12	200	29	27	EGD
77	A59962C	J	A	Run 7,01	831	171	12007	2	3	107	178	106	22	143	7	649	33	34	NZD
78	A59962D	J	A	Run 7,02	672	36	10080	10	5	73	178	79	22	127	3	549	32	31	WGD
79	A59962E	J	A	Run 9,02	707	113	12917	3	3	85	176	105	20	143	6	637	32	34	NZD
80	A59962F	J	A	Run 9,03	358	230	10922	4	2	106	207	15	24	83	11	228	28	27	EGD
81	A59962G	J	A	Run 9,04	361	271	10849	2	3	42	209	15	23	85	13	223	30	29	EGD
82	A59962H	J	A	Run 7,06	1063	301	15138	5	4	226	163	95	19	123	9	556	30	29	NZD
83	A59962I	J	A	Run 9,06	348	17	10249	6	4	97	186	65	24	115	3	291	33	33	ApcE
84	A59962J	J	A	Run 9,07	606	31	11325	6	2	167	171	103	21	141	3	602	33	33	NZD
85	A59962K	J	A	Run 7,09	404	356	10161	4	3	438	178	13	21	67	15	175	25	24	EGD
86	A59963A	J	A	Run 7,10	335	320	8398	6	3	35	198	14	23	78	16	229	26	2	EGD
87	A59963B	J	A	Run 7,11	276	282	8764	4	3	35	209	9	26	79	14	88	28	26	EGD

88	A59963C	J	A	Run 7,12	369	424	9348	2	2	28	210	15	24	86	21	255	31	27	EGD
89	A59963D	J	A	Run 7,13	378	402	8492	1	2	39	206	15	25	83	20	258	27	26	EGD
90	A59976F	J	A	Run 7,14	943	443	12616	3	3	56	194	114	24	153	15	840	35	35	NZD
91	A59976G	J	A	Run 7,15	807	413	9726	2	2	53	179	106	22	142	15	699	32	32	NZD
92	A59976H	J	A	Run 9,09	425	127	11322	4	4	79	168	83	25	152	8	516	30	30	AacE
93	A59977A	J	A	Run 9,10	459	360	11163	5	3	77	181	13	20	70	15	196	28	24	EGD
94	A59977B	J	A	Run 7,18	377	-10	9924	11	9	148	187	14	3	66	2	194	30	27	EGD
95	A59977C	J	A	Run 7,19	368	83	11132	5	4	115	220	16	26	79	6	179	34	31	EGD
96	A59977D	J	A	Run 8,01	297	20	8176	9	4	74	186	13	19	76	4	143	28	24	EGD
97	A59977I	J	A	Run 8,02	247	10	6956	2	4	55	158	10	19	66	4	179	24	23	EGD
98	A59977J	J	A	Run 9,13	292	83	10731	3	2	38	206	14	25	80	6	156	30	27	EGD
99	A59977K	J	A	Run 8,04	324	476	9197	2	2	2	190	13	20	75	25	200	28	25	EGD
100	A59977L	J	A	Run 8,05	476	42	8768	6	4	72	188	14	22	72	4	121	29	2	EGD
101	A59977M	J	A	Run 8,06	301	93	7885	6	4	37	184	13	22	73	7	200	28	24	EGD
102	A59977N	J	A	Run 8,07	338	198	9805	3	3	61	203	13	24	77	12	179	31	29	EGD
103	A59977O	J	A	Run 9,14	501	264	9834	5	4	39	164	12	18	65	13	190	25	22	EGD
104	A59982A	J	A	Run 9,15	356	481	7451	3	3	132	194	14	24	78	23	243	28	28	EGD
105	A59982B	J	A	Run 8,10	1169	71	17297	3	5	65	230	45	30	322	6	390	35	32	BB
106	A59982C	J	A	Run 8,11	715	503	10052	3	3	230	160	93	17	125	19	710	30	27	NZD
107	A59982D	J	A	Run 9,17	339	284	8042	3	2	52	189	14	23	76	14	257	25	25	EGD
108	A59996	J	G	Run 8,13	404	187	12577	3	4	55	226	16	23	86	10	209	36	31	EGD
109	A59997	J	G	Run 8,14	359	486	8723	1	3	32	208	13	23	80	26	236	29	27	EGD
110	A59998	J	G	Run 8,15	897	272	26435	8	1	276	281	1	149	1349	41	10	73	40	BA/NMD
111	A59999	J	G	Run 8,16	343	167	8790	4	2	66	193	13	21	75	11	209	28	25	EGD
112	A60000	J	G	Run 8,17	742	5	8448	9	6	91	144	84	15	120	2	519	26	26	NZD
113	A60001	J	G	Run 8,18	423	115	8892	4	4	84	198	14	23	80	9	165	30	27	EGD
114	A60002	J	G	Run 8,19	304	140	8409	4	2	82	188	13	22	77	10	174	26	4	EGD
115	A60003	J	G	R. 10,01	892	369	23336	6	0	203	235	2	140	1286	55	1	50	31	BA/NMD
116	A60004	J	G	R. 10,02	200	-20	5603	10	9	127	136	8	15	62	2	161	19	20	EGD
117	A60005	J	G	R. 10,03	250	-4	7546	8	4	79	165	11	20	77	3	151	25	24	EGD

118	A60006	J	G	R. 10,04	256	92	8131	5	3	64	193	10	22	72	9	118	26	25	EGD
119	A60007	J	A	R. 10,05	801	244	10243	5	3	51	172	101	21	138	11	710	30	30	NZD
120	A60008	J	A	R. 10,06	295	13	8295	6	6	54	175	13	21	70	4	160	27	27	EGD
121	A60009	J	F	R. 10,07	331	423	8042	2	3	24	194	14	23	79	24	253	28	26	EGD
122	A60010	J	F	R. 10,08	359	384	11551	3	3	27	219	14	25	84	22	212	30	28	EGD
123	A60014	J	F	R. 10,09	336	361	9009	2	2	26	196	16	23	79	21	227	26	25	EGD
124	A60018	J	A	R. 10,10	280	26	7423	5	3	73	172	13	21	74	5	158	24	24	EGD
125	A60019	J	A	R. 10,11	865	178	15011	4	4	59	185	109	22	147	9	621	33	33	NZD
126	A60021	J	F	R. 10,12	318	81	10106	1	5	35	199	14	24	79	8	225	28	27	EGD
127	A60027	J	A	R. 10,13	401	316	8546	4	2	43	195	13	23	80	20	219	28	28	EGD
128	A60028	J	A	R. 10,14	333	50	9952	7	3	48	202	14	23	78	6	171	30	28	EGD
129	A60029	J	A	R. 10,15	372	294	9556	4	2	87	204	15	24	82	18	218	28	27	EGD
130	A60030	J	A	R. 10,16	701	104	10889	5	3	54	166	99	22	138	7	652	29	29	NZD
131	A45770	D	?	R. 19,01	299	330	8479	4	3	27	210	11	25	78	19	123	29	27	EGD
132	A45771	D	?	R. 19,02	337	345	7190	3	1	23	191	13	24	82	17	218	28	27	EGD
133	A45772	D	?	R. 19,03	273	113	8070	8	4	31	189	13	22	76	9	211	27	27	EGD
134	A48063C	D	?	R. 19,04	297	255	6768	3	4	26	183	13	21	74	16	263	25	24	EGD
135	A48063E	D	?	R. 19,05	382	442	7712	4	4	30	203	16	22	77	23	218	29	28	EGD
136	A48063O	D	?	R. 19,06	311	263	8294	3	2	25	192	13	24	74	15	197	27	25	EGD
137	A48063P	D	?	R. 19,07	266	223	6524	5	3	25	182	13	23	72	15	226	25	25	EGD
138	A48063Q	D	?	R. 19,08	276	322	7021	5	1	25	199	10	23	78	18	123	26	26	EGD
139	A48063U	D	?	R. 19,09	454	563	8933	4	2	30	227	17	25	83	23	225	33	31	EGD
140	A48063V	D	?	R. 19,10	370	316	7233	5	2	25	197	15	22	80	15	189	29	27	EGD
141	A48063Y	D	?	R. 13,16	275	314	7378	4	2	22	193	10	24	73	17	142	24	24	EGD
142	A48063Z	D	?	R. 19,11	964	473	22641	9	0	231	250	1	146	1348	59	3	54	31	BA/NMD
143	A48065A	D	?	R. 19,12	954	352	13199	8	4	53	155	93	18	124	12	580	29	27	NZD
144	A48065B	D	?	R. 19,13	1073	273	13791	4	3	57	149	87	16	113	10	437	26	26	NZD
145	A48065C	D	?	R. 19,14	327	451	10378	2	2	28	187	13	21	73	21	195	26	24	EGD
146	A48065D	D	?	R. 19,15	1197	178	18956	5	6	56	210	42	26	286	11	345	31	26	BB
147	A48065E	D	?	R. 19,16	659	251	9186	6	4	36	172	9	20	64	14	118	23	20	EGD

148	A48065F	D	?	R. 20,12	410	262	10793	4	5	46	159	11	18	58	10	134	23	22	EGD
149	A48065G	D	?	R. 19,18	434	370	11150	3	3	33	188	13	20	73	18	172	27	25	EGD
150	A48065H	D	?	R. 18,01	1030	322	12822	5	4	57	161	96	20	129	10	572	31	28	NZD
151	A48065I	D	?	R. 18,02	<u>1513</u>	113	16968	5	7	71	178	36	24	243	6	314	*28*	*25*	BB
152	A48065J	D	?	R. 18,03	715	473	12828	3	4	46	162	96	20	130	16	613	30	29	NZD
153	A48065K	D	?	R. 18,04	758	218	10234	7	5	48	166	8	19	83	10	94	23	22	AW
154	A48065L	D	?	R. 18,05	966	394	14264	4	4	56	164	96	20	127	11	524	31	29	NZD
155	A48065M	D	?	R. 20,03	642	355	12555	2	4	54	151	90	18	120	13	608	27	27	NZD
156	A48065N	D	?	R. 20,04	927	392	14870	3	4	56	155	90	18	118	13	537	31	29	NZD
157	A48065O	D	?	R. 18,08	800	217	9013	4	5	43	161	9	19	56	9	120	22	19	EGD
158	A48065P	D	?	R. 18,09	671	269	10488	3	6	43	167	11	19	63	12	174	26	22	EGD
159	A48065Q	D	?	R. 20,06	971	390	14255	3	4	52	148	87	17	115	12	556	27	28	NZD
160	A48065R	D	?	R. 18,11	616	236	9927	3	4	44	153	10	18	65	11	151	22	20	EGD
161	A48065S	D	?	R. 18,12	364	396	10391	4	3	33	185	10	20	66	17	88	25	23	EGD
162	A48065T	D	?	R. 18,13	509	302	10564	6	4	38	170	12	19	63	13	162	25	23	EGD
163	A48065U	D	?	R. 20,07	381	357	11228	4	3	36	190	10	21	65	15	109	29	27	EGD
164	A48065V	D	?	R. 18,15	410	354	10545	3	4	33	178	12	22	68	14	185	27	24	EGD
165	A48065W	D	?	R. 18,16	616	226	9875	3	7	47	144	9	16	52	9	116	20	19	EGD
166	A48065X	D	?	R. 18,17	725	216	10397	5	7	52	156	11	18	57	9	142	23	20	EGD
167	A48065Y	D	?	R. 18,18	768	271	10763	4	5	46	175	13	18	65	11	146	27	23	EGD
168	A48065Z	D	?	R. 18,19	654	235	9981	4	5	47	158	11	18	67	11	182	23	19	EGD
169	A48070A	D	?	R. 17,01	298	104	9644	7	4	35	202	14	23	87	8	175	27	33	EGD
170	A48070B	D	?	R. 17,02	288	121	8718	6	3	29	190	13	22	75	8	171	27	28	EGD
171	A48070C	D	?	R. 17,03	324	208	10364	4	3	30	198	14	22	84	12	168	27	30	EGD
172	A48070D	D	?	R. 17,04	268	73	11763	7	3	38	216	11	23	77	6	151	31	29	EGD
173	A48070E	D	?	R. 17,05	298	143	12920	5	3	36	230	12	24	82	9	134	33	30	EGD
174	A48070F	D	?	R. 17,06	274	269	8247	4	1	26	196	10	22	75	16	147	27	28	EGD
175	A48070G	D	?	R. 17,07	287	87	10138	5	2	35	200	15	21	78	7	210	28	31	EGD
176	A48070H	D	?	R. 17,08	303	86	10924	6	4	39	204	14	24	80	7	159	29	32	EGD
177	A48070I	D	?	R. 17,09	293	56	10838	6	4	44	202	15	21	77	6	187	27	29	EGD

178	A48070J	D	?	R. 17,10	286	96	10346	3	3	35	199	14	21	84	8	191	30	30	EGD
179	A48070K	D	?	R. 17,11	313	232	8751	4	2	26	192	13	22	77	13	221	27	29	EGD
180	A48070L	D	?	R. 17,12	240	133	9960	4	3	29	204	11	24	74	9	83	29	29	EGD
181	A48070M	D	?	R. 17,13	302	99	11962	4	3	33	203	15	23	78	7	184	31	32	EGD
182	A48070N	D	?	R. 17,14	885	421	17221	3	4	53	192	114	22	154	14	804	35	36	NZD
183	A48070O	D	?	R. 17,15	294	124	9978	5	2	35	200	15	23	77	9	193	29	30	EGD
184	A48070P	D	?	R. 17,16	868	346	16583	2	3	50	194	113	22	152	13	766	37	38	NZD
185	A48070Q	D	?	R. 17,17	228	-12	9352	8	6	67	169	12	20	86	2	205	25	24	EGD
186	A48070R	D	?	R. 17,18	245	50	9415	6	5	39	189	13	22	73	5	158	29	28	EGD
187	A48070S	D	?	R. 17,19	737	264	10475	6	5	104	157	95	19	130	12	870	28	31	NZD
188	A48070U	D	?	R. 16,01	335	135	9589	6	2	35	215	16	24	83	9	207	30	34	EGD
189	A48070W	D	?	R. 16,02	357	104	8993	5	5	38	196	15	24	83	8	177	28	31	EGD
190	A48070X	D	?	R. 16,03	284	105	7870	4	5	40	191	12	24	78	7	170	27	25	EGD
191	A48070Y	D	?	R. 16,04	787	81	13216	8	8	75	182	107	22	142	4	621	33	34	NZD
192	A48074A	D	?	R. 16,05	284	37	9307	6	7	49	188	14	23	76	4	155	29	29	EGD
193	A48074B	D	?	R. 16,06	350	76	10345	7	4	44	214	15	23	80	6	175	29	30	EGD
194	A48074C	D	?	R. 16,07	324	115	10355	8	5	38	208	15	25	83	8	204	29	32	EGD
195	A48074D	D	?	R. 16,08	337	35	8850	7	8	64	191	13	22	75	3	149	30	28	EGD
196	A48074E	D	?	R. 16,09	242	26	5983	8	5	49	155	11	21	64	4	204	21	22	EGD
197	A48074F	D	?	R. 16,10	308	110	8444	7	5	34	193	13	24	77	7	207	28	27	EGD
198	A48074G	D	?	R. 16,11	360	326	10184	3	3	29	210	15	24	86	17	215	28	31	EGD
199	A48074H	D	?	R. 16,12	298	1	7811	9	8	81	183	9	23	65	2	114	26	24	EGD
200	A48074I	D	?	R. 16,13	1167	-18	16685	19	10	104	214	44	29	292	1	420	35	31	BB
201	A48074J	D	?	R. 16,14	251	29	7485	6	6	49	188	8	22	70	4	117	28	30	EGD
202	A48074K	D	?	R. 16,15	341	122	8301	5	7	41	194	15	24	75	9	185	27	29	EGD
203	A48074L	D	?	R. 16,16	265	34	7963	7	5	49	191	9	22	70	4	128	30	27	EGD
204	A48074M	D	?	R. 16,17	331	11	8345	6	8	67	189	12	19	74	2	148	27	23	EGD
205	A48074N	D	?	R. 16,18	299	115	8157	3	3	33	196	12	24	79	8	167	26	26	EGD
206	A48074O	D	?	R. 16,19	238	115	6703	5	3	31	179	10	23	72	9	132	25	25	EGD
207	A48074P	D	?	R. 15,01	712	64	23462	10	3	218	228	1	134	1250	14	10	51	30	BA/NMD

208	A48074Q	D	?	R. 15,02	198	41	5875	4	3	35	168	8	22	64	4	82	21	23	EGD
209	A48074R	D	?	R. 15,03	265	144	7899	5	3	27	196	11	22	73	9	152	27	26	EGD
210	A48074S	D	?	R. 15,04	259	59	8001	5	5	40	191	11	23	71	6	137	25	23	EGD
211	A48074T	D	?	R. 15,05	191	82	6691	2	3	24	161	11	21	68	8	219	20	19	EGD
212	A48075L	D	?	R. 15,06	808	122	29885	8	1	228	235	1	140	1297	19	18	51	31	BA/NMD
213	A48081	D	?	R. 15,07	262	58	9358	3	3	45	206	10	23	80	5	96	28	28	EGD
214	A48082	D	?	R. 15,08	401	244	11631	3	4	40	221	16	25	86	10	225	31	28	EGD
215	A48083	D	?	R. 15,09	396	330	12375	2	3	34	223	16	25	87	14	192	33	31	EGD
216	A48085	D	?	R. 15,10	311	124	9626	5	4	51	206	14	23	81	8	177	29	27	EGD
217	A48086	D	?	R. 15,11	730	221	10708	4	3	58	170	100	20	139	8	626	29	29	NZD
218	A59089	D	?	R. 15,12	281	192	6617	2	3	24	180	13	22	72	11	179	26	25	EGD
219	A59099	K	C	R. 11,01	866	8	15980	5	7	66	224	47	32	322	3	431	34	34	BB
220	A59102	K	C	R. 11,02	1270	82	21629	6	5	63	246	51	34	346	5	450	36	34	BB
221	A59103	K	C	R. 11,03	309	60	9375	10	6	44	202	11	25	73	5	154	28	26	EGD
222	A59106	K	C	R. 11,04	1423	157	25908	8	6	62	265	54	34	365	8	499	38	37	BB
223	A59108	K	C	R. 11,05	358	238	11007	3	3	30	205	14	25	93	11	235	26	27	EGD
224	A59109	K	C	R. 11,06	386	85	11867	9	4	47	216	15	23	85	5	269	32	29	EGD
225	A59113	K	C	R. 11,07	1212	28	22824	11	7	73	246	51	33	346	3	442	36	37	BB
226	A59114	K	C	R. 11,08	1120	107	37430	12	3	229	226	1	129	1120	9	3	52	33	BA/NMD
227	A59118	K	C	R. 11,09	423	113	12193	6	2	52	191	3	37	178	10	41	30	43	PAS
228	A59119	K	C	R. 11,10	1013	26	16246	8	6	60	214	43	30	311	4	470	29	30	BB
229	A59120	K	C	R. 11,11	1096	190	36402	9	3	220	226	1	131	1126	15	0	53	30	BA/NMD
230	A59127	K	C	R. 11,12	1333	75	20865	15	6	63	231	50	33	337	4	446	31	33	BB
231	A59128	K	C	R. 11,13	1368	145	45499	9	3	231	225	1	129	1080	10	12	51	35	BA/NMD
232	A59132	K	C	R. 11,14	314	307	8197	2	2	23	191	14	23	77	15	219	26	26	EGD
233	A59245	K	D	R. 11,15	334	372	7451	4	1	25	194	13	21	80	17	241	26	26	EGD
234	A59246	K	D	R. 11,16	1191	252	14897	3	3	49	232	46	31	331	13	532	31	32	BB
235	A59248	K	D	R. 11,17	370	233	10839	3	2	33	207	15	25	87	11	248	30	28	EGD
236	A59249	K	D	R. 11,18	721	48	10983	5	5	69	162	95	19	135	3	619	31	32	NZD
237	A59252	K	D	R. 11,19	356	87	10882	7	3	41	210	16	24	79	6	175	31	29	EGD

238	A59256	K	D	R. 12,01	942	19	16949	14	6	66	227	47	32	325	5	384	33	32	BB
239	A59344	K	E	R. 12,02	967	42	17002	4	6	62	236	50	32	330	5	404	36	36	BB
240	A59347	K	E	R. 12,03	986	45	15886	8	8	59	232	50	31	331	6	466	34	36	BB
241	A59352	K	E	R. 12,04	1071	102	18400	3	5	54	233	48	32	331	8	489	34	37	BB
242	A59355	K	E	R. 12,05	1097	40	21519	8	6	72	258	51	35	351	5	439	38	39	BB
243	A59365	K	E	R. 12,06	268	-27	8373	8	9	101	171	12	18	62	1	163	28	25	EGD
244	A59367	K	E	R. 12,07	287	146	12169	4	3	37	235	12	24	85	10	157	33	31	EGD
245	A59372	K	E	R. 12,08	340	245	10784	4	3	33	221	12	25	83	14	150	30	29	EGD
246	A59373	K	E	R. 12,09	284	106	8867	3	4	37	205	12	22	76	8	164	29	29	EGD
247	A59379	K	E	R. 12,10	281	17	9556	7	7	59	207	14	21	75	4	160	30	28	EGD
248	A59387	K	E	R. 12,11	412	237	19355	2	3	101	241	20	65	319	18	78	37	34	MD
249	A59391	K	E	R. 12,12	284	95	9358	5	5	38	202	15	22	85	8	203	30	27	EGD
250	A59392	K	E	R. 12,13	319	29	8391	6	8	46	200	9	24	71	5	76	27	28	EGD
251	A59393	K	E	R. 12,14	1120	197	13871	3	5	48	228	46	30	326	12	492	33	31	BB
252	A59398	K	E	R. 12,15	302	193	8313	2	5	28	199	14	23	79	13	215	27	27	EGD
253	A59400	K	E	R. 12,16	297	114	10155	4	3	37	208	15	24	83	9	197	29	30	EGD
254	A59402	K	E	R. 12,17	389	196	16279	6	3	104	226	20	62	305	15	96	32	30	MD
255	A59403	K	E	R. 12,18	761	126	25542	6	1	216	230	0	131	1251	23	0	47	32	BA/NMD
256	A59404	K	E	R. 12,19	852	212	35383	10	1	226	247	2	143	1346	32	0	51	31	BA/NMD
257	A59411	K	E	R. 22,02	402	10	12267	10	6	134	203	25	54	264	3	100	34	32	MD
258	A59417	K	E	R. 14,02	1227	41	22611	5	8	75	257	51	34	354	4	417	37	37	BB
259	A59426	K	E	R. 14,03	345	304	9308	4	3	29	204	15	22	79	16	221	28	28	EGD
260	A59429	K	E	R. 14,04	794	44	26199	12	7	248	228	1	135	1227	11	21	47	31	BA/NMD
261	A59437	K	E	R. 22,03	322	-2	7852	15	8	79	177	15	20	66	2	194	28	28	EGD
262	A59439	K	E	R. 14,06	364	123	10951	12	5	44	207	14	23	80	7	225	30	29	EGD
263	A59440	K	E	R. 14,07	837	109	26969	9	2	230	223	1	137	1243	17	0	47	28	BA/NMD
264	A59443	K	E	R. 14,08	1209	66	18632	6	7	70	238	47	32	332	5	426	34	35	BB
265	A59446	K	E	R. 14,09	747	35	24925	11	4	228	217	1	130	1202	11	15	47	29	BA/NMD
266	A59458	K	E	R. 14,10	1288	119	19251	8	6	62	244	49	34	340	8	448	34	35	BB
267	A59463	K	E	R. 14,11	492	34	13586	10	6	75	207	3	38	193	5	0	35	50	PAS

268	A59468	K	E	R. 14,12	1027	270	31815	7	2	208	224	0	131	1118	24	12	52	29	BA/NMD
269	A59469	K	E	R. 14,13	292	123	9579	5	5	40	211	12	24	76	8	172	29	27	EGD
270	A59472	K	E	R. 14,14	998	41	12721	8	6	62	212	45	29	306	4	435	30	29	BB
271	A59482	K	E	R. 14,15	336	210	8313	5	3	52	235	13	28	74	22	9	35	36	EGD
272	A59490	K	E	R. 14,16	1203	54	20103	8	8	69	242	53	33	342	4	441	36	33	BB
273	A59496	K	E	R. 14,17	669	267	10011	4	4	45	186	8	20	61	12	80	26	24	EGD
274	A59498	K	E	R. 14,18	326	25	8973	10	7	71	194	13	24	75	3	192	29	26	EGD
275	A59501	K	E	R. 14,19	374	243	8705	7	3	30	193	14	24	78	13	196	27	28	EGD
276	A59505	K	E	R. 13,01	917	262	31709	11	1	216	245	1	151	1340	33	10	51	32	BA/NMD
277	A59508	K	E	R. 13,02	311	332	8034	4	3	25	205	11	24	75	16	152	28	26	EGD
278	A59510	K	E	R. 22,05	946	-6	14098	6	6	82	212	43	30	297	3	383	31	31	BB
279	A59511	K	E	R. 13,04	339	185	9269	6	2	29	203	15	23	76	10	219	28	28	EGD
280	A59518	K	E	R. 13,05	319	222	9940	2	4	27	219	11	27	79	12	122	29	27	EGD
281	A59521	K	E	R. 13,06	765	71	25531	12	4	207	210	1	132	1200	13	11	43	28	BA/NMD
282	A59529	K	E	R. 13,07	1298	63	20929	6	4	63	243	54	35	347	5	472	36	35	BB
283	A59533	K	E	R. 13,08	307	249	7874	3	2	23	185	13	23	77	14	214	24	24	EGD
284	A59539	K	E	R. 13,09	307	228	8392	4	2	25	191	12	25	78	13	187	25	24	EGD
285	A59540	K	E	R. 13,10	1051	25	13593	8	6	57	224	46	32	320	4	412	33	33	BB
286	A59542	K	E	R. 13,11	1151	192	14084	7	7	48	228	48	32	326	11	482	32	30	BB
287	A59545	K	E	R. 13,12	751	27	24713	15	4	214	210	0	129	1183	9	20	44	28	BA/NMD
288	A59547	K	E	R. 13,13	359	230	9845	4	2	30	206	14	24	87	12	216	27	28	EGD
289	A59550	K	E	R. 13,14	517	60	17805	10	7	118	223	34	59	307	6	95	33	30	MD
290	A59553	K	E	R. 13,15	356	123	11898	6	4	37	221	15	26	81	8	193	31	31	EGD

Abbreviation key for Table 6.0.0a.

Site: **J**=Tell al-Judaidah; **D**=Tell Dhahab; **K**=Tell Kurdu

Source: **EGD**=East Göllu Dağ; **WGD**=West Göllu Dağ; **NZD**=Nenezi Dag; **ApcE**=Acigöl Post-Caldera East; **AacE**=Acigöl Ante-Caldera East; **AW**=Acigöl West; **BB**=Bingol B; **BA/NMD**=Bingol A/Nemrut Dag; **MD**=Meydan Dağ; **SKS**=Sarıkamış; **PAS**=Pasinler.

Table 6.0.0b: Final list of XRF runs on all peralkaline artefacts using RGM-2A. (See abbreviation key below.)

No.	Artefact	Site	Phase	Na2O-Norm	Al2O3-Norm	K2O-Norm	CaO-Norm	TiO2-Norm	MnO2-Norm	Fe2O3-Norm	Source
6	A45476A	J	G	2.428	1.925	3.298	0.284	0.052	0.014	0.823	NMD
14	A45490	J	G	2.572	4.387	4.084	0.333	0.102	0.033	1.746	NMD
21	A59846	J	G	2.465	2.009	3.286	0.284	0.049	0.012	0.780	NMD
28	A59854	J	G	2.684	2.993	3.498	0.284	0.061	0.015	1.185	NMD
31	A59862	J	G	3.001	3.710	3.654	0.324	0.104	0.036	2.261	NMD
46	A59883	J	G	2.742	3.014	3.491	0.303	0.076	0.026	1.460	NMD
48	A59889	J	G	2.229	1.165	3.105	0.268	0.030	0.005	0.309	NMD
60	A59914	J	G	2.306	1.676	3.166	0.268	0.027	0.004	0.248	NMD
110	A59998	J	G	3.272	4.993	3.840	0.318	0.094	0.033	2.382	BA
115	A60003	J	G	2.745	3.405	3.616	0.305	0.062	0.019	1.022	NMD
142	A48063Z	D	?	3.842	7.435	4.244	0.378	0.105	0.049	2.437	NMD
207	A48074P	D	?	2.697	3.313	3.543	0.303	0.058	0.017	0.955	NMD
212	A48075L	D	?	2.692	3.594	3.539	0.300	0.059	0.017	0.945	NMD
226	A59114	K	C	2.504	2.167	3.297	0.290	0.054	0.015	0.833	NMD
229	A59120	K	C	2.887	3.516	3.561	0.313	0.085	0.033	1.854	NMD
231	A59128	K	C	2.362	1.547	3.240	0.286	0.052	0.014	0.780	NMD
255	A59403	K	E	2.567	2.846	3.399	0.288	0.046	0.012	0.684	NMD
256	A59404	K	E	3.219	4.933	3.882	0.321	0.094	0.034	2.422	BA
260	A59429	K	E	2.620	3.166	3.465	0.290	0.050	0.014	0.787	NMD
263	A59440	K	E	2.433	2.303	3.317	0.277	0.037	0.008	0.476	NMD
265	A59446	K	E	2.698	3.501	3.506	0.315	0.057	0.016	0.905	NMD
268	A59468	K	E	3.050	4.230	3.754	0.333	0.106	0.044	2.406	NMD
276	A59505	K	E	2.881	4.428	3.701	0.309	0.071	0.023	1.229	NMD
281	A59521	K	E	2.668	3.392	3.501	0.295	0.056	0.016	0.877	NMD
287	A59545	K	E	2.204	1.107	3.109	0.267	0.023	0.002	0.132	NMD

Abbreviation key for Table 6.0.0b.

Site: **J**=Tell al-Judaidah; **D**=Tell Dhahab; **K**=Tell Kurdu

Source: **NMD**= Nemrut Dag; **BA**= Bingöl A

Table 6.0.1: Artefact source distribution across phases represented by Tell al-Judaidah and Tell Kurdu with artefacts of unknown temporal context from Tell al-Judaidah and Tell Dhahab included.

Chronologies				Source Regions										Total number of artefacts per phase
				Cappadocia				Lake Van area				North East Anatolia		
Absl. Date (BCE)	Archae. Period	Cult. Pr.	Amuq Phase	A	EGD	WGD	NZD	BA	BB	NMD	MD	SKS	PSL	
Uknwn	Early Bronze Age	Early Dynastic	SMR		2				1					3
			I and J											0
2900-2400			H				1		2					3
3500-2700		Uruk Expansion	G		29		18	1	12	9		1		70
4500-3500	Late Chalco/ EBA	Early Uruk	F		6									0
4800-4300	Chalcolithic	Ubaid	E		24			1	14	8	4		1	52
5200-4800		Halaf-Ubaid	D		3		1		2					6
5700-52000		Halaf	C		4				6	3			1	14
Unknwn	Late Neolithic	Halaf-ish with Hassuna	FMR		2									2
5500-5000			B											
6000-5500			A	2	27	1	10		1					41
Tell al-Judaidah Unknown Phases					5									5
Tell Dhahab Unknown Phases*					69		9 (+4)		3	3				88
Total number of artefacts per source				2	171	1	43	2	41	23	4	1	2	**290**

*Tell Dhahab artefacts are MOST LIKELY from Phases A, B and H according to Braidwood and Braidwood (1960).

Figure 6.0.0: Sr vs Zr plot of MAX Lab Database with Amuq Valley obsidian.

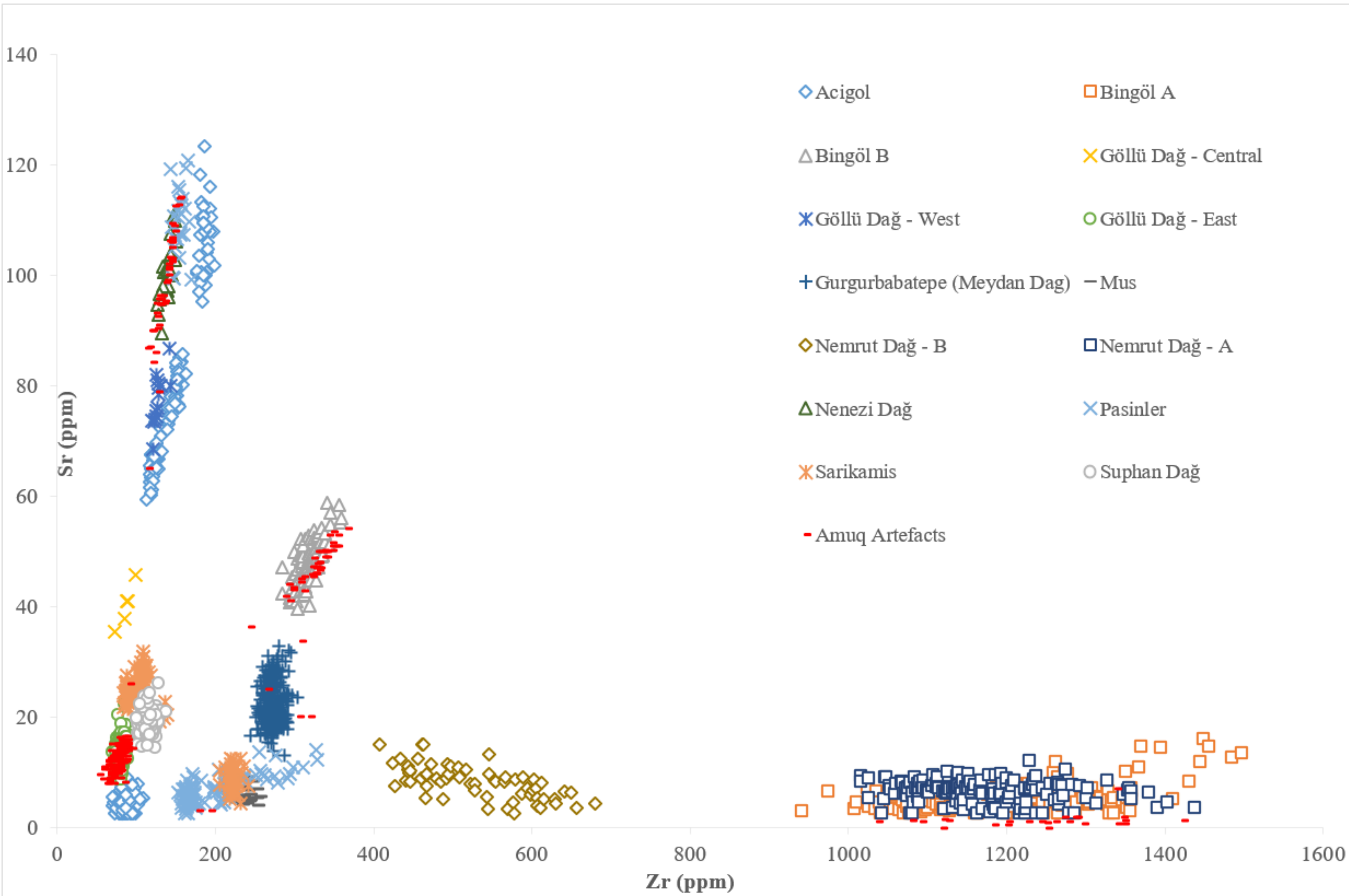
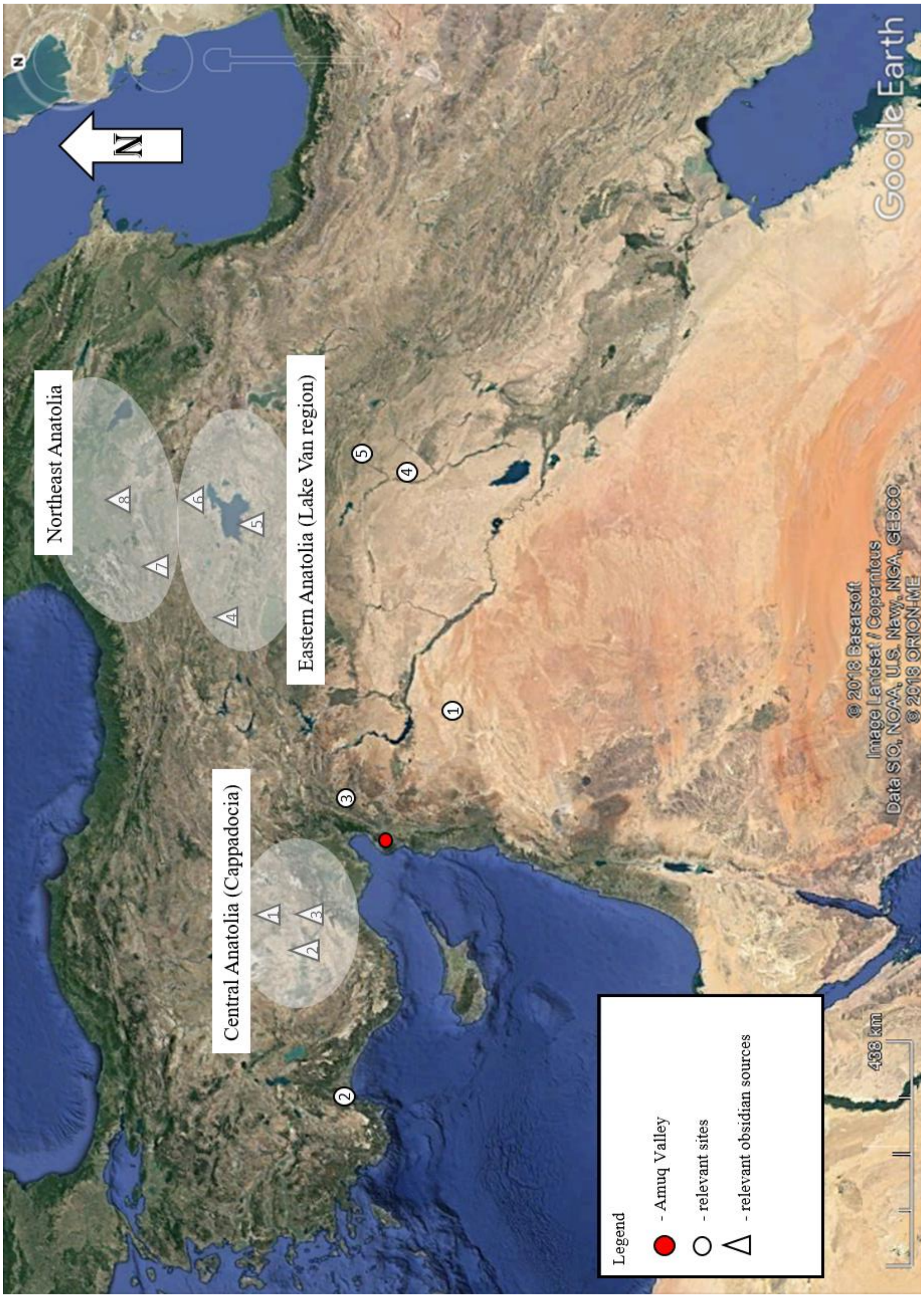


Figure 6.1.1: Major Anatolian obsidian sources in the Near East.



Relevant sites: 1-El Kowm 2; 2-Okuzini Cave; 3-Domuztepe; 4-Surezha; 5-Tell Nader.
Relevant obsidian sources: 1- Acigöl; 2- Göllü Dağ; 3-Nenezi Dağ; 4-Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8-Sarıkamış.

Figure 6.1.2: Göllü Dağ obsidian and its sub-sources.

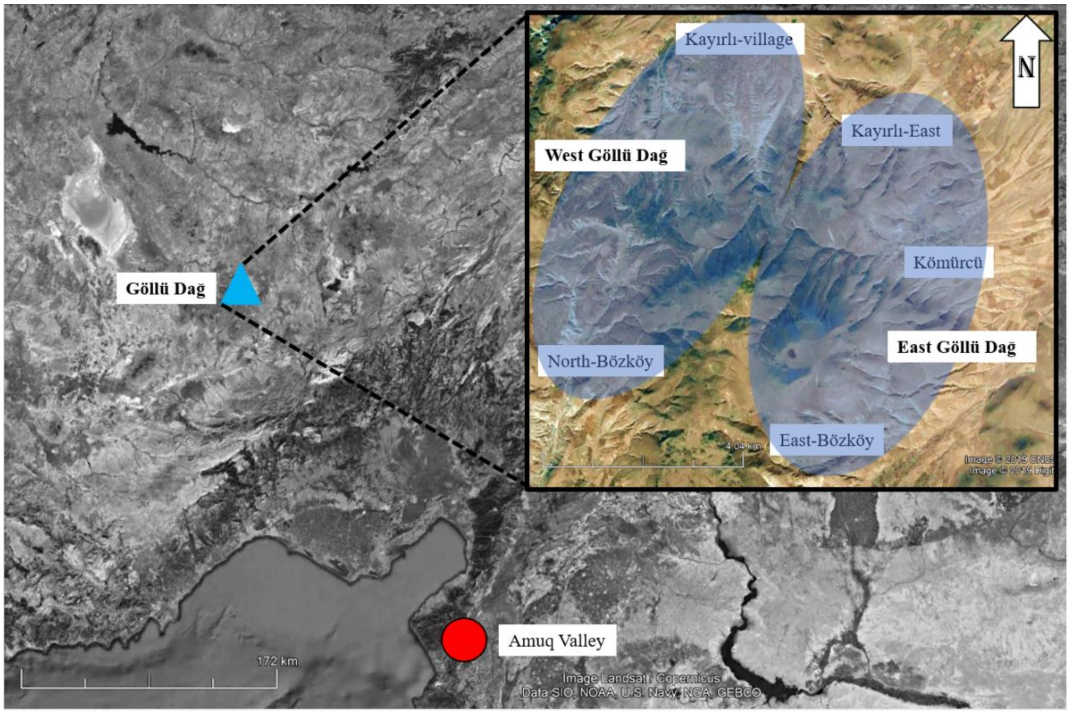


Figure 6.1.3: Acigöl obsidian and its sub-sources.

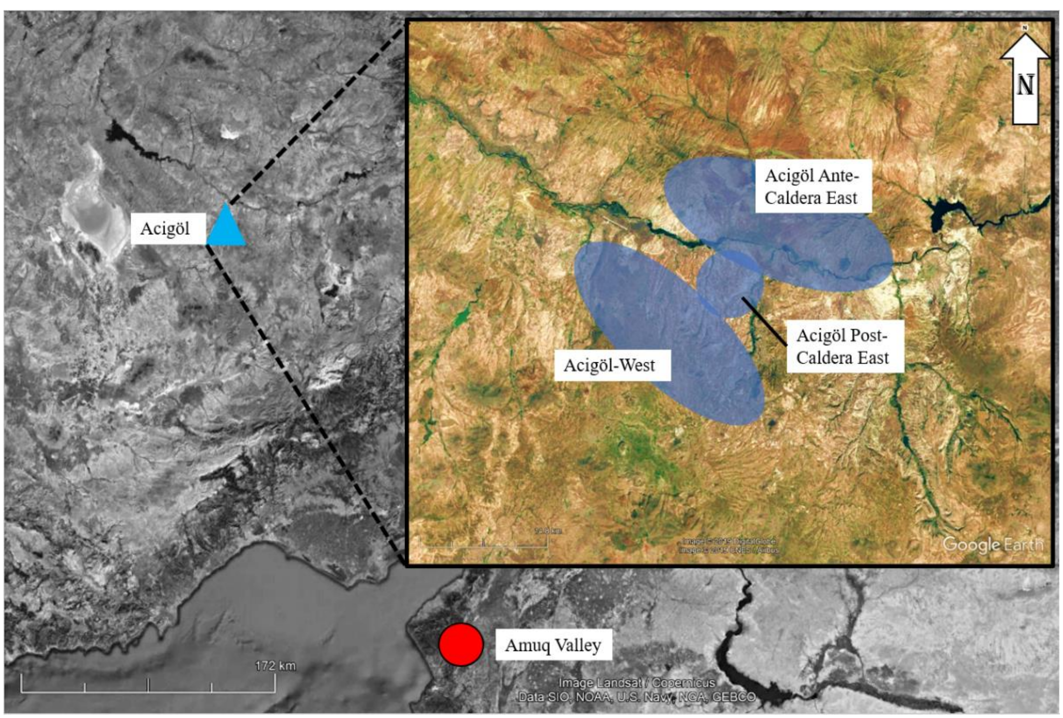


Figure 6.1.4: Bingöl obsidian and its sub-sources.

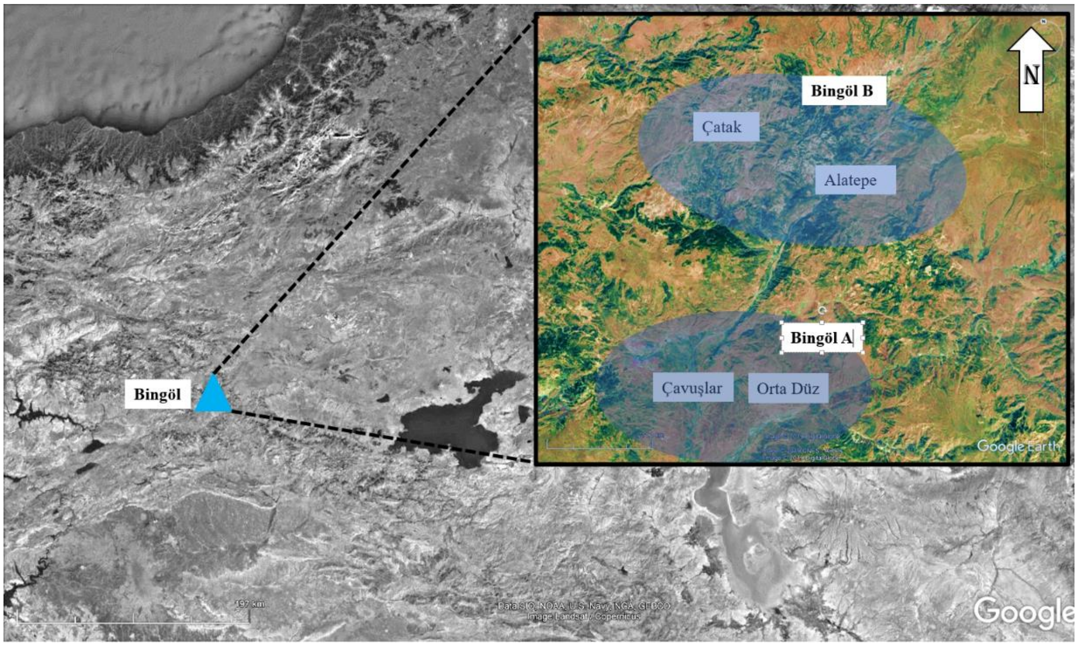
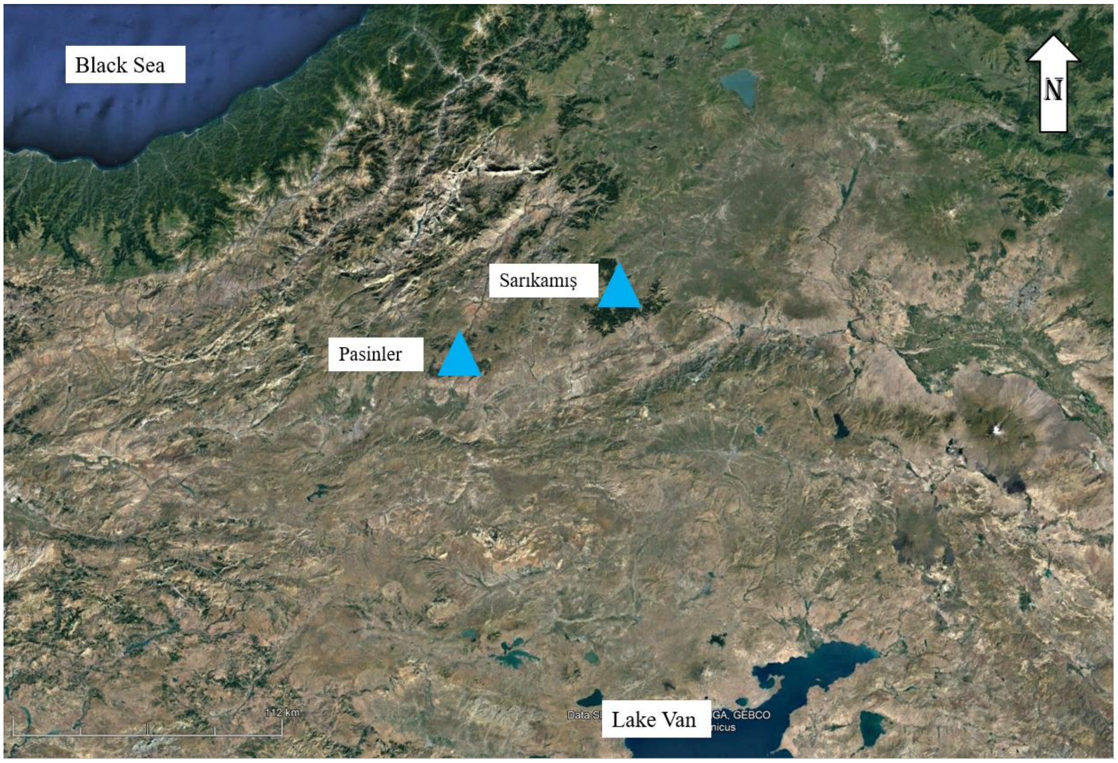


Figure 6.1.5: Nemrut Dağ and Meydan Dağ obsidian.

Figure 6.1.6: Sarıkamış and Pasinler obsidian.



6.7 Chapter 6 Parts II-IV Tables and Figures

Table 6.2.0: Amuq Phases where obsidian artefacts were recovered at Tell al-Judaidah.

Amuq Phase	Obsidian artefacts recovered
SMR	x
Phase J	
Phase I	
Phase H	x
Phase G	x
Phase F	x
Phase E	
Phase D	
Phase C	
FMR	x
Phase B	x (but not included in this study)
Phase A	x

Figure 6.2.0: Distribution of obsidian artefacts from all temporal Phases at Tell al-Judaidah

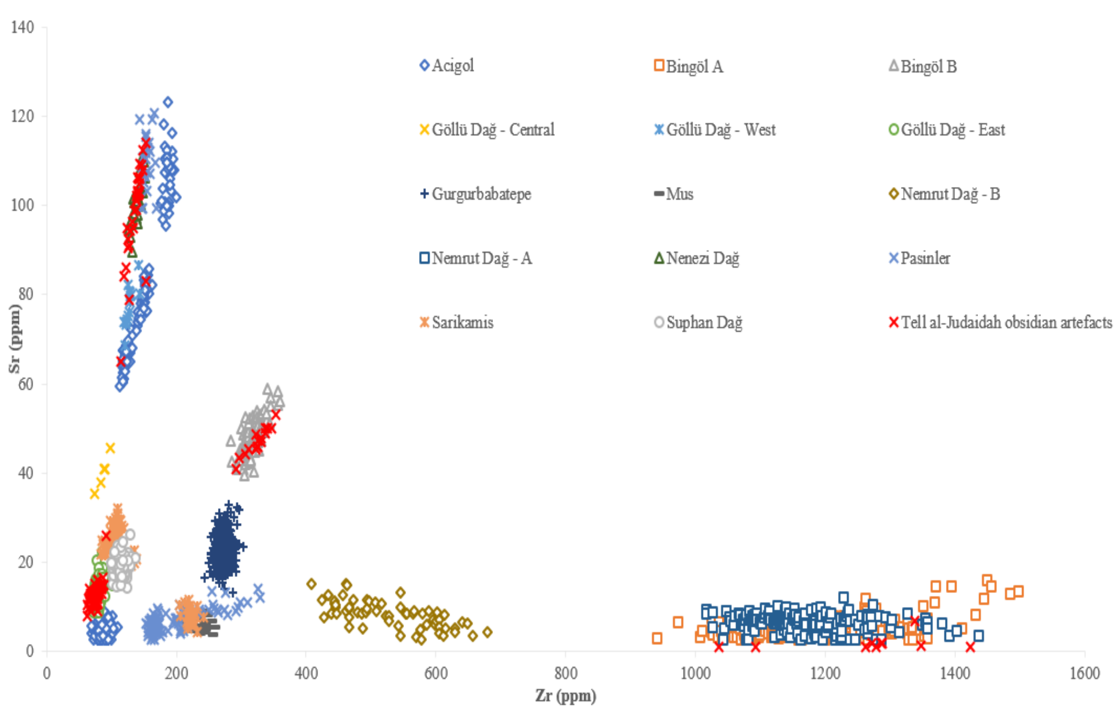


Figure 6.2.1: Distribution of obsidian artefacts from Tell al-Judaidah Phase A.

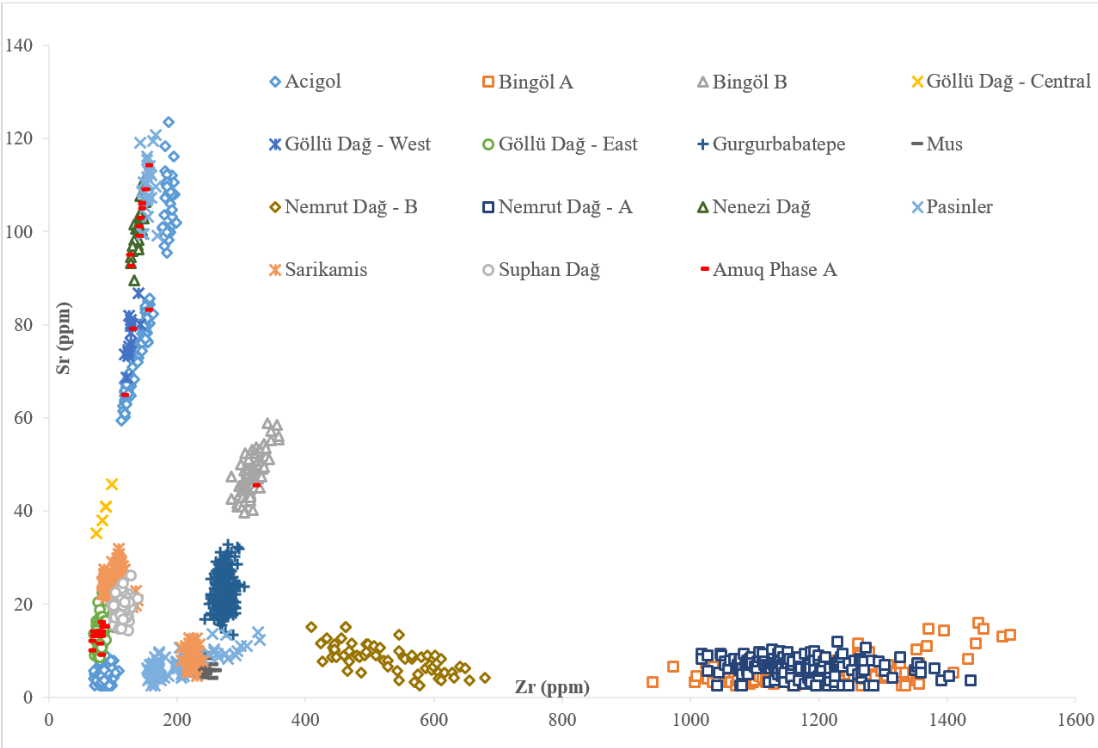


Figure 6.2.2: Close up of Figure 6.2.1 for East Göllü Dağ.

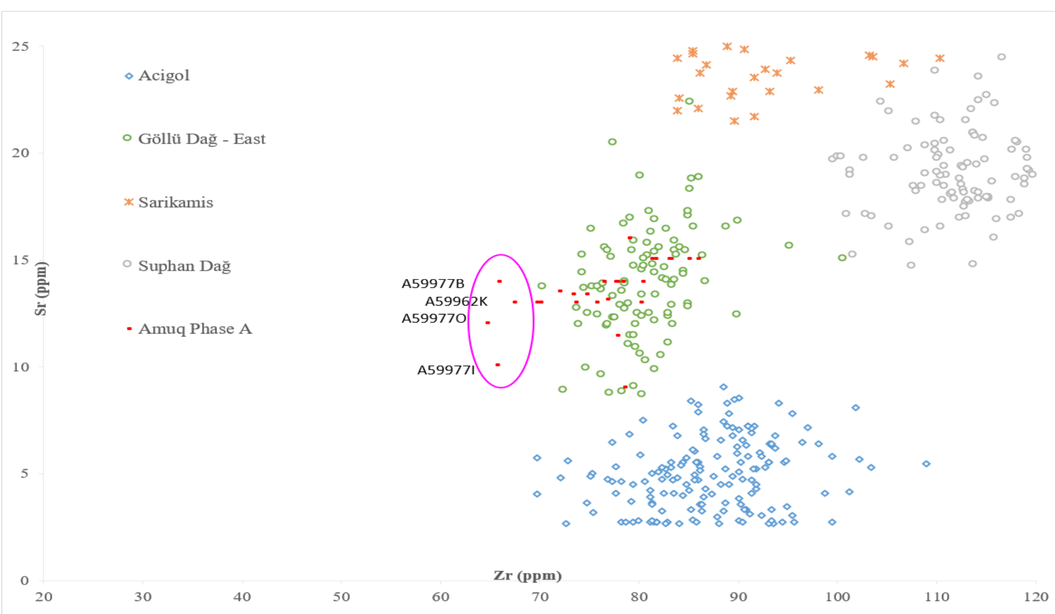


Figure 6.2.3: Line graph comparing A59977B to the average ppm values of select elements from the MAX Lab East Göllü Dağ source database.

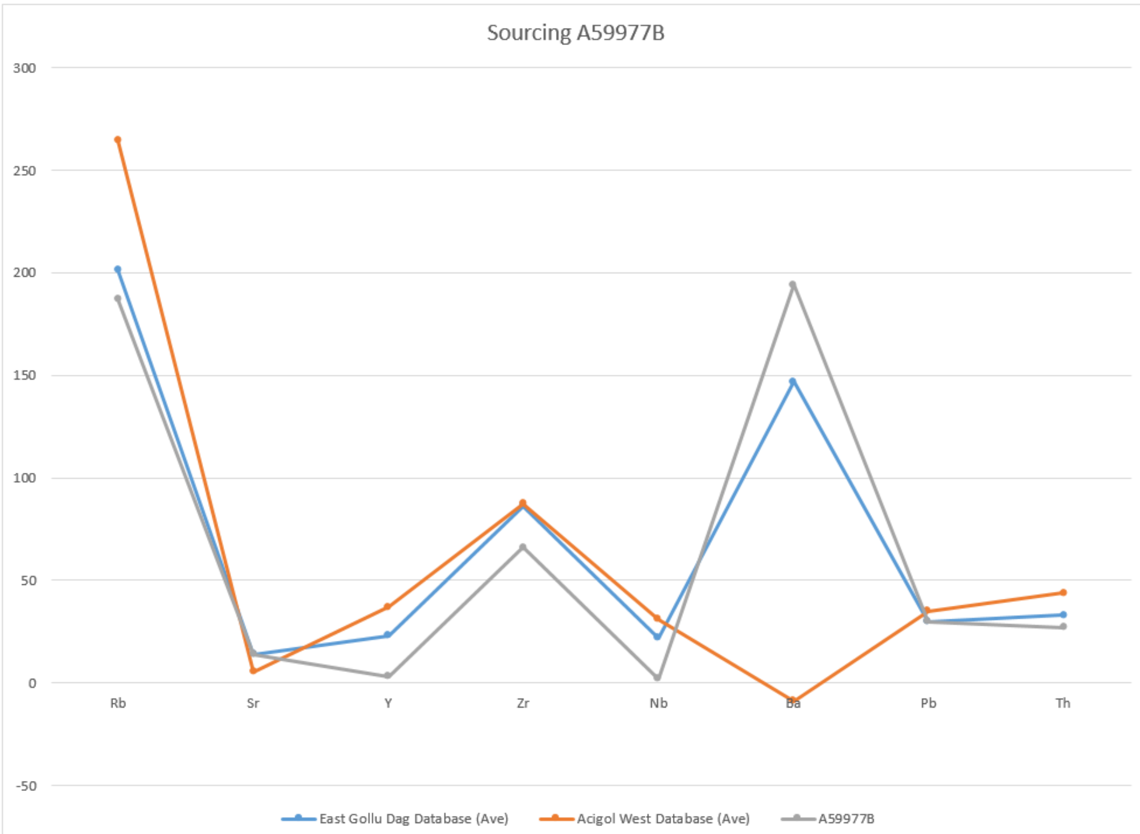


Table 6.2.2: Elemental ppm values used for Figure 6.2.3.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
A59977B	187	14	3	66	2	194	30	27

Figure 6.2.4: Line graph comparing A59962K to the average ppm values of select elements from the MAX Lab East Göllü Dağ source database.

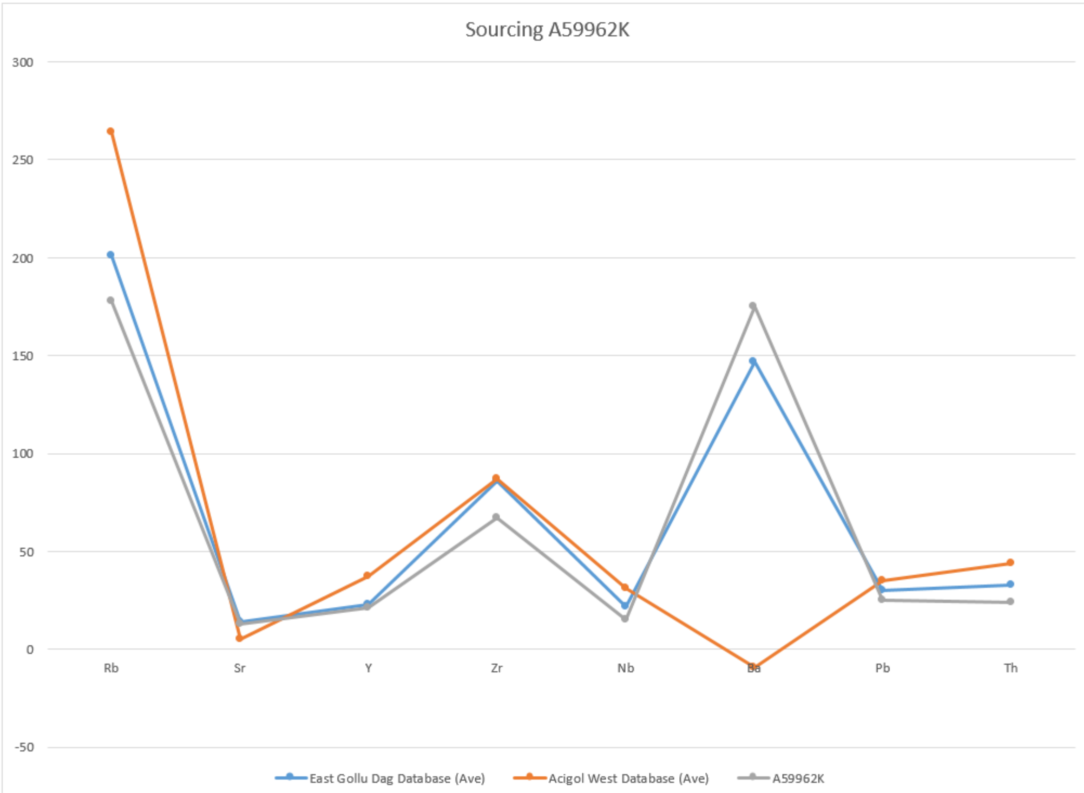


Table 6.2.3: Elemental ppm values used for Figure 6.2.4.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	444444 44
A59962K	178	13	21	67	15	175	25	24

Figure 6.2.5: Line graph comparing A59977O to the average ppm values of select elements from the MAX Lab East Göllü Dağ source database.

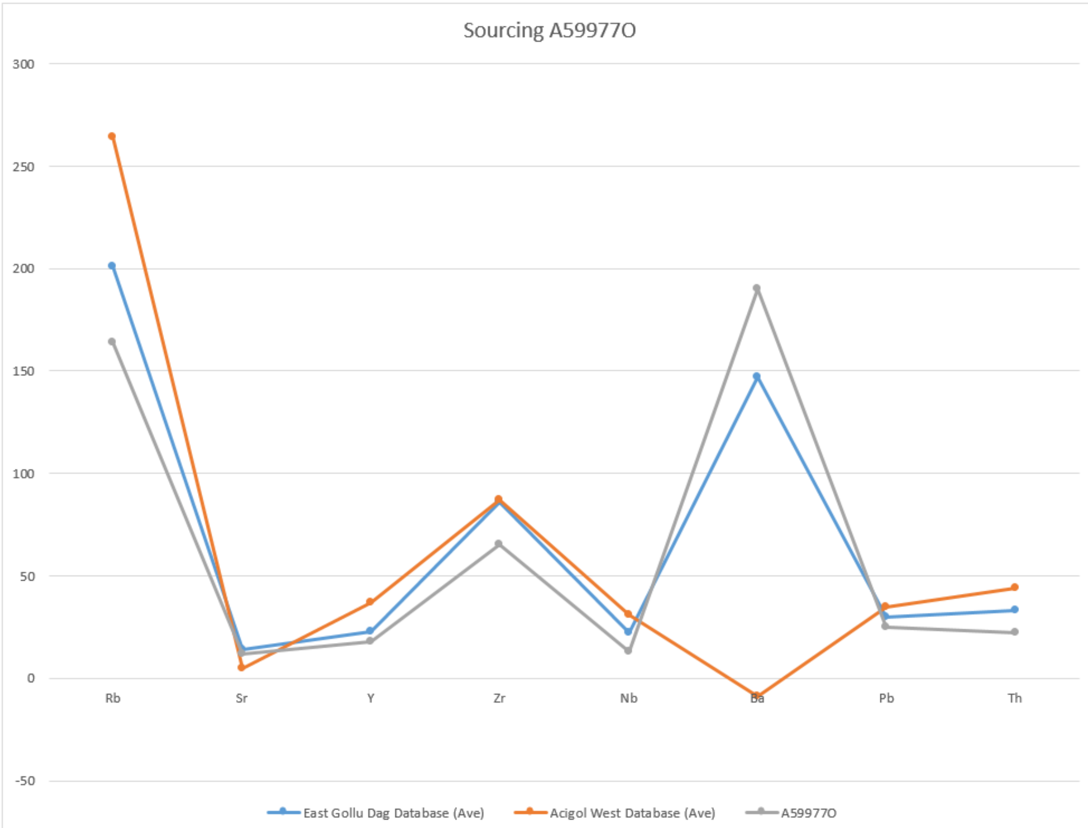


Table 6.2.4: Elemental ppm values used for Figure 6.2.5.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
A59977O	164	12	18	65	13	190	25	22

Figure 6.2.6: Line graph comparing A59977I to the average ppm values of select elements from the MAX Lab East Göllü Dağ source database.

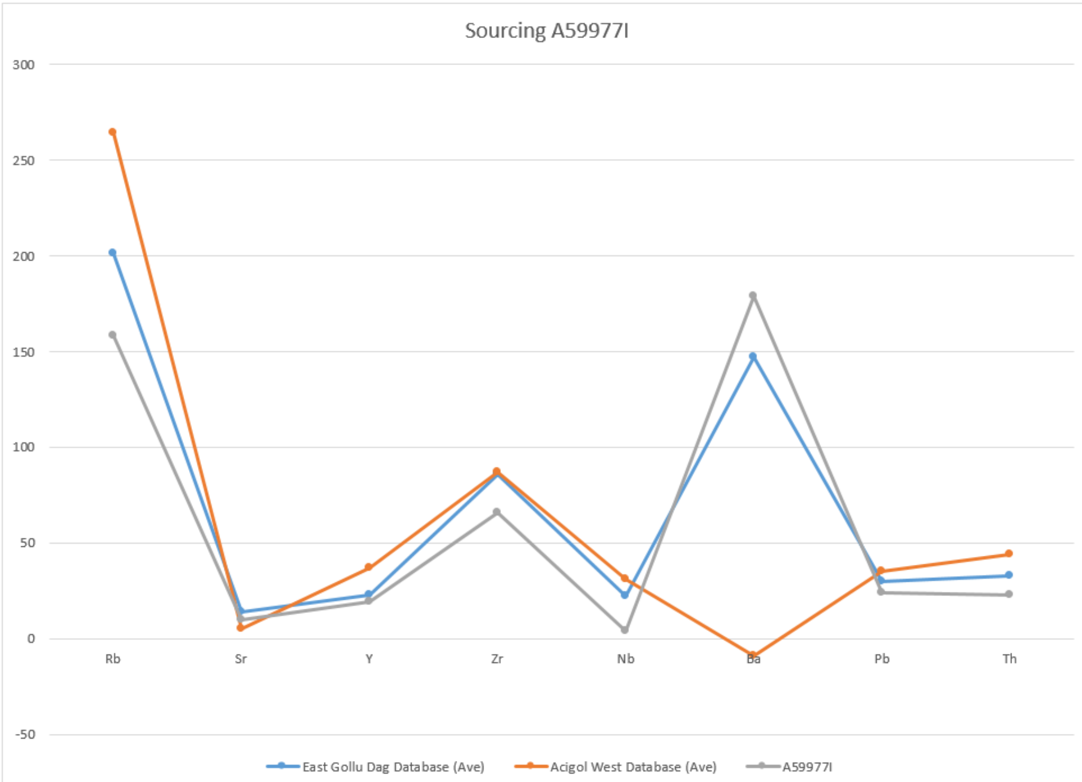


Table 6.2.5: Elemental ppm values used for Figure 6.2.6.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
A59977I	158	10	19	66	4	179	24	23

Figure 6.2.7: Line graph using the average ppm values from artefacts A59977B, A59962K, A59977O and A59977I.

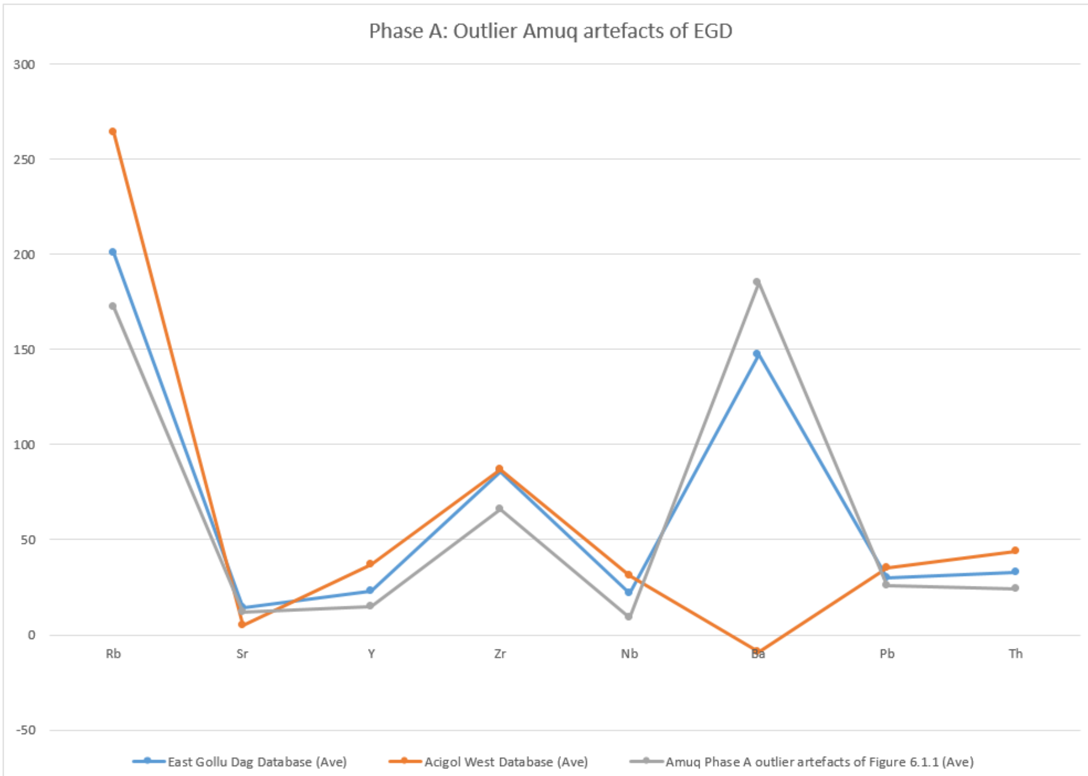


Table 6.2.6: Elemental ppm values used for Figure 6.2.7.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
Amuq Phase A outlier artefacts of Figure 6.2.2 (Av)	172	12	15	66	9	185	26	24

Figure 6.2.8: Close up of Figure 6.2.1 for Nenezi Dağ and Pasinler.

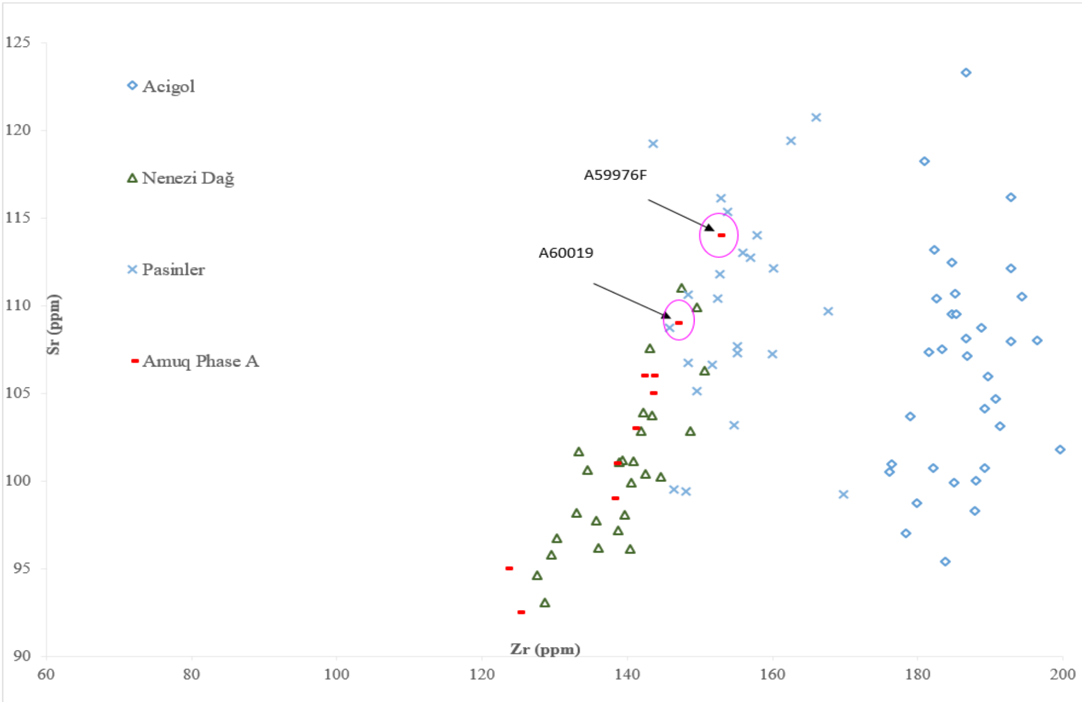


Figure 6.2.9: Plot taken after Carter et al. 2017 for distinguishing Pasinler and Nenezi Dağ sources.

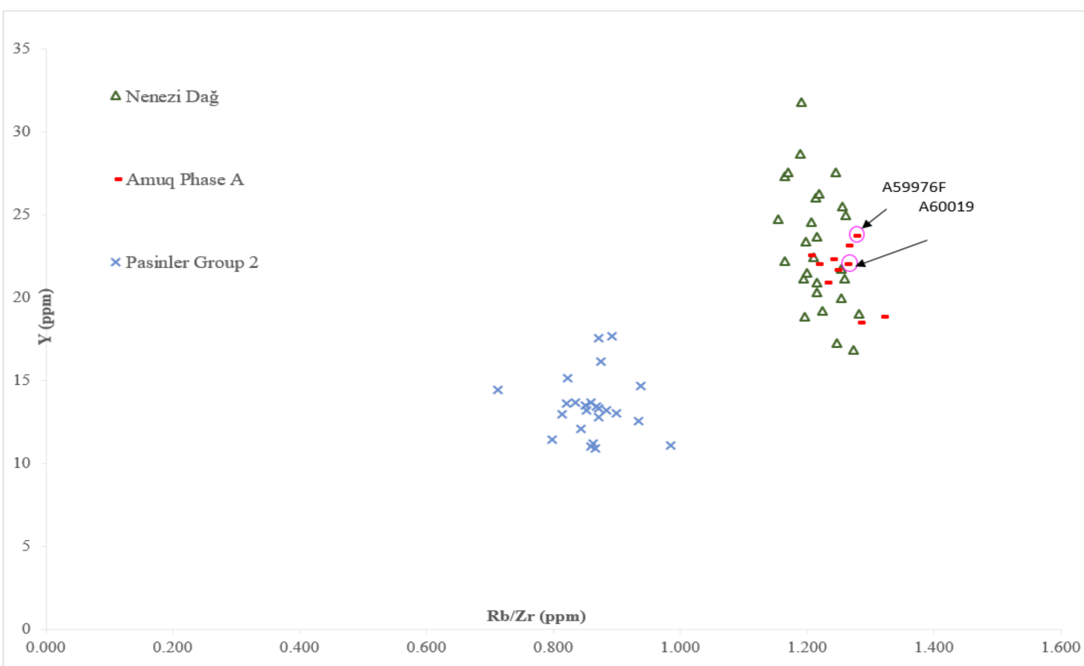


Figure 6.2.10: Close up Figure 6.2.1 for West Göllü Dağ.

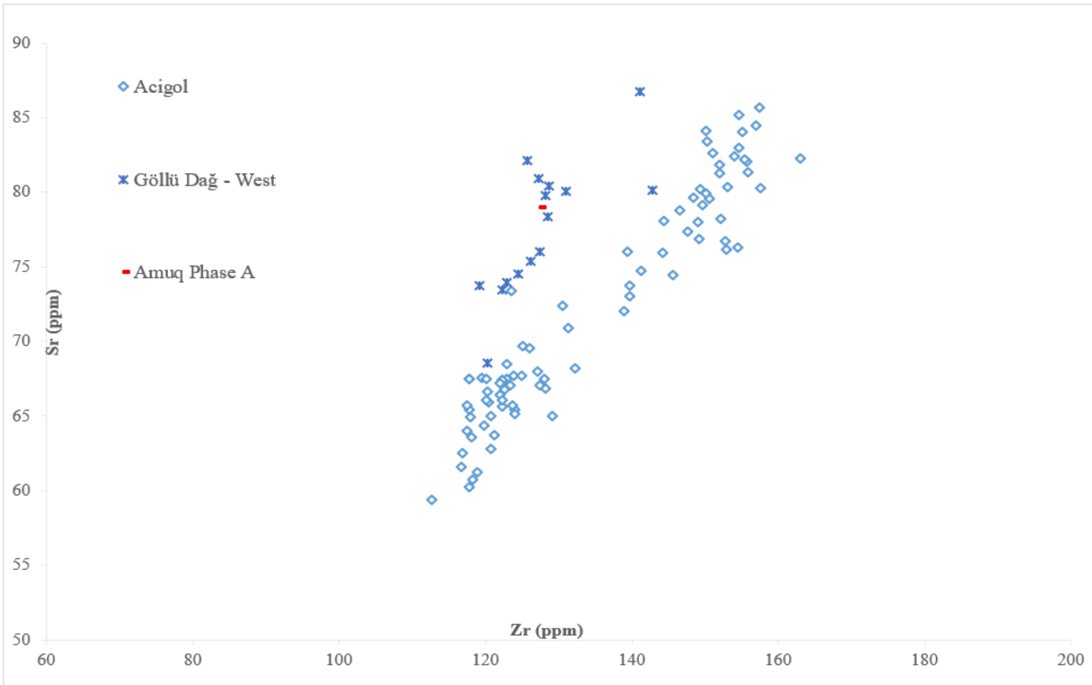


Figure 6.2.11: Close up Figure 6.2.1 for Acigöl.

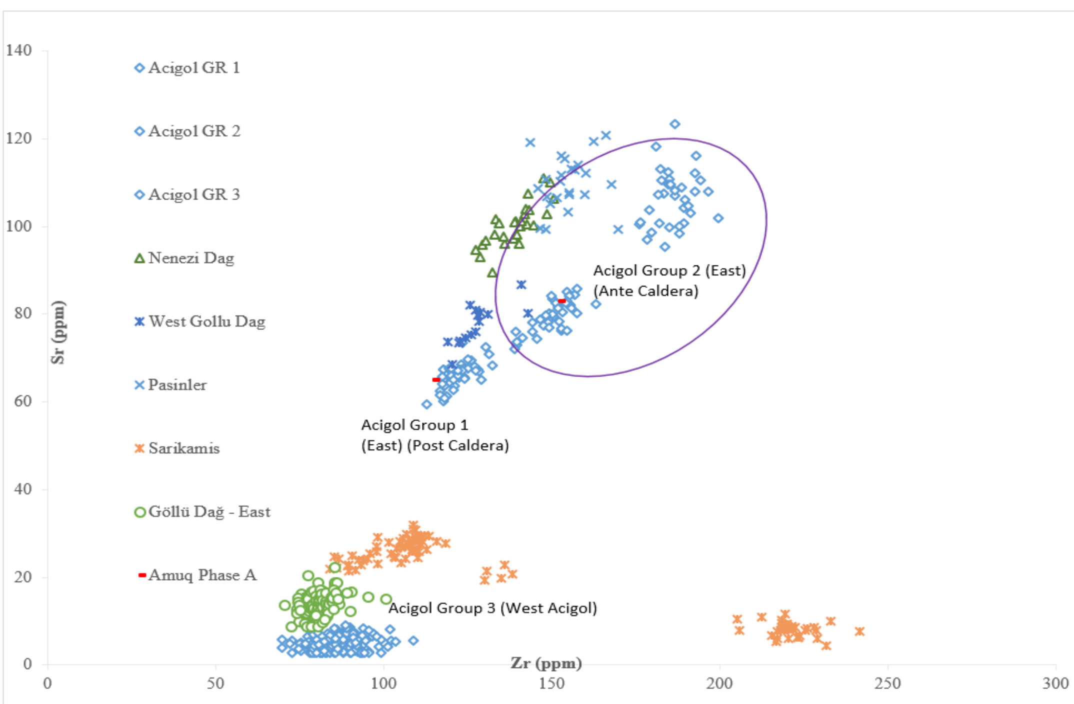


Figure 6.2.12: Zr vs Sr plot of obsidian artefacts from Tell al-Judaidah First Mixed Range.

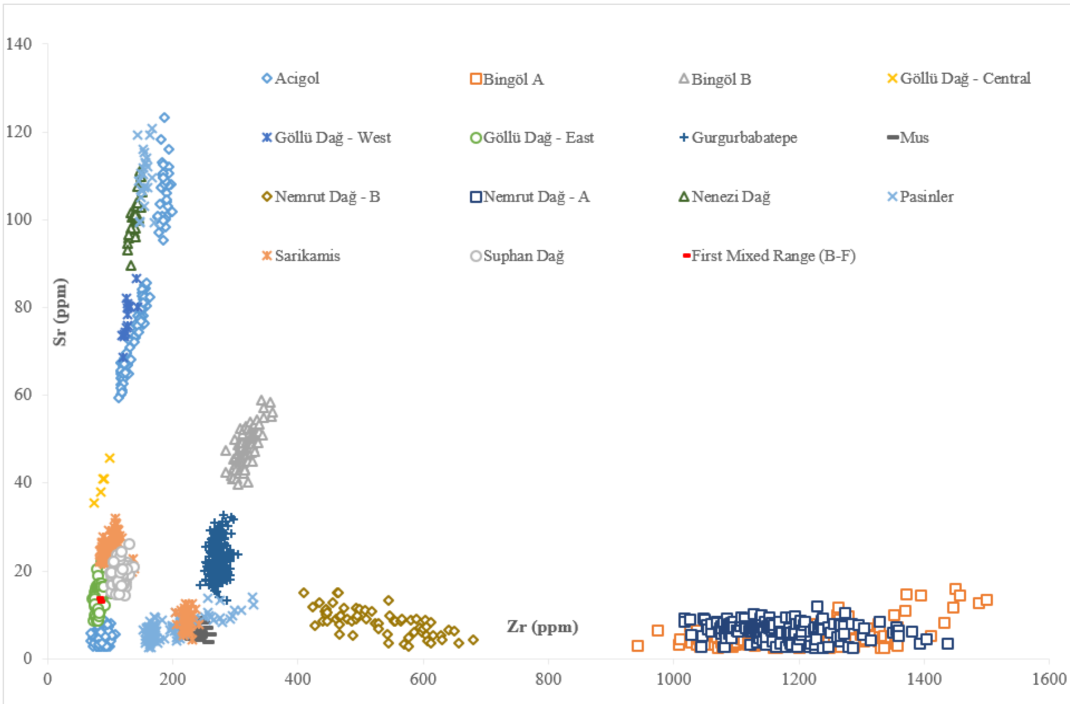


Figure 6.2.13: Close up of Figure 6.2.12 to show A59960B and A59961B in relation to the East Göllü Dağ source database.

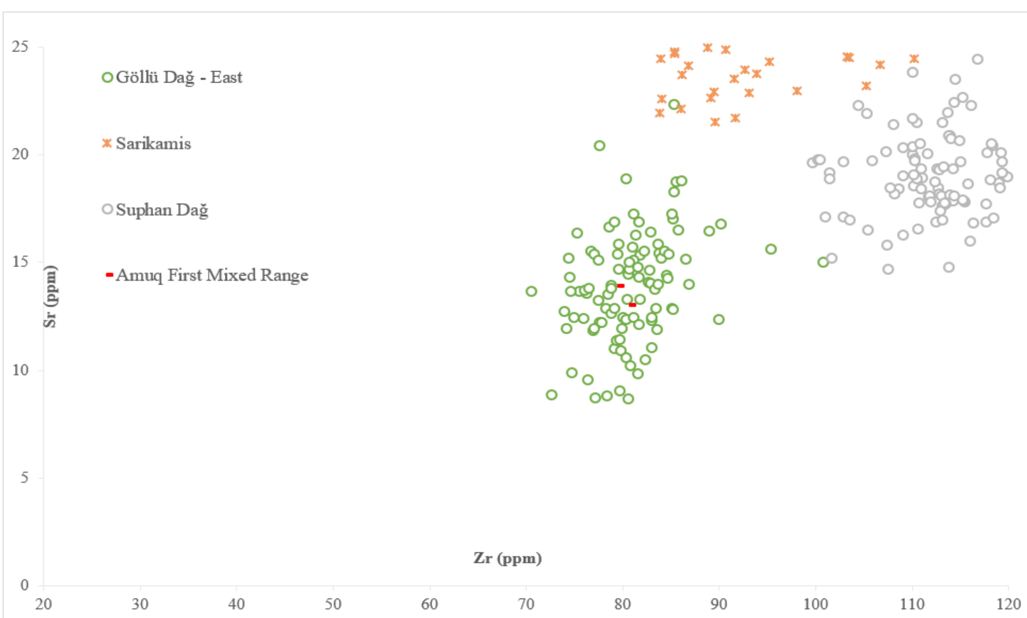


Figure 6.2.14: Zr vs Sr plot of obsidian artefacts from Tell al-Judaidah Phase F.

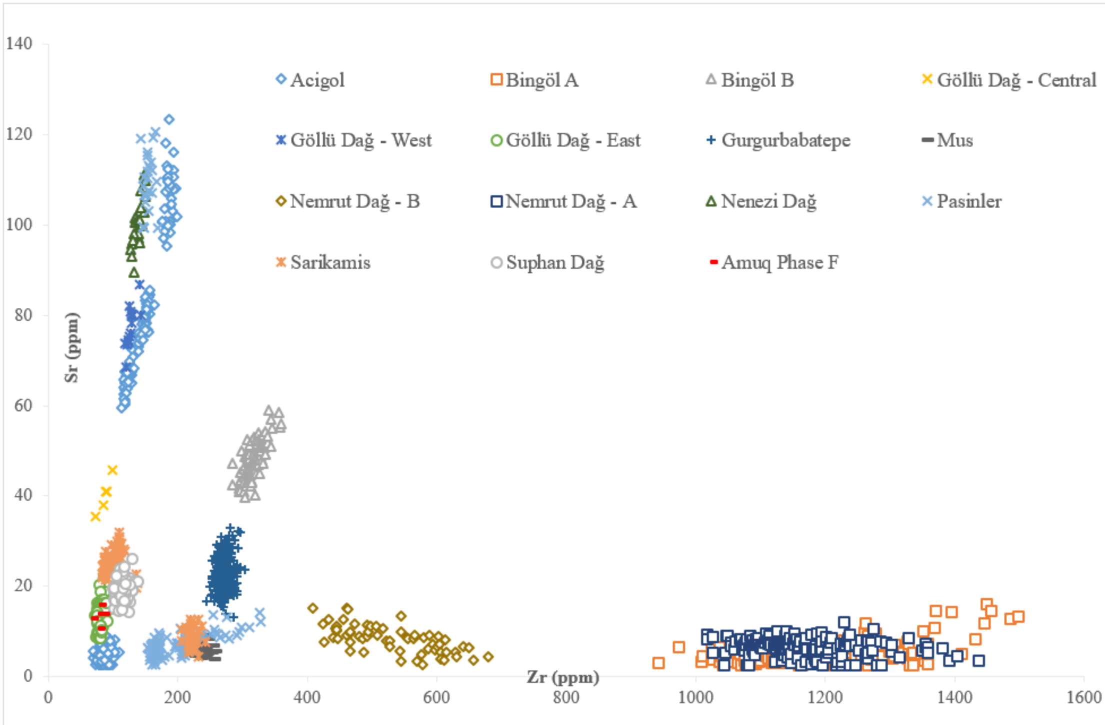


Figure 6.2.15: Close up of Figure 6.2.14 for East Göllü Dağ.

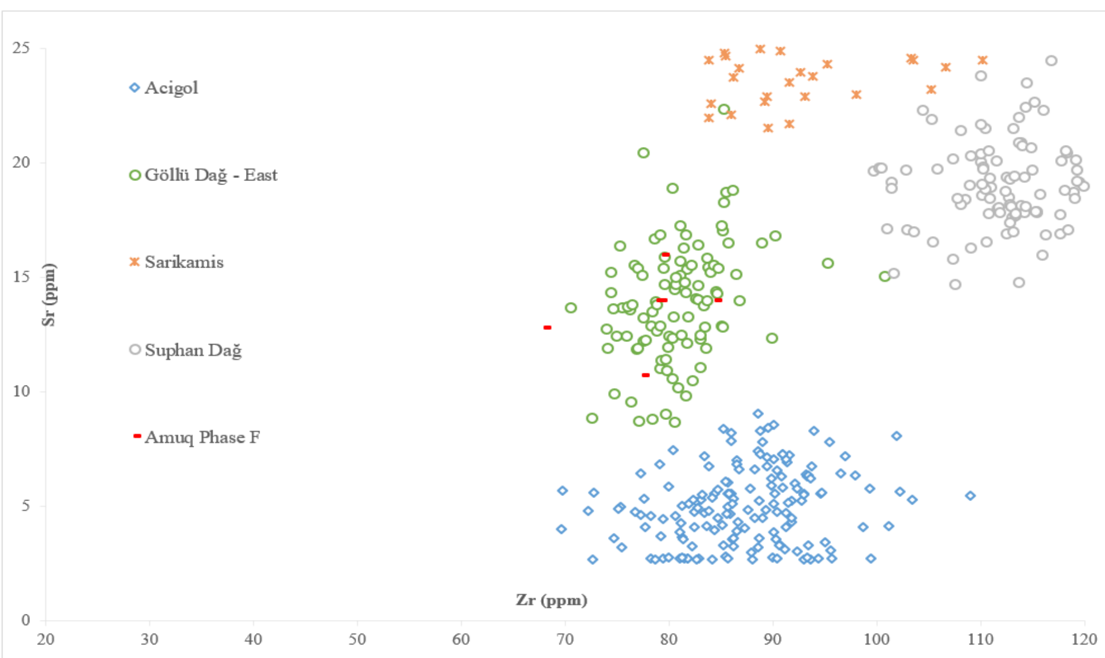


Figure 6.2.16: Distribution of obsidian artefacts from Tell al-Judaidah Phase F.

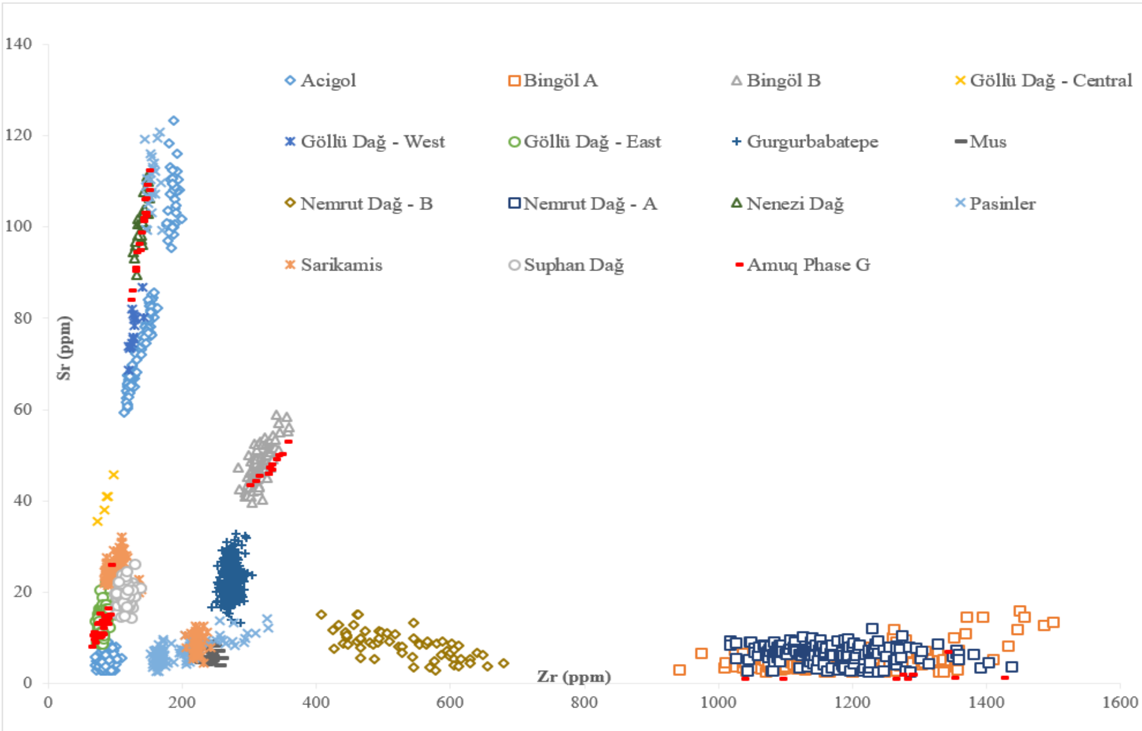


Figure 6.2.17: Close up of Figure 6.2.16 for East Göllü Dağ.

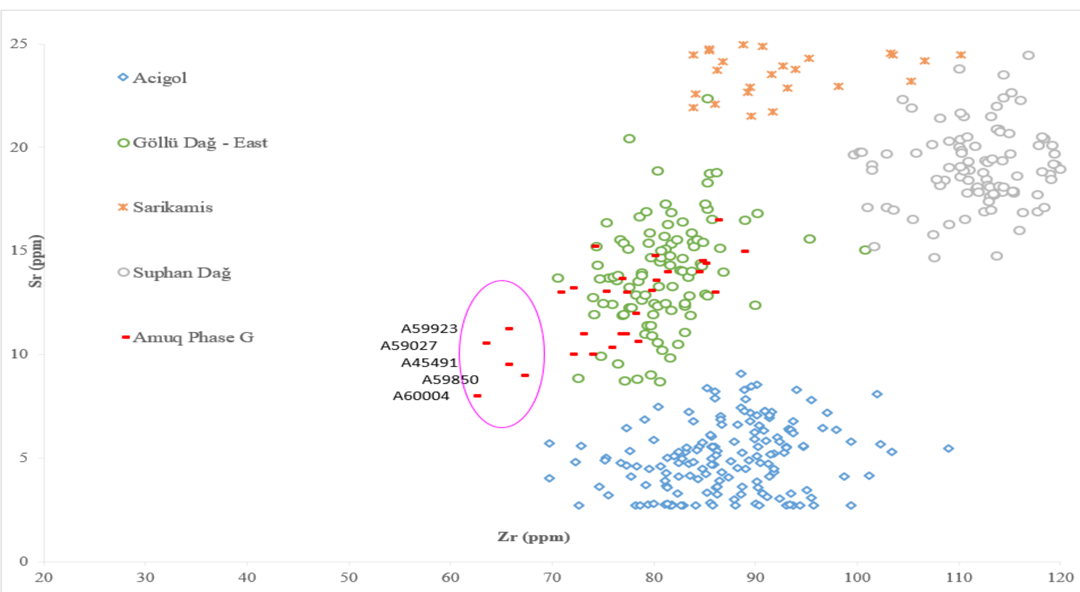


Figure 6.2.18: Line graph using the average ppm values from artefacts A59923, A59027, A45491, A59850 and A60004.

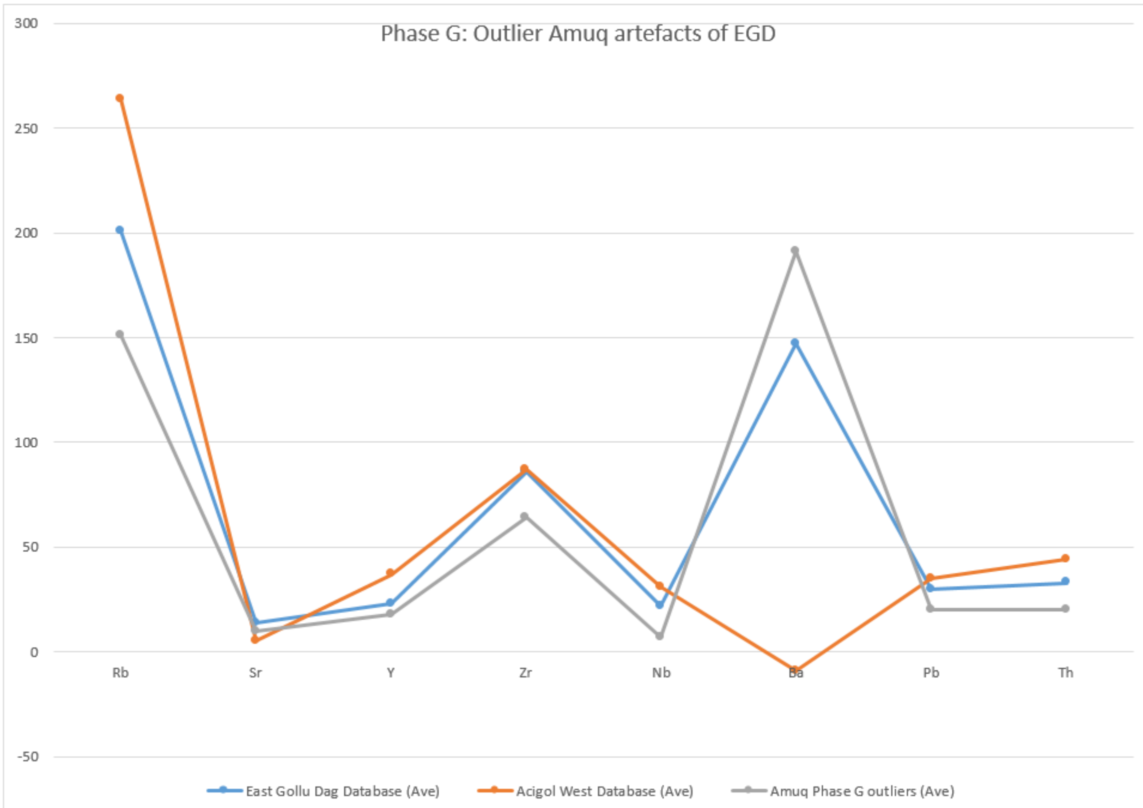


Table 6.2.7: Elemental ppm values used for Figure 6.2.17.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
Amuq Phase G outlier artefacts of Figure 6.2.17 (Av)	151	10	18	64	7	191	20	20

Figure 6.2.19: Close up of Figure 6.1.16 to better show the Amuq artefacts of Phase G sourced to Nenezi Dağ.

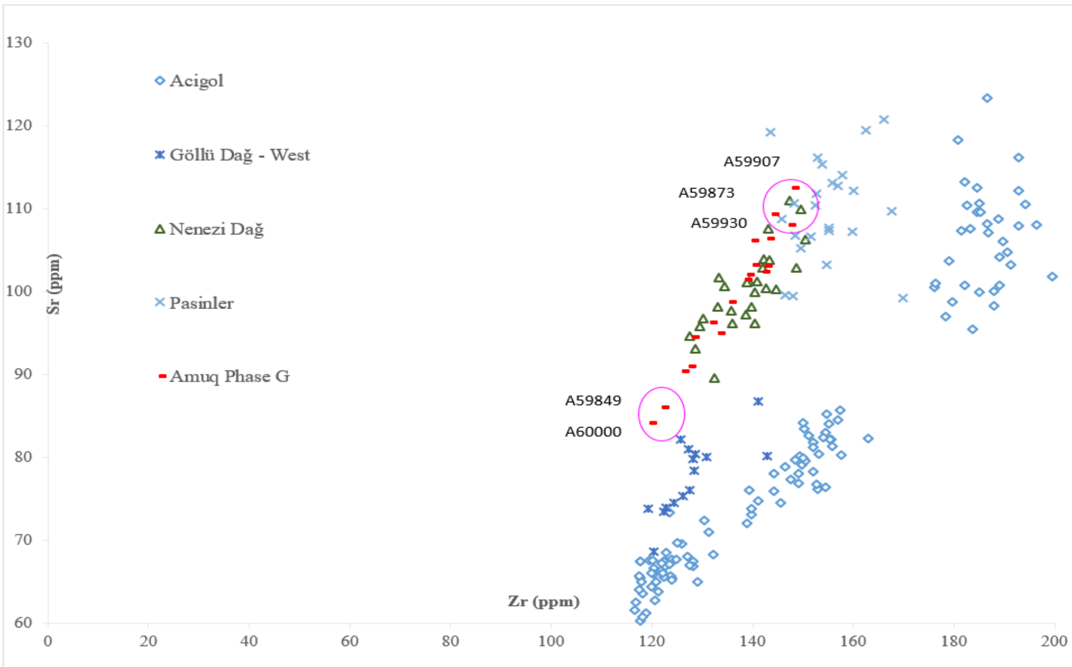


Figure 6.2.20: Plot taken after Carter et al. 2017 for distinguishing Pasinler and Nenezi Dağ sources.

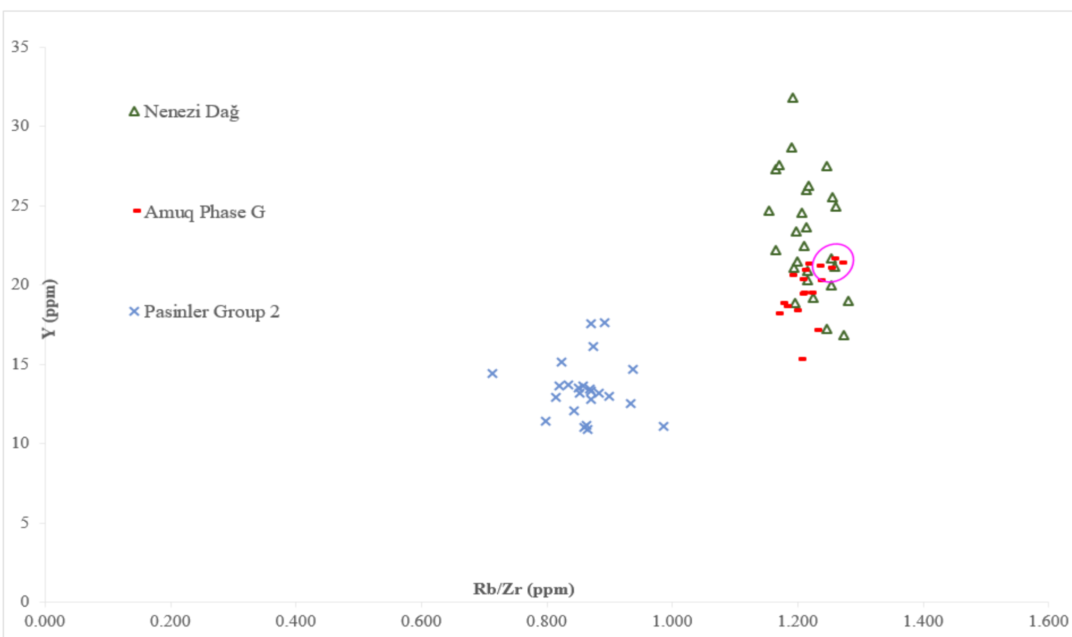


Figure 6.2.21: Line graph trying to source A59849 and A6000. (Unsuccessful.)

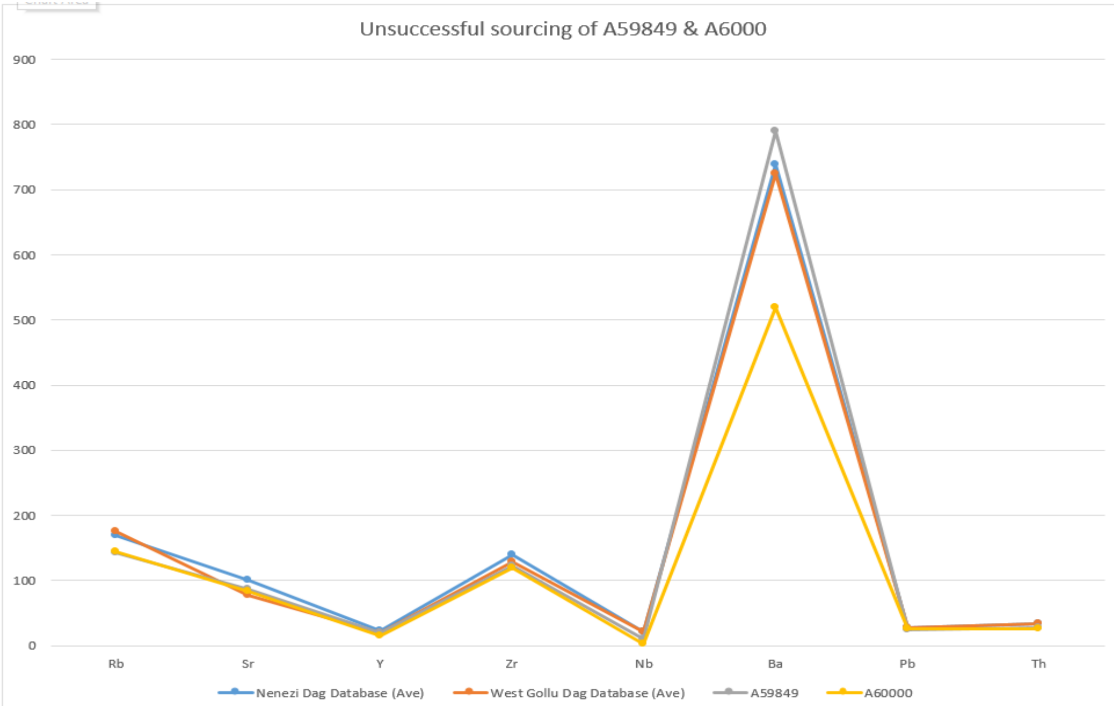


Figure 6.2.22: Close up of Figure 6.2.21 for possible distinction appearing between source databases.

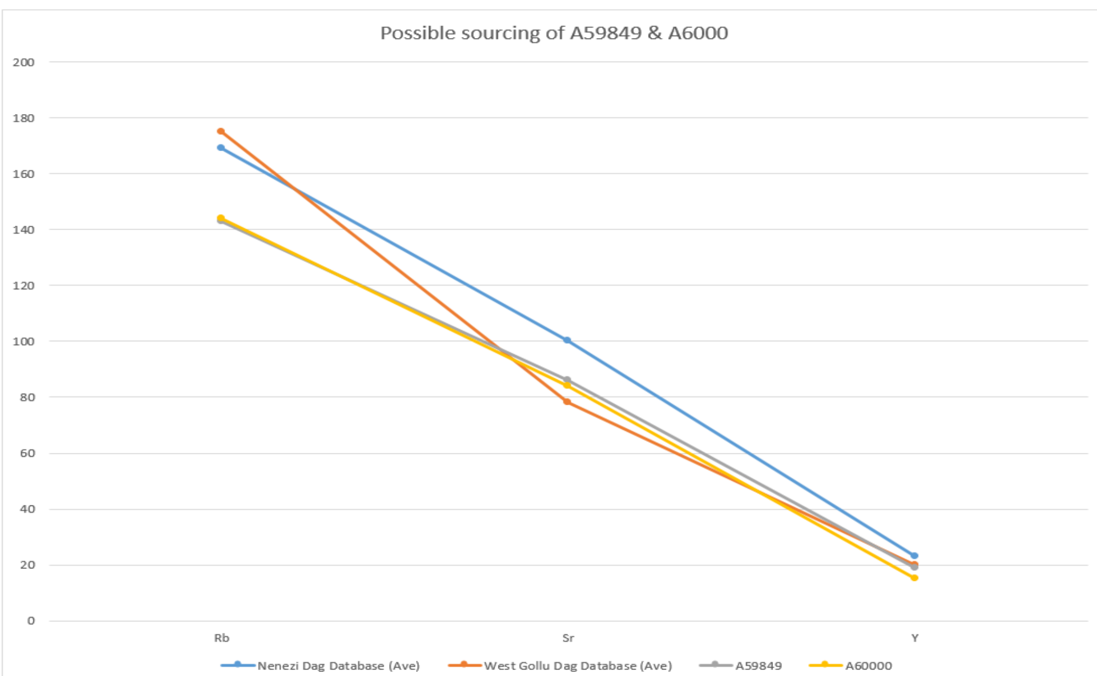


Table: 6.2.8: Elemental ppm values used for Figures 6.2.21 and 6.2.22.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
Nenezi Dag Database (Av)	169	100	23	139	22	738	28	33
West Gollu Dag Database (Av)	175	78	20	128	21	725	27	33
A59849	143	86	19	122	10	789	25	27
A60000	144	84	15	120	2	519	26	26

Figure 6.2.23: Another attempt to source A59849 and A6000 using Sr/Zr ratios. (Unsuccessful.)

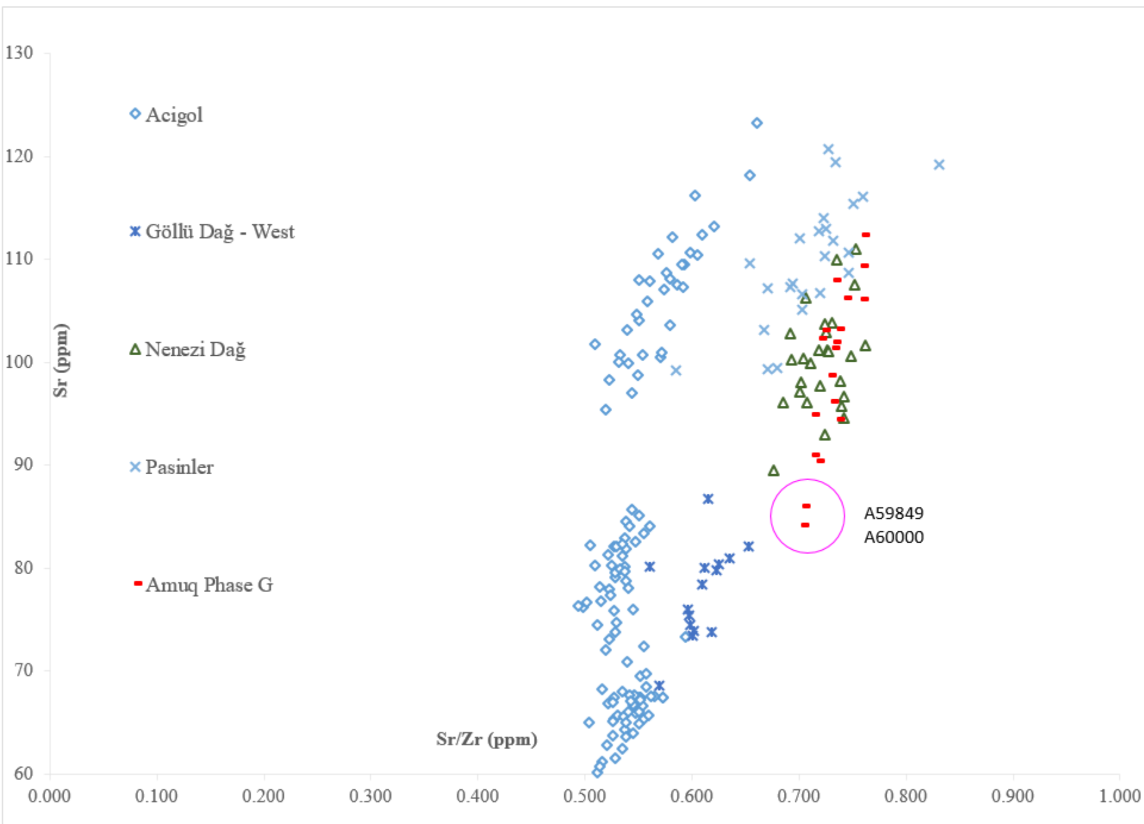


Figure 6.2.24: Close up of Figure 6.2.16 for Bingöl B.

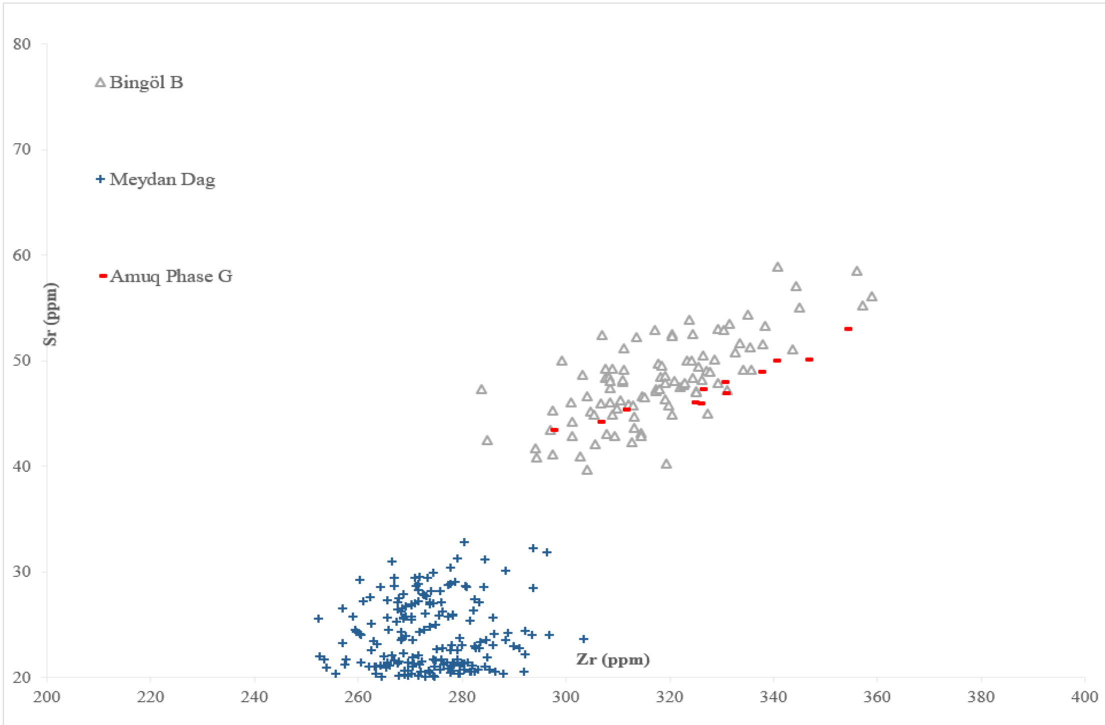


Figure 6.2.25: Fe2O3 vs MnO.

Figure 6.2.26: Fe2O3/CaO vs Na2O/MnO2.

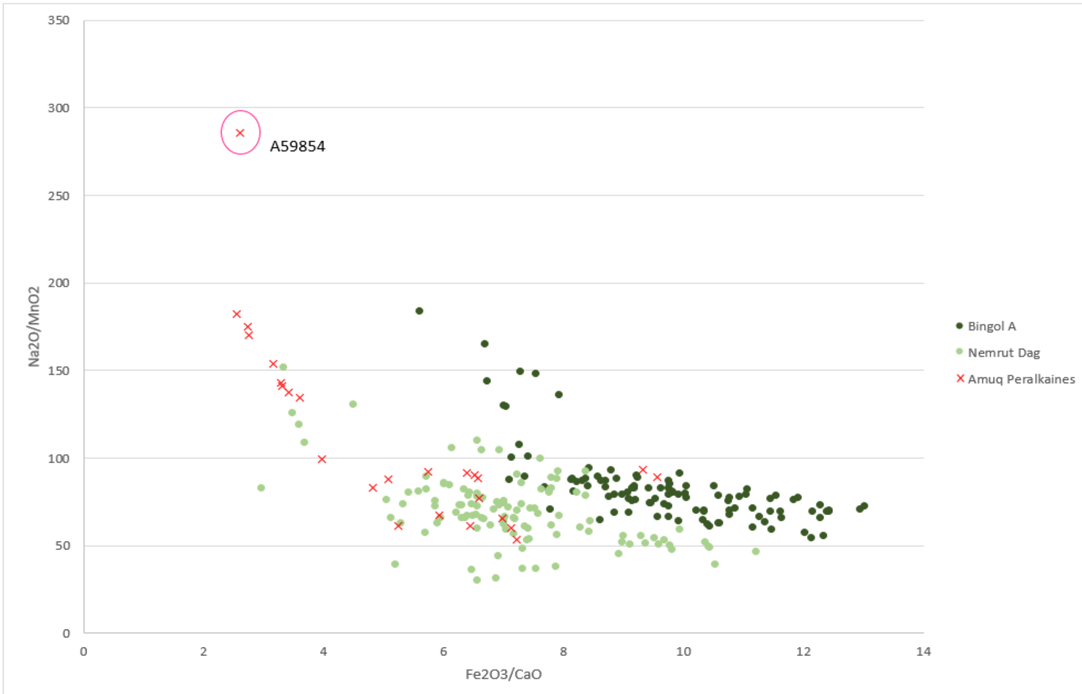


Figure 6.2.27: Na2O/Fe2O3 vs Na2O/MnO2.

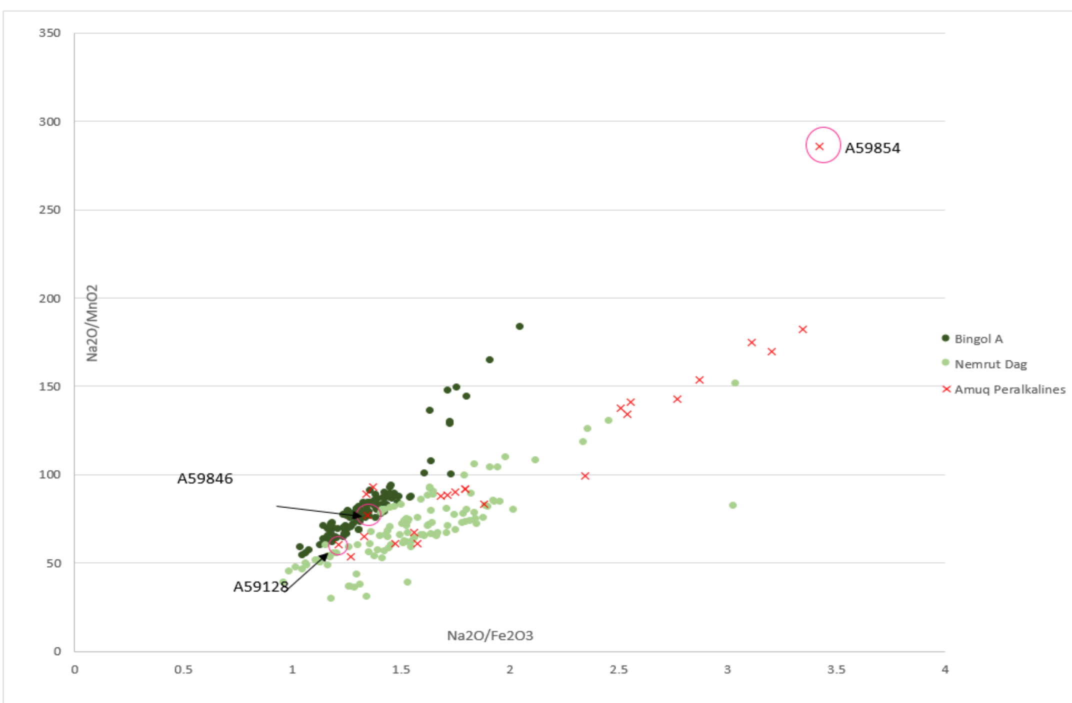


Figure 6.2.28: Close up of Figure 6.2.16 for Sarıkamış.

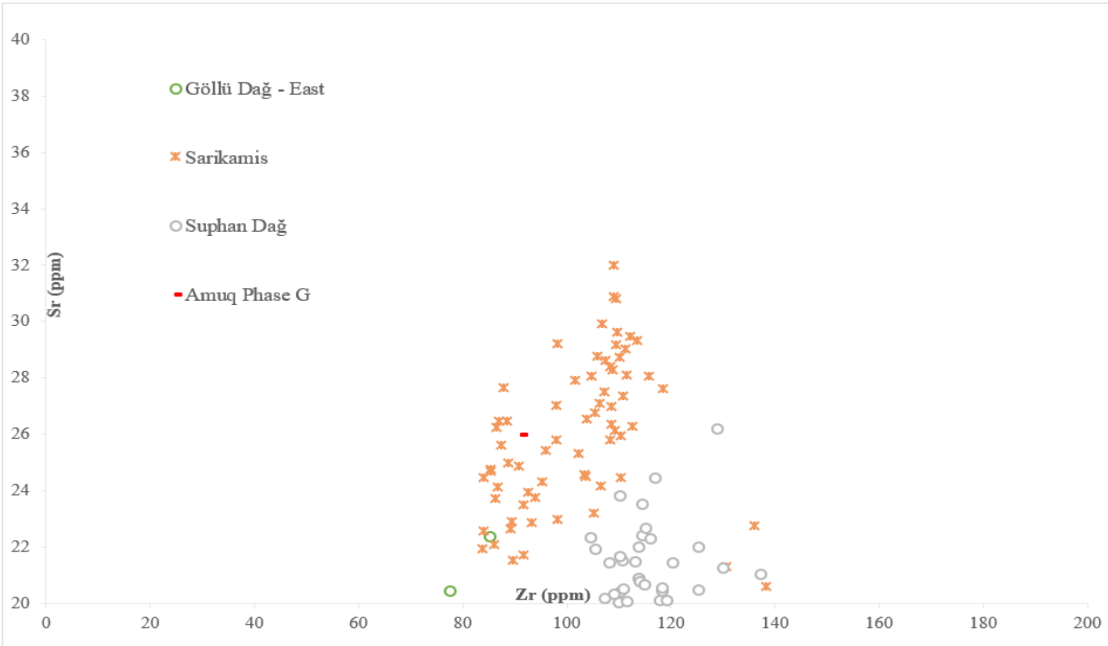


Figure 6.2.29: Ba vs Y plot to distinguish most likely Sarıkamış sub-source of A59845.

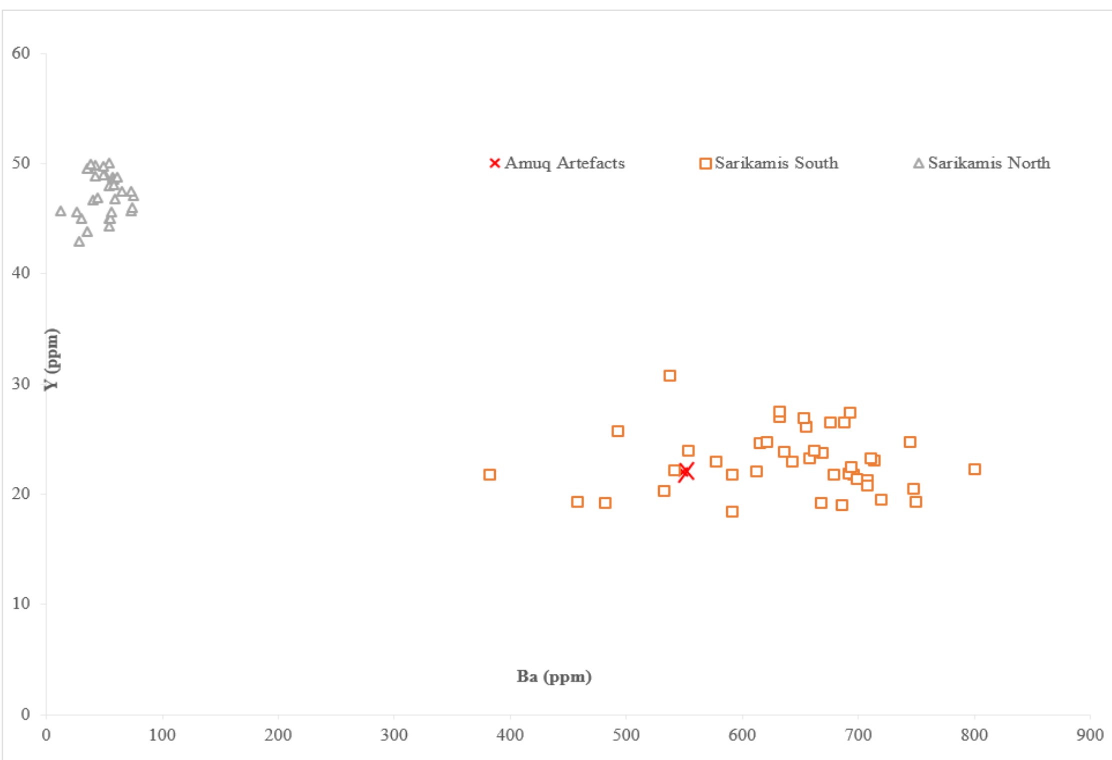


Figure 6.2.30: Distribution of obsidian artefacts from Tell al-Judaidah Phase H.

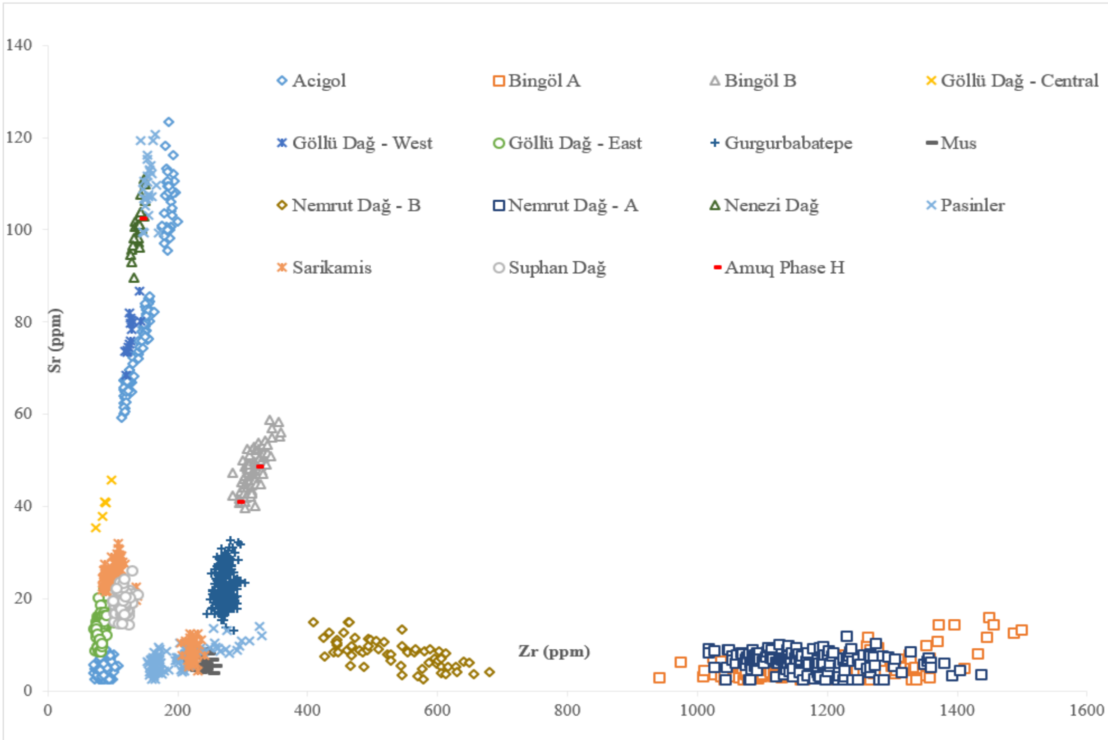


Figure 6.2.31: Close up of Figure 6.2.30 for Nenezi Dağ.

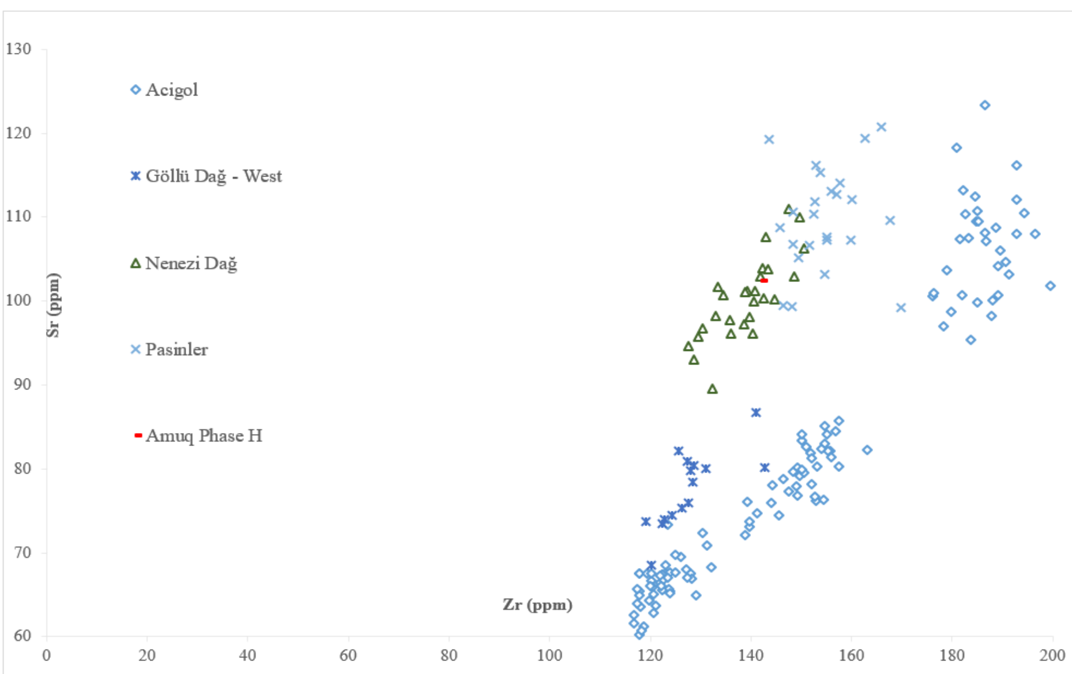


Figure 6.2.32: Close up of Figure 6.2.30 for Bingöl B.

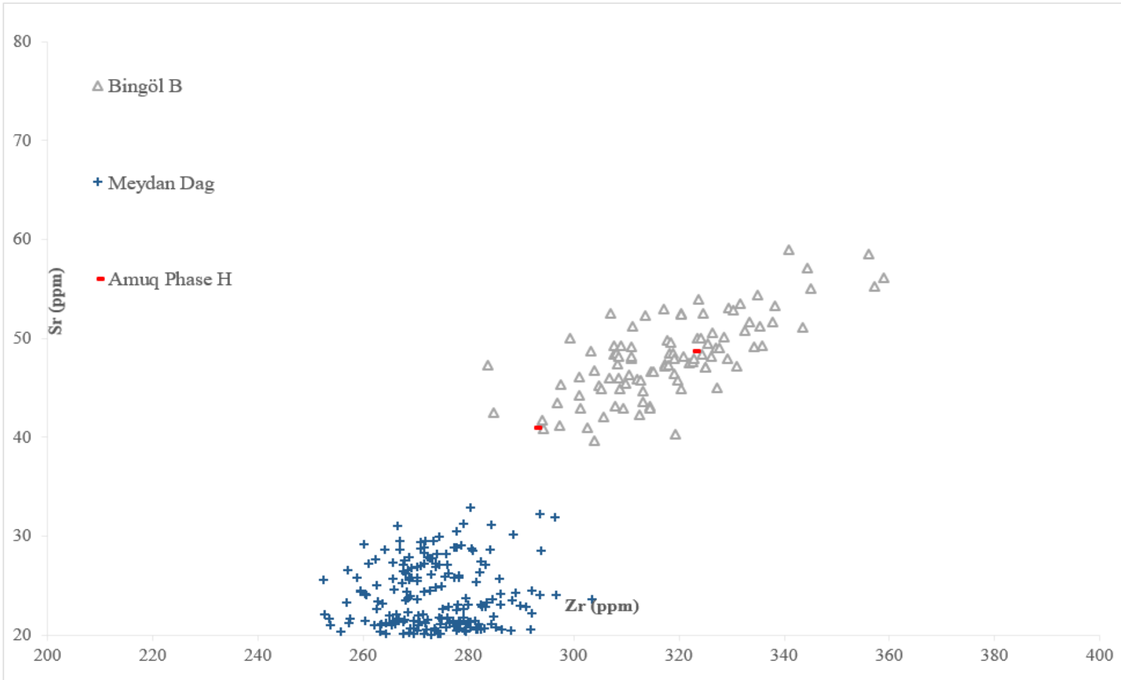


Figure 6.2.33: Distribution of obsidian artefacts recovered from Tell al-Judaidah Second Mixed Range.

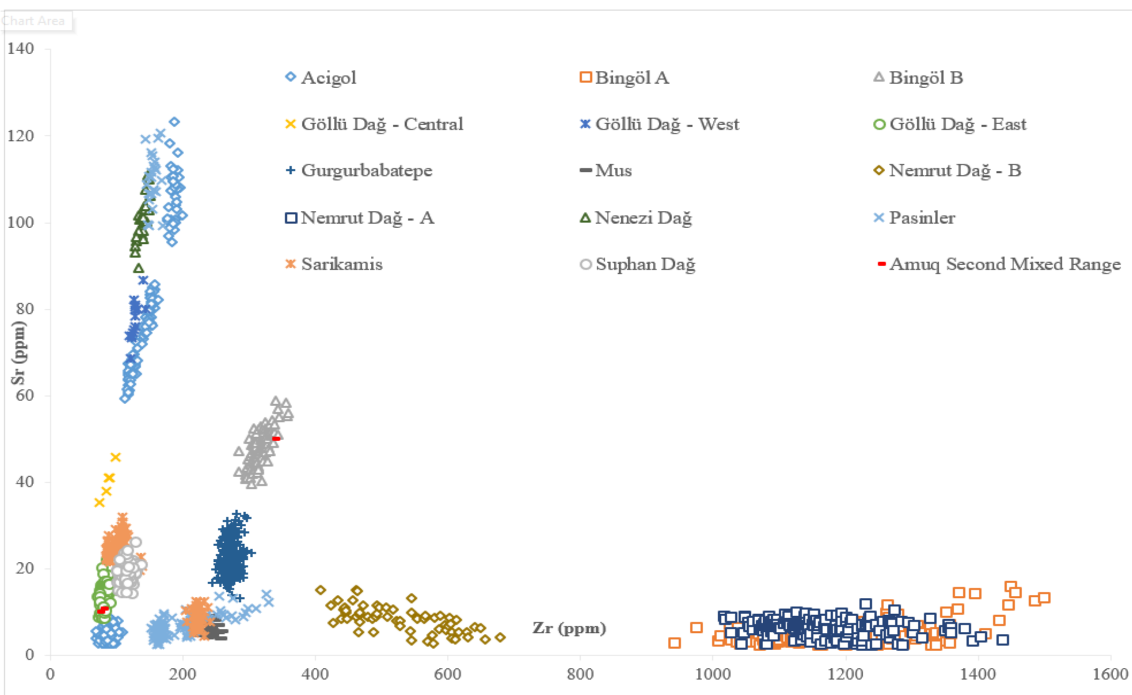


Figure 6.2.34: Close up of Figure 6.2.33 for East Göllü Dağ.

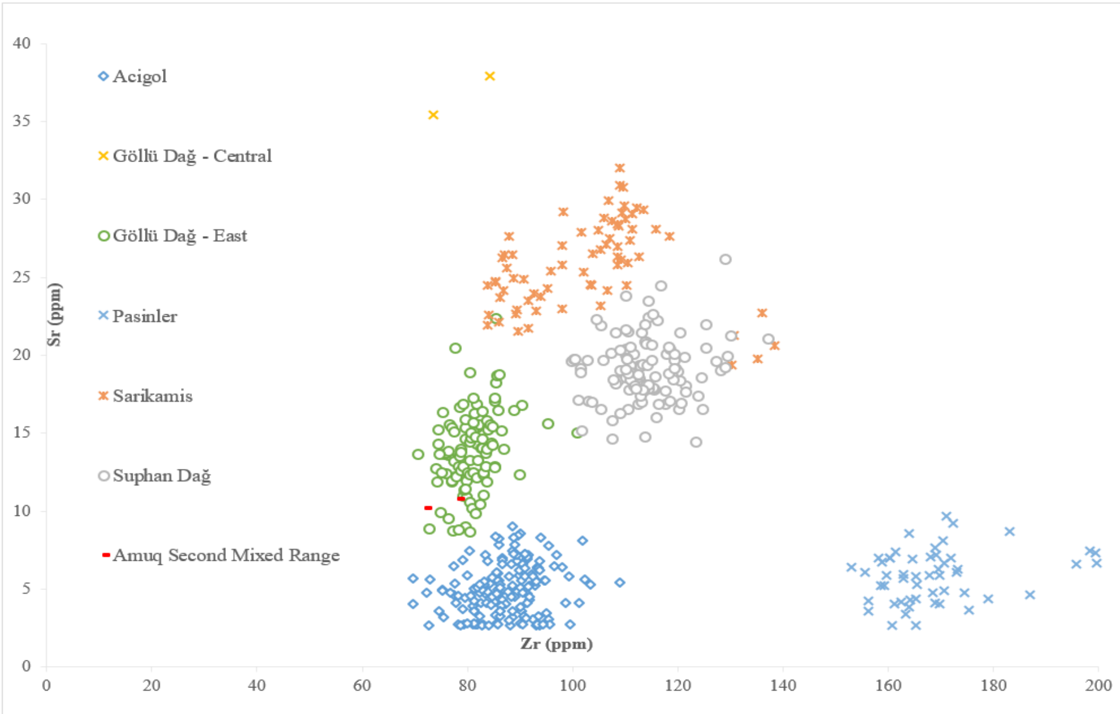


Figure 6.2.35: Close up of Figure 6.3.33 for Bingöl B.

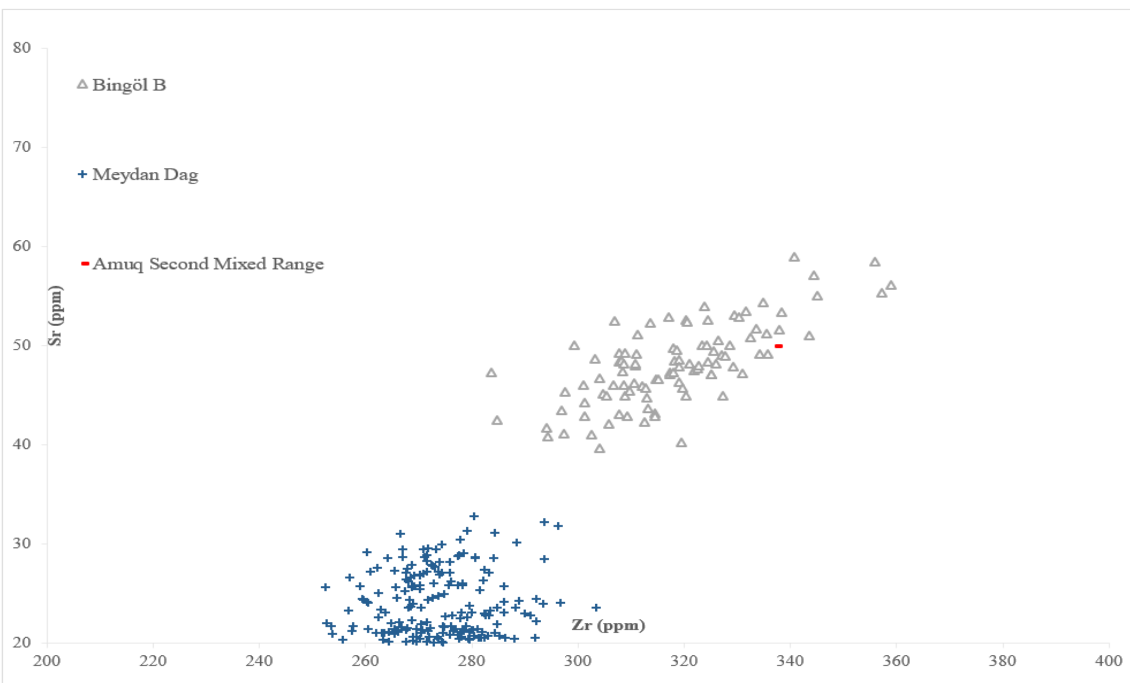


Figure 6.2.36: Amuq artefacts with unconfirmed temporal Phase sourced to East Göllü Dağ.

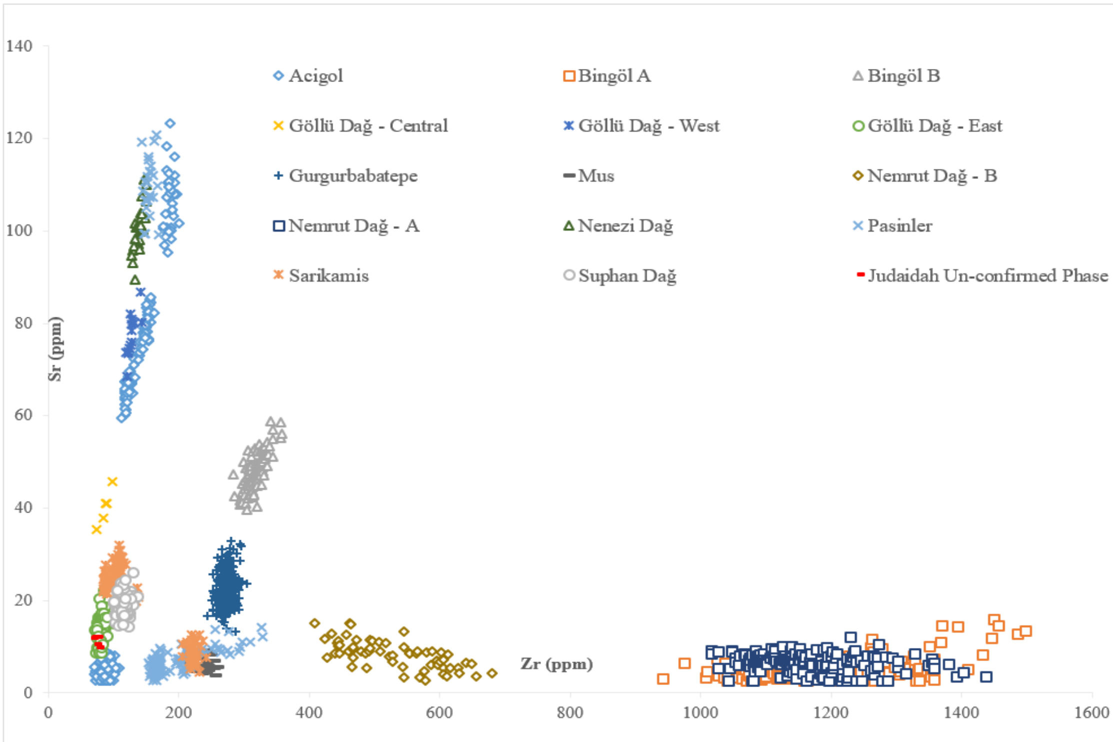


Figure 6.2.37: Close up of Figure 6.2.36 for East Göllü Dağ.

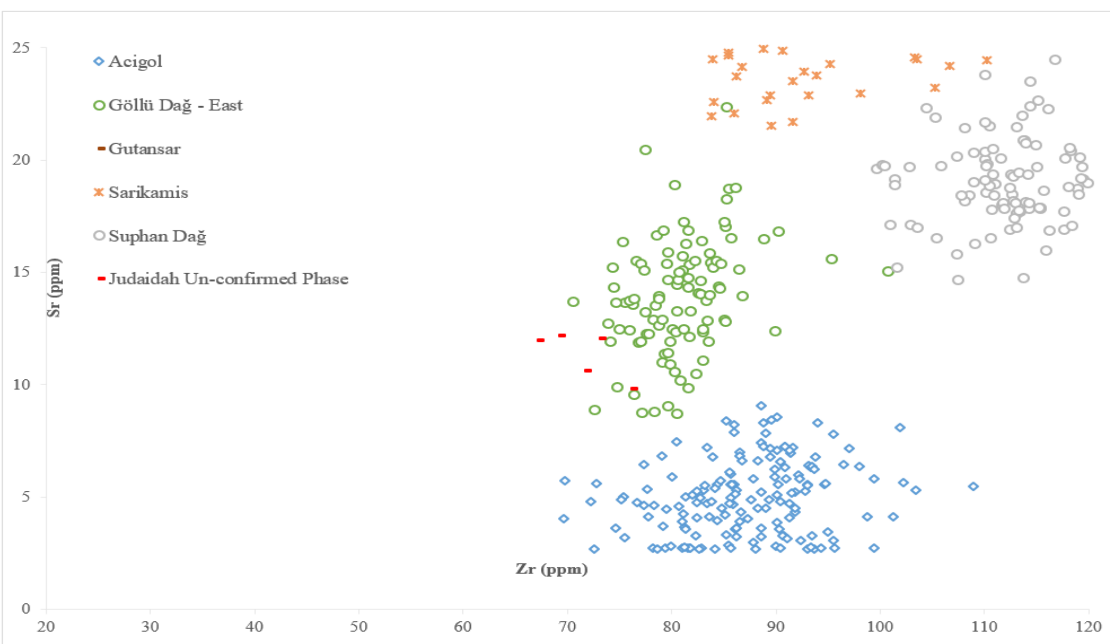


Table 6.3.0: Amuq Phases where obsidian artefacts were recovered at Tell Kurdu.

Amuq Phase	Obsidian artefacts recovered
SMR	
Phase J	
Phase I	
Phase H	
Phase G	
Phase F	
Phase E	x
Phase D	x
Phase C	x
FMR	
Phase B	
Phase A	

Figure 6.3.0: Distribution of obsidian artefacts from all temporal Phases at Tell Kurdu.

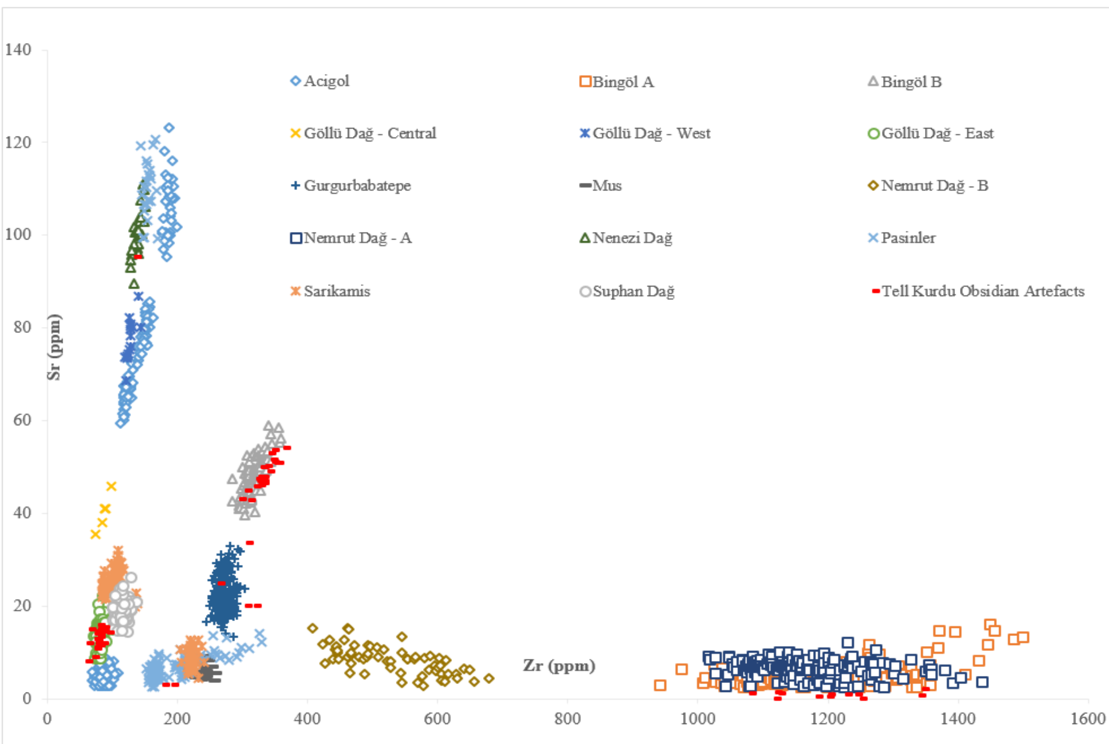


Figure 6.3.1: Amuq artefacts recovered from Phase C at Tell Kurdu.

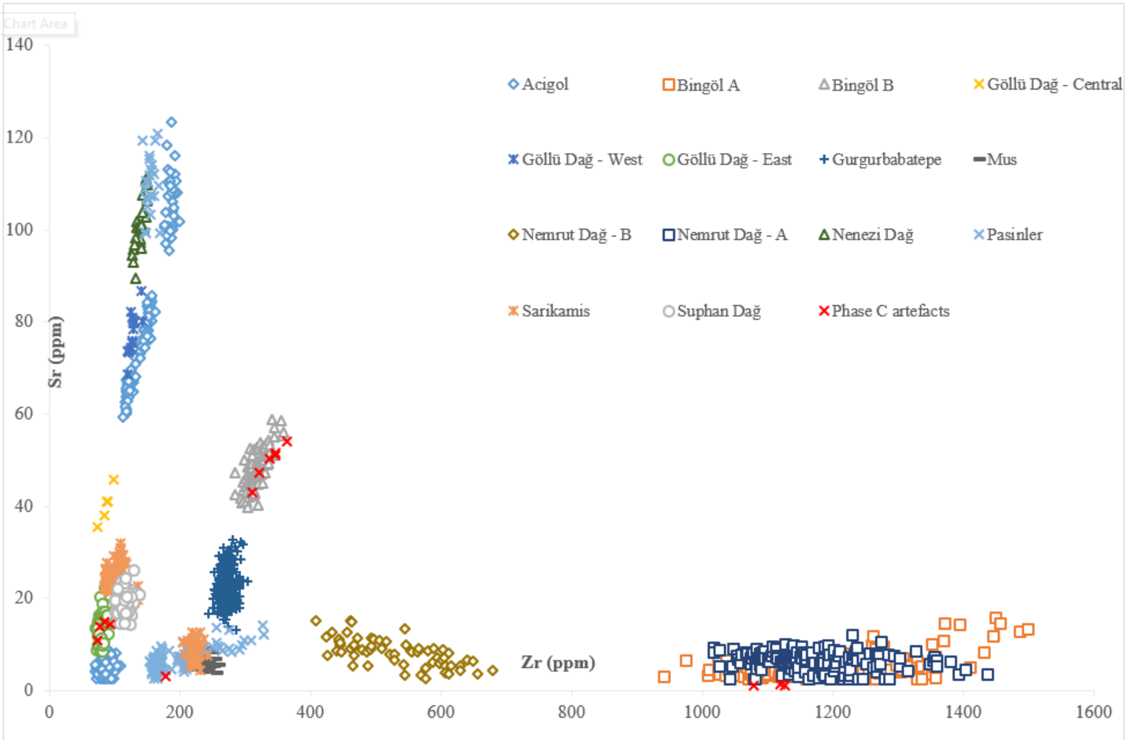


Figure 6.3.2: Close up of Figure 6.3.2 East Göllü Dağ.

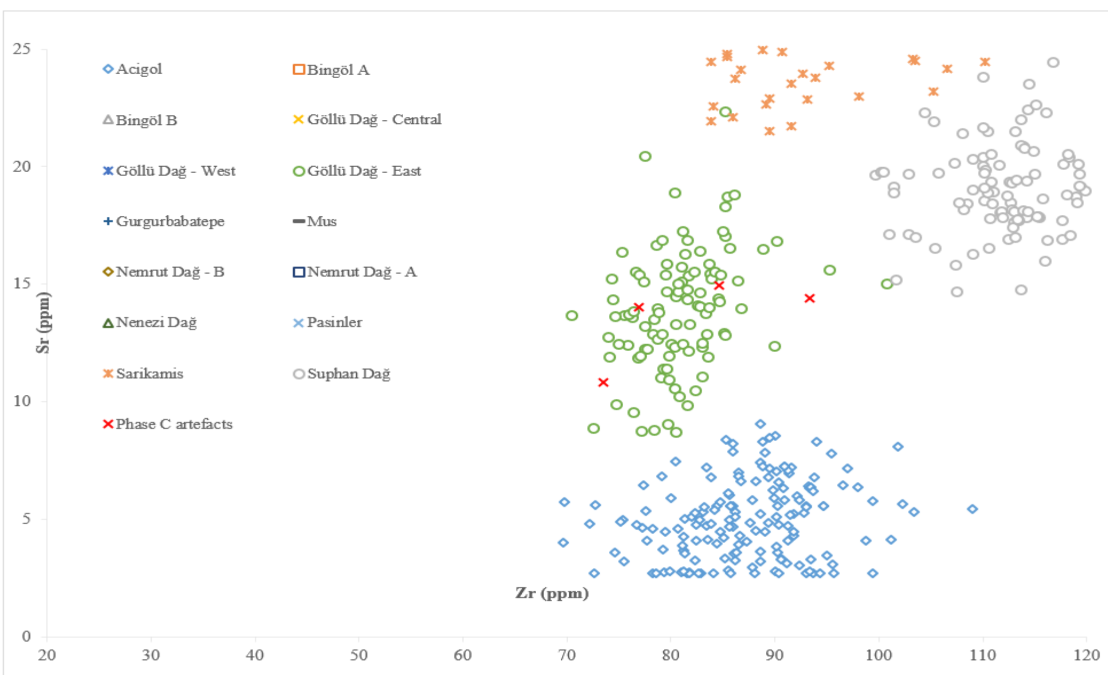


Figure 6.3.3: Amuq artefacts recovered from Phase D at Tell Kurdu.

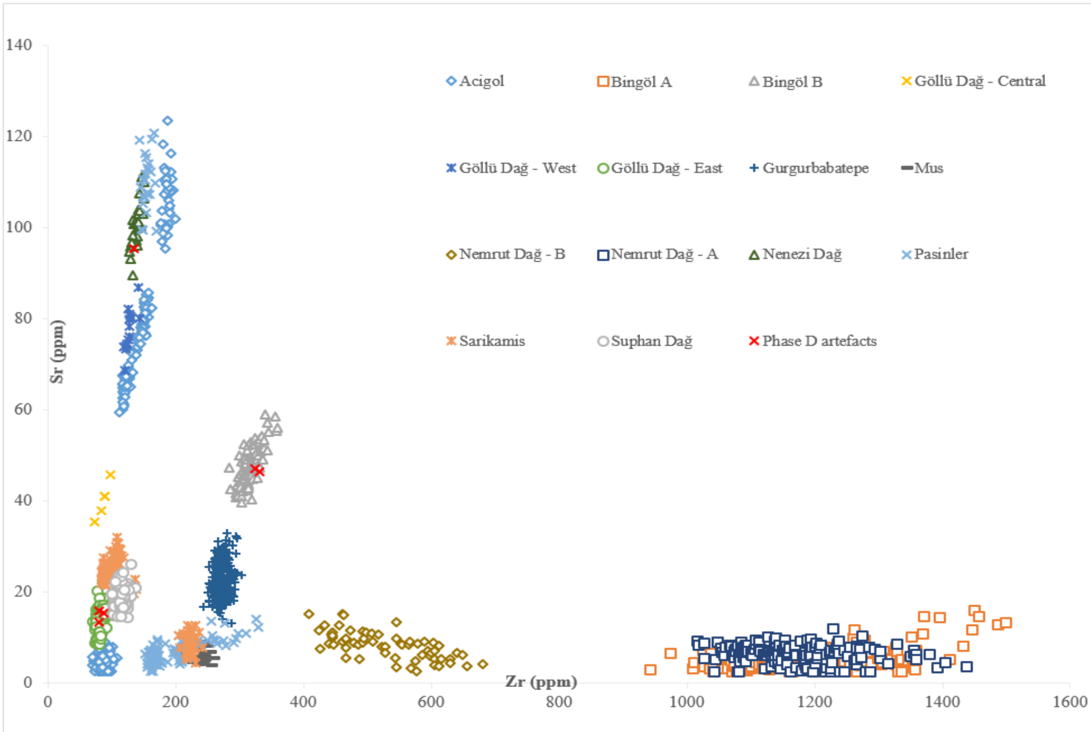


Figure 6.3.4: Close up of Figure 6.3.3 for East Göllü Dağ.

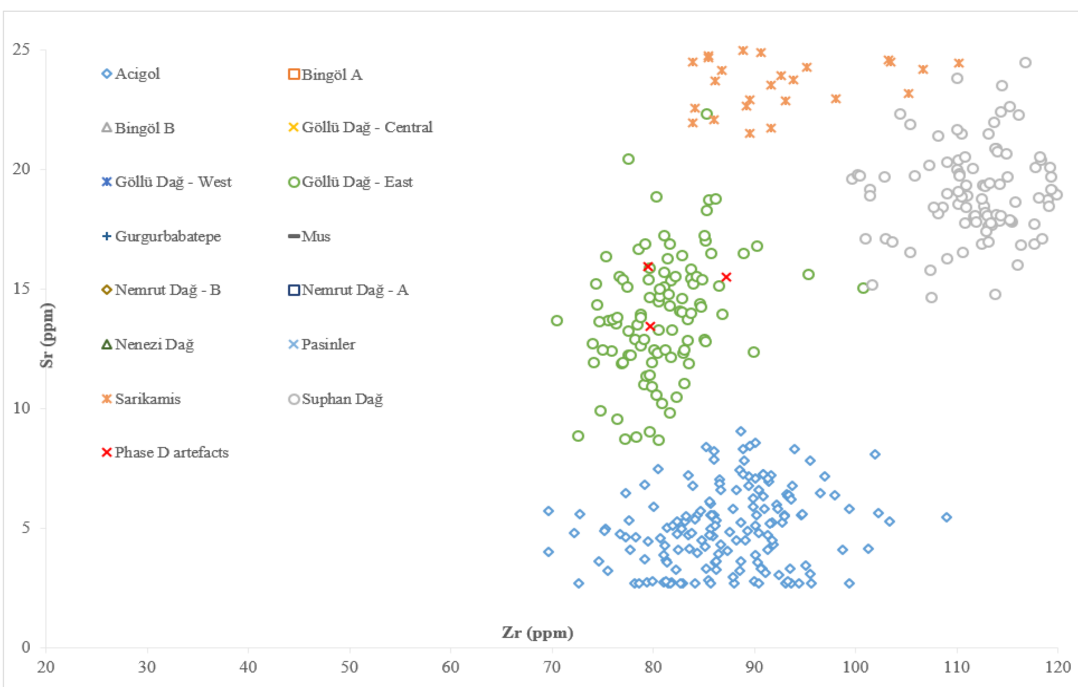


Figure 6.3.5: Close up of Figure 6.3.3 for Nenezi Dağ.

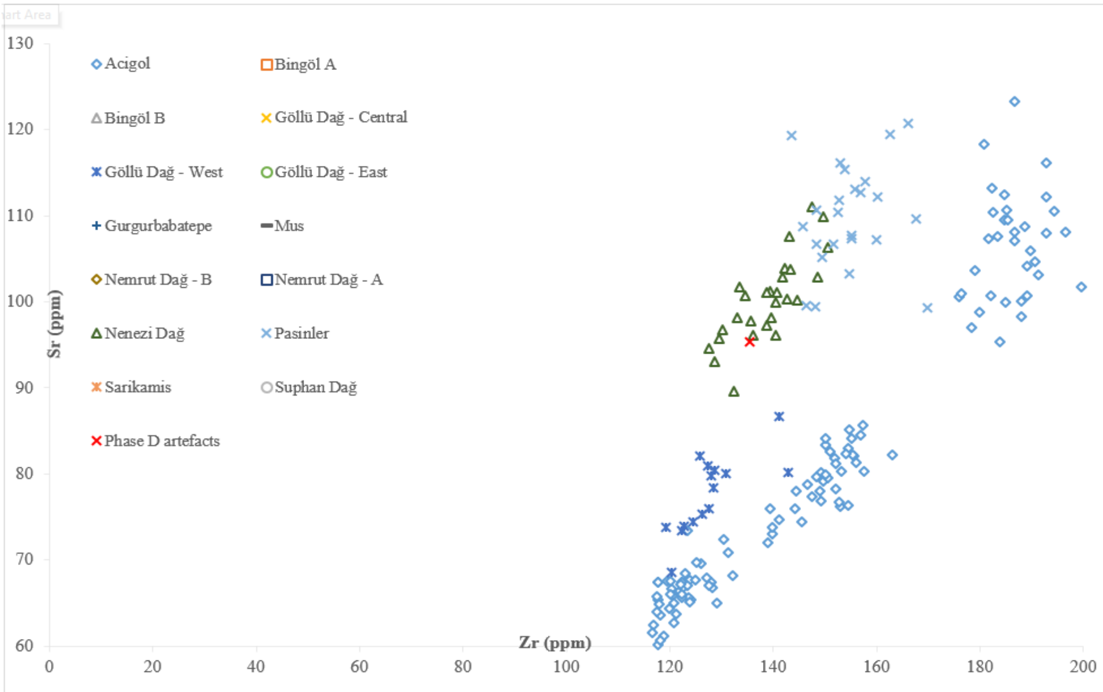


Figure 6.3.6: Amuq artefacts recovered from Phase E at Tell Kurdu.

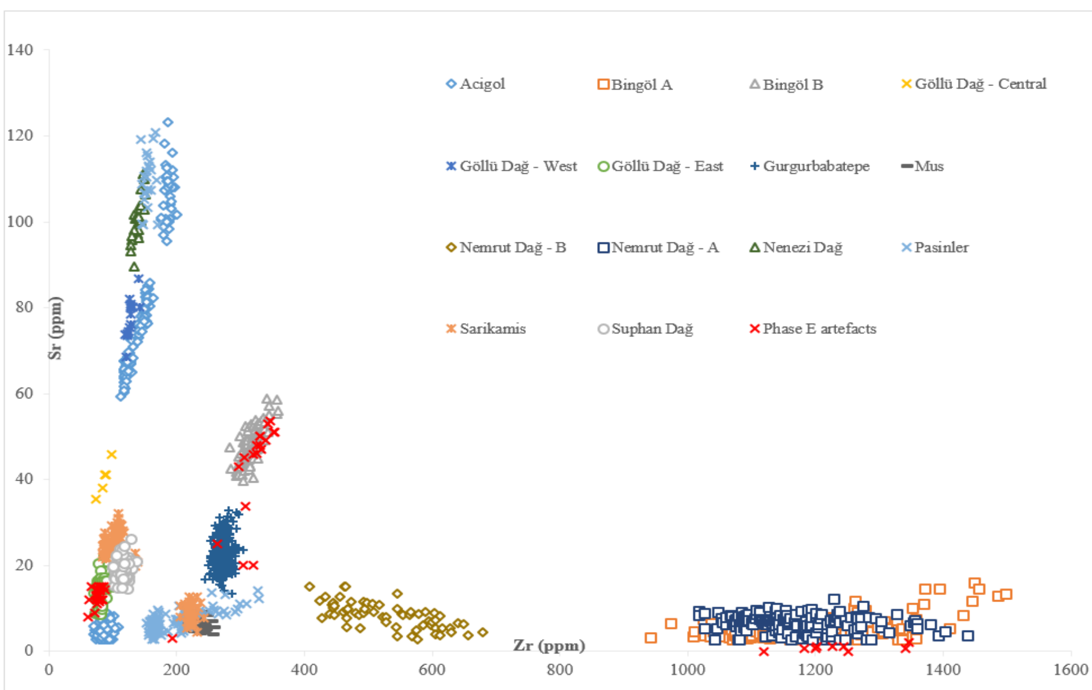


Figure 6.3.7: Close up Figure 6.3.6 for East Göllü Dağ.

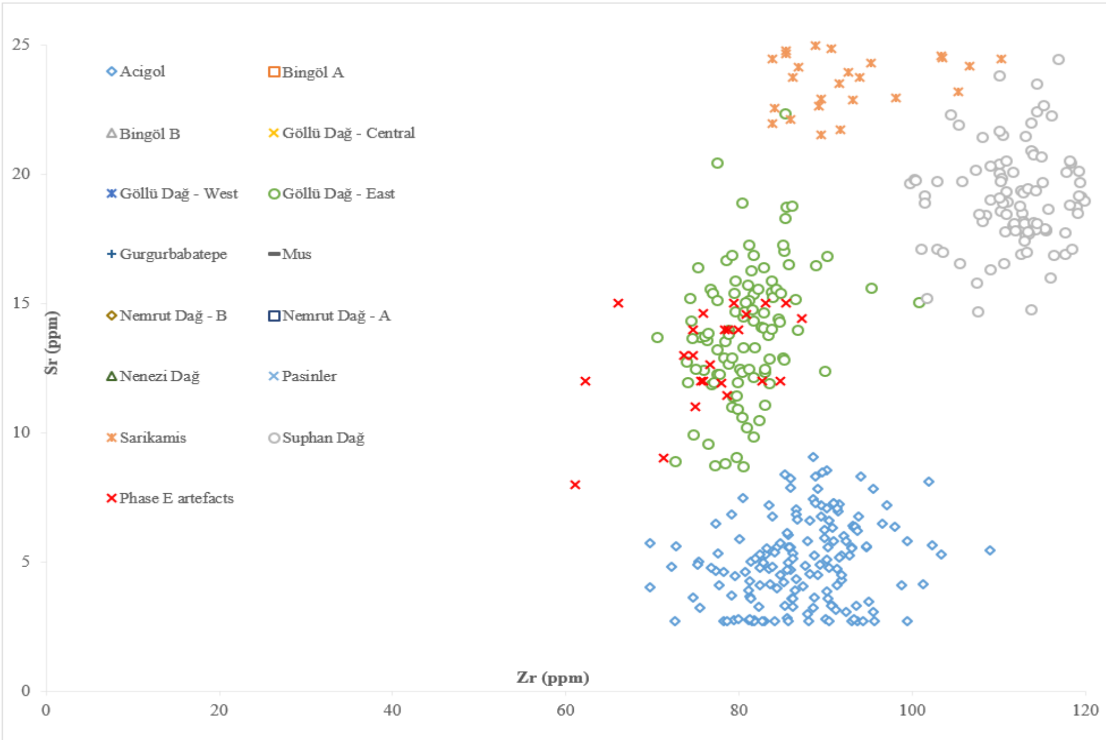


Figure 6.3.8: Close up of Figure 6.3.6 for peralkalines.

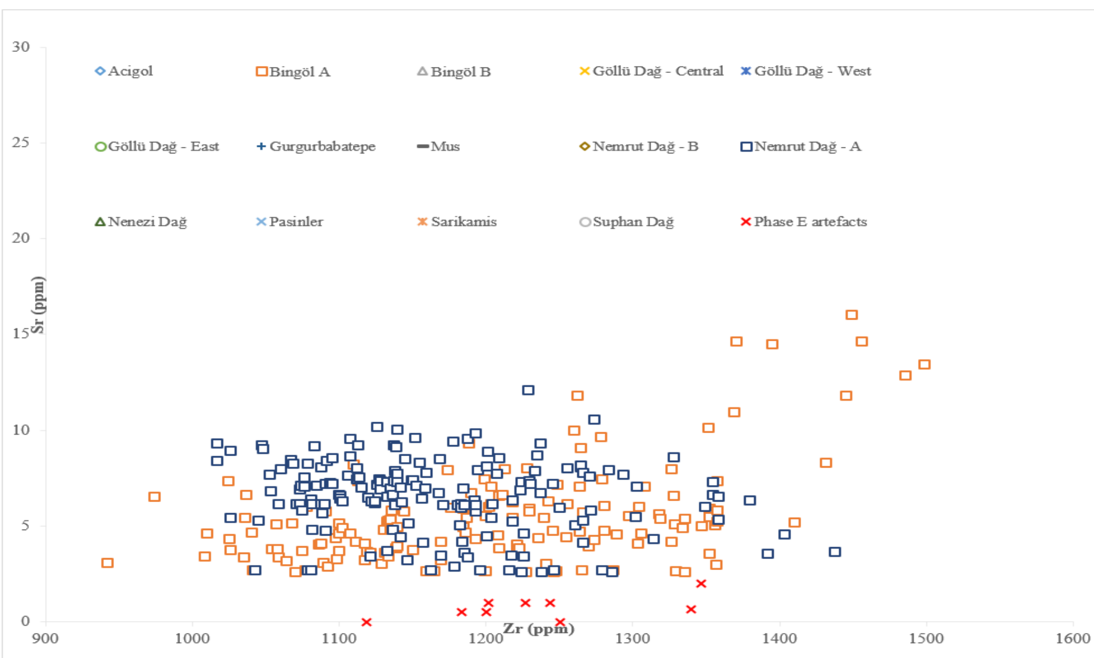


Figure 6.3.9: Close up of Figure 6.3.6 for Meydan Dağ and Bingöl B.

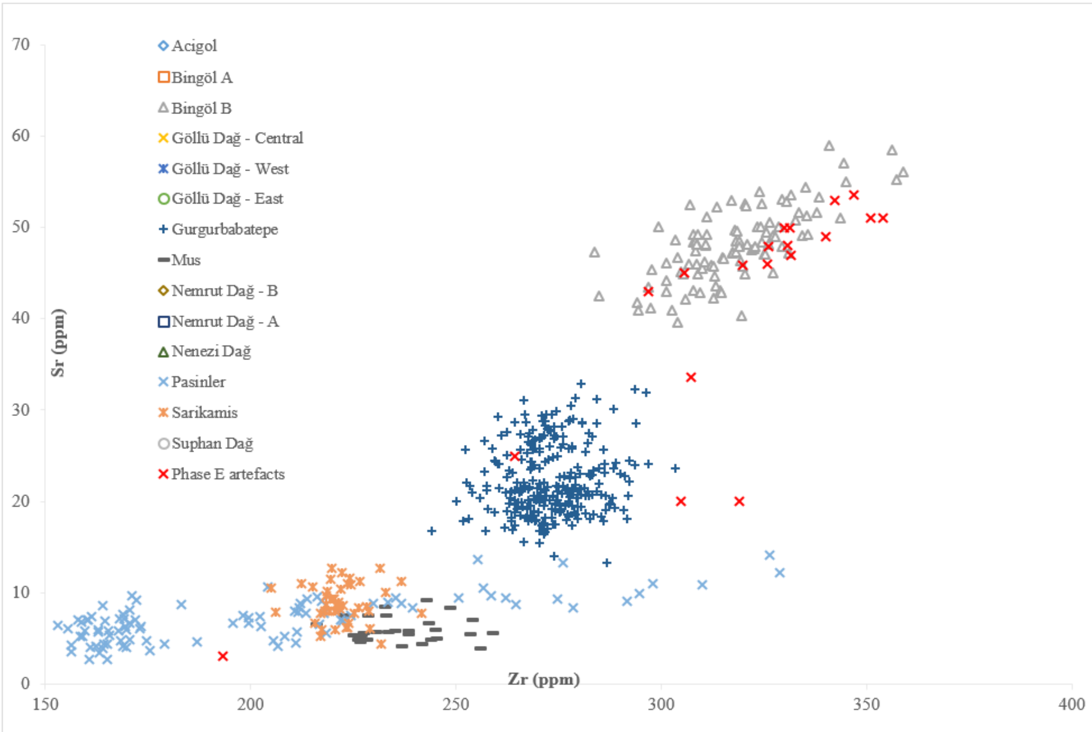


Figure 6.3.10: Close up of Figure 6.3.6 for Pasinler (Low Sr).

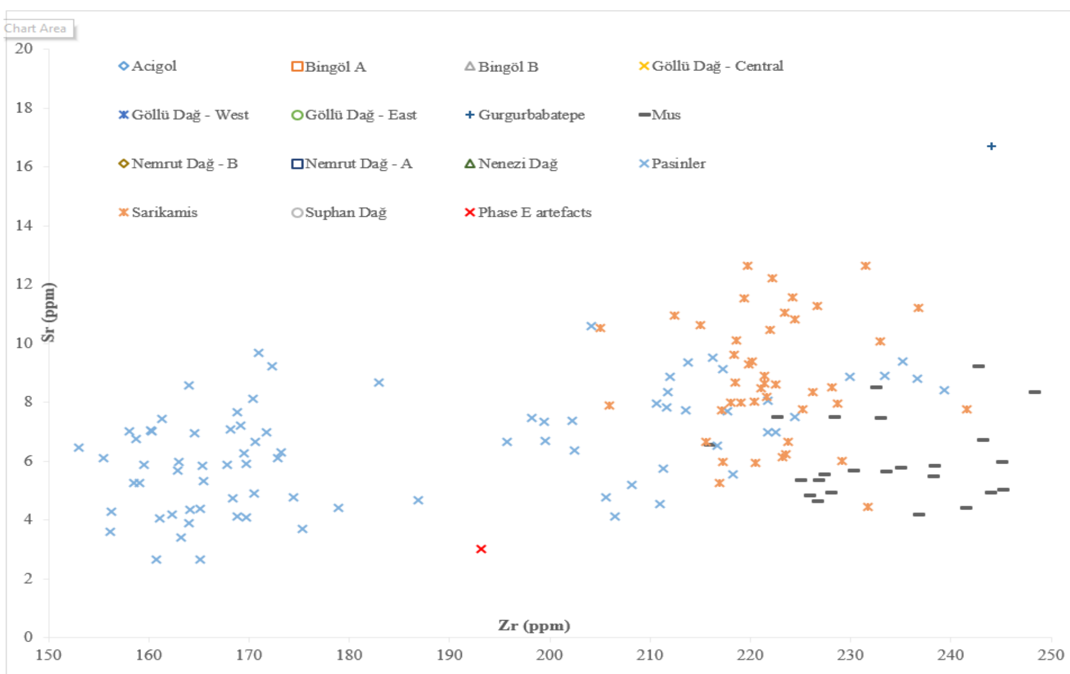


Figure 6.3.11: Line graph sourcing A59537 to a source following average elemental ppm values of the East Göllü Dağ and Acigöl West source databases.

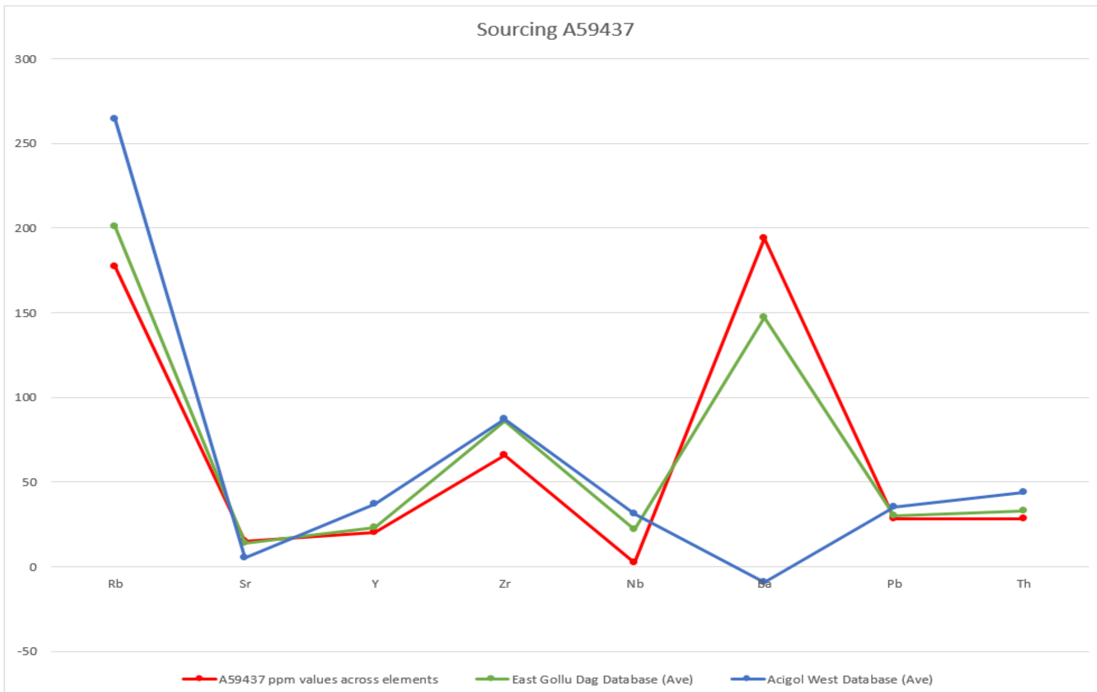


Figure 6.3.12: Line graph sourcing A59365 to a source following average elemental ppm values of the East Göllü Dağ and Acigöl West source databases.

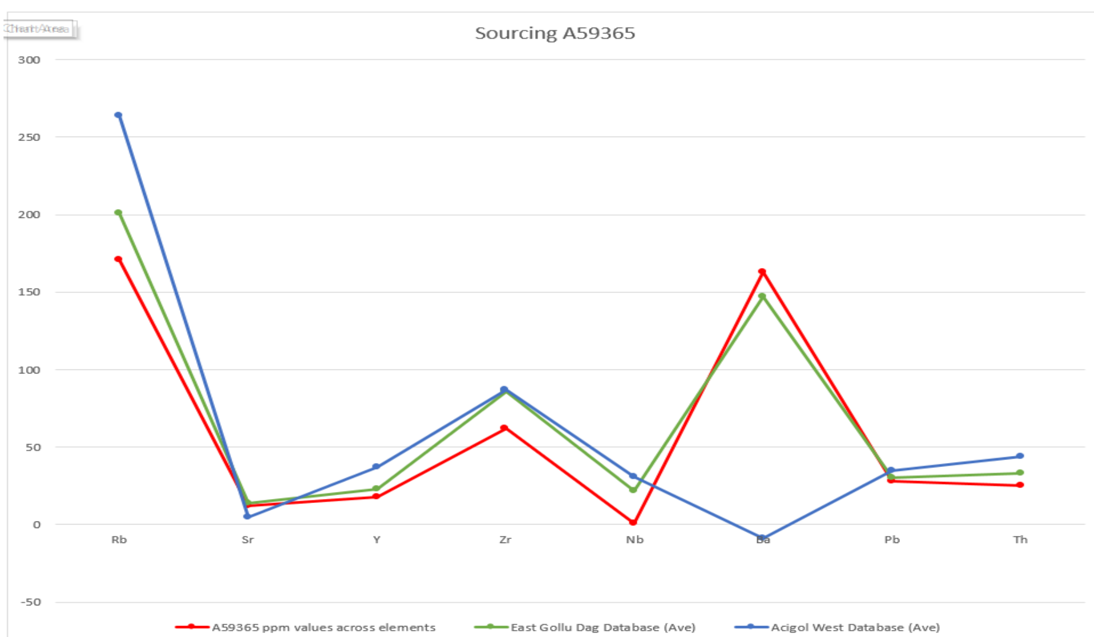


Figure 6.3.13: Line graph sourcing A59496 to a source following average elemental ppm values of the East Göllü Dağ and Acigöl West source databases.

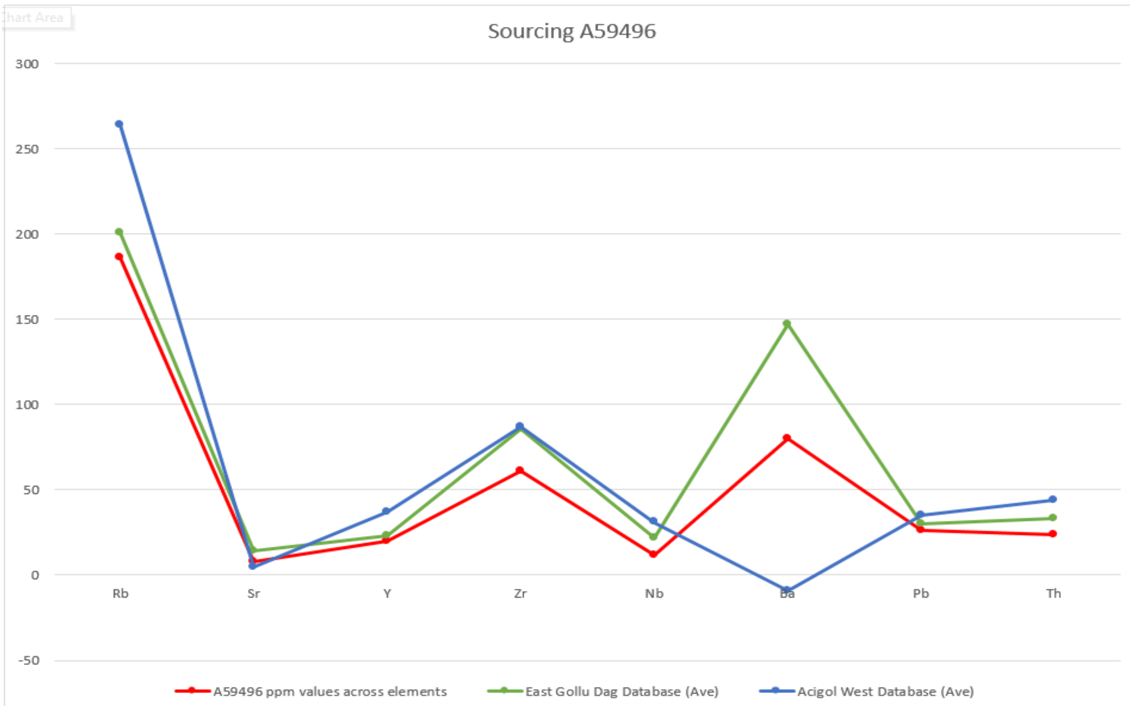


Table 6.3.2: Elemental ppm values for artefacts A59437, A59365, and A59496 for comparison against average ppm values for East Göllü Dağ and Acigöl West source databases.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
A59437 ppm values across elements	177	15	20	66	2	194	28	28
A59365 ppm values across elements	171	12	18	62	1	163	28	25
A59496 ppm values across elements	186	8	20	61	12	80	26	24
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44

Table 6.3.3: Elemental ppm values for A59463 for comparison against average ppm values for Pasinler (N or S), Sarıkamış and Mus source databases.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
Pasinler N/S database (Av)	175	7	33	201	25	16	26	47
Sarıkamış database (Av)	136	11	32	148	22	398	28	26
Mus database (Av)	193	6	63	237	75	-13	52	29
A59463	207	3	38	193	5	0	35	50

Figure 6.3.14: Line graph sourcing A59463 to a source following average elemental ppm values of the Pasinler (low Sr), Sarıkamış and Mus source databases.

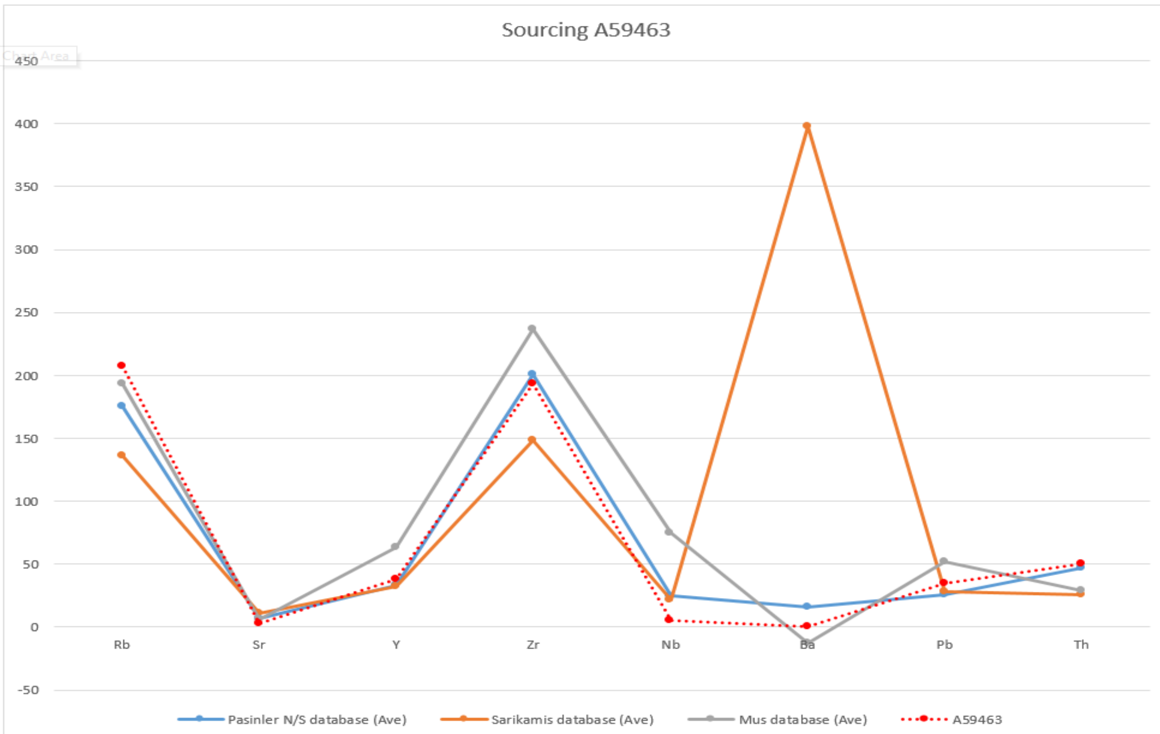


Figure 6.3.15: Zr vs Y plot from Khalidi et al. 2009, used for distinguishing Meydan Dağ and Bingöl B.

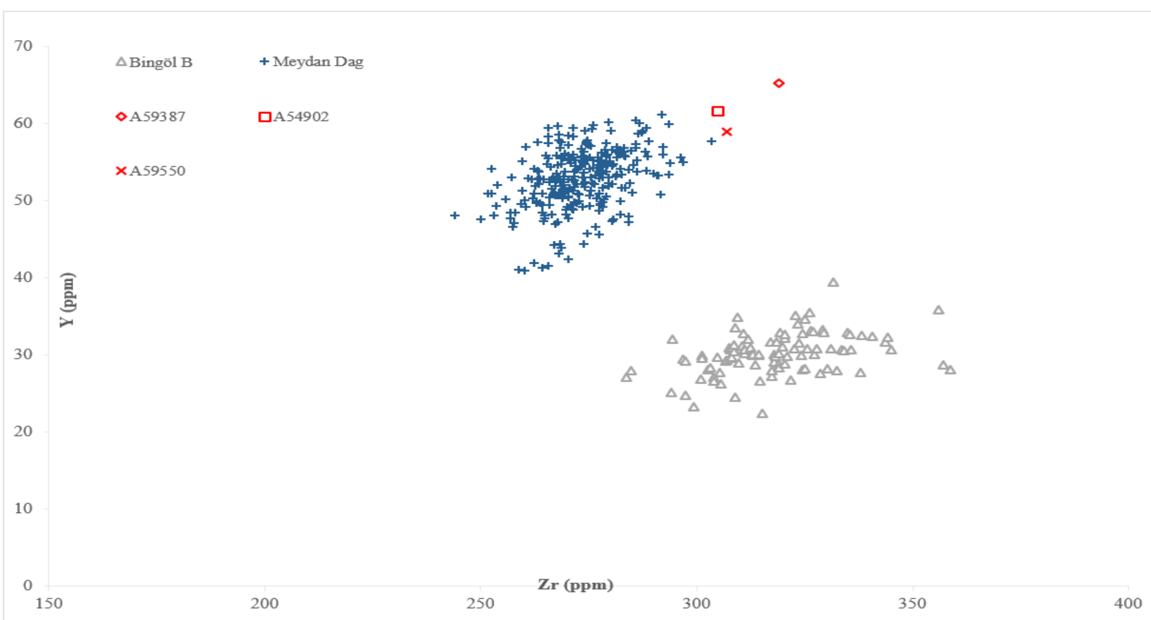


Figure 6.3.16: Ba vs Zr plot from Khalidi et al. 2009, used for distinguishing Meydan Dağ and Bingöl B.

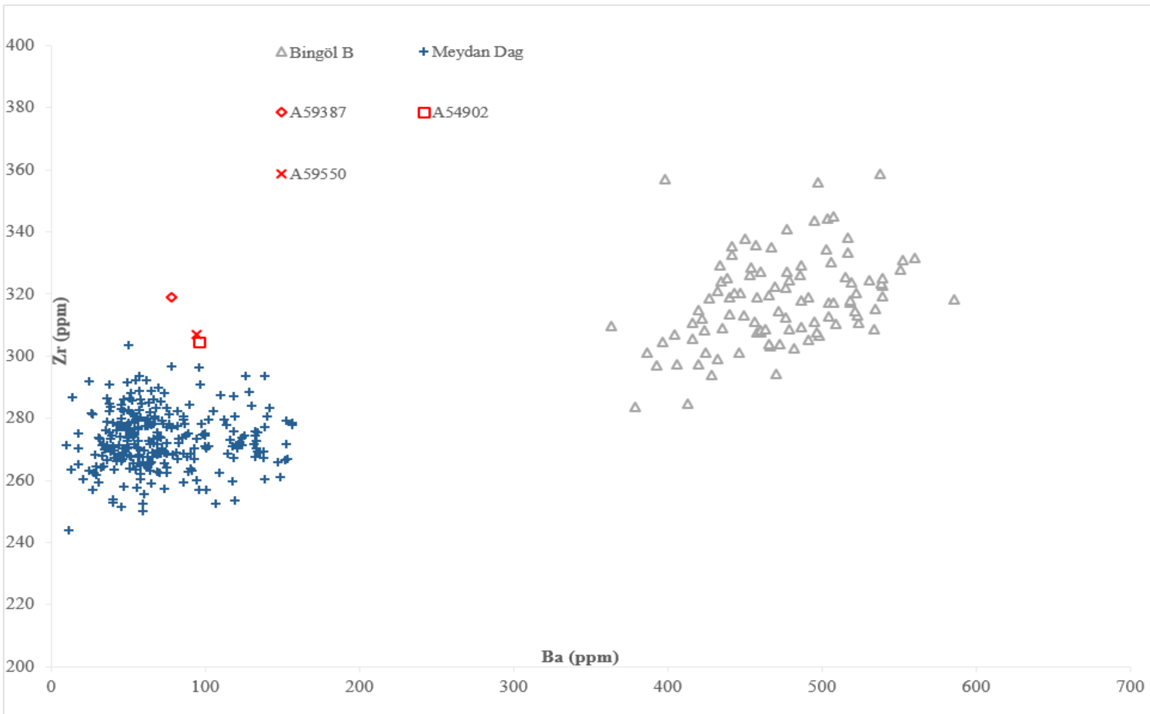


Figure 6.3.17: Rb vs Sr plot for distinguishing Meydan Dağ and Bingöl B.

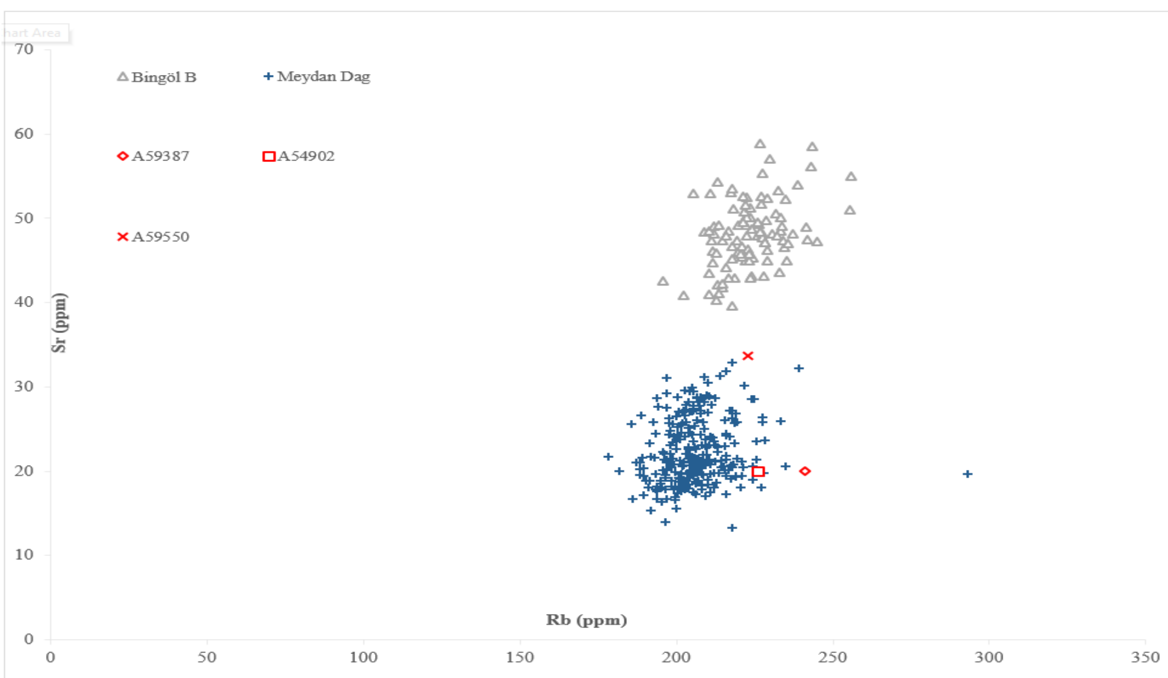


Figure 6.3.18: Rb vs Sr/Zr plot for distinguishing Meydan Dağ and Bingöl B.

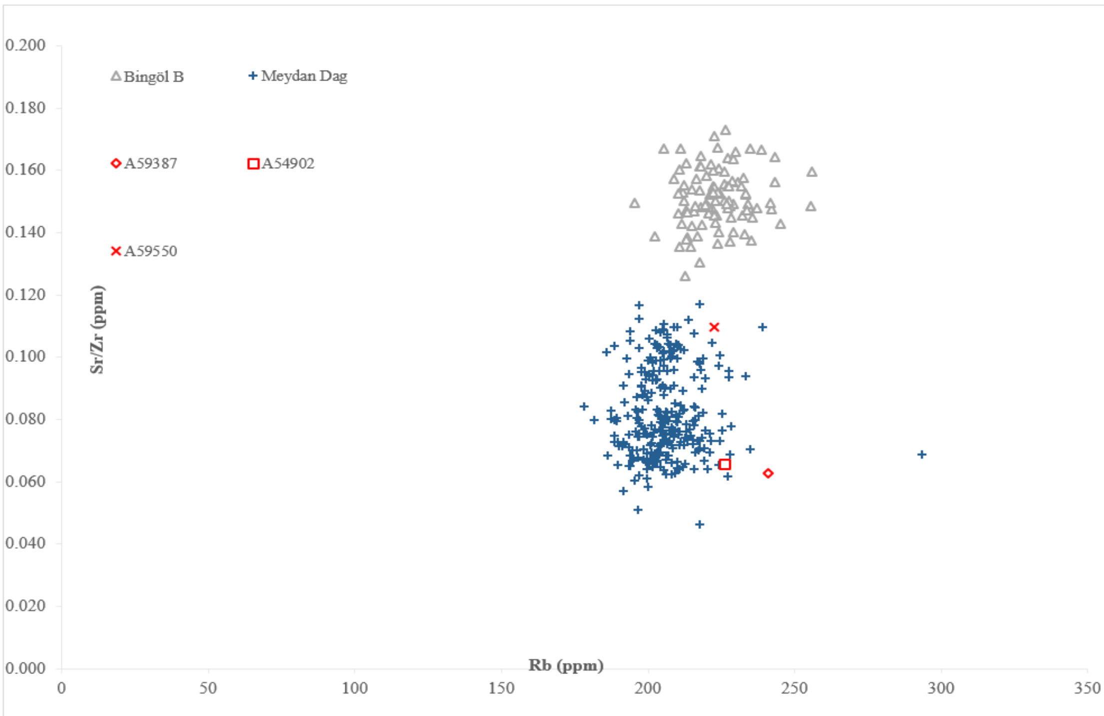


Figure 6.4.0: Distribution of obsidian artefacts from Tell Dhahab.

Figure 6.4.1: Close up of Figure 6.4.0 of artefacts from Tell Dhahab.

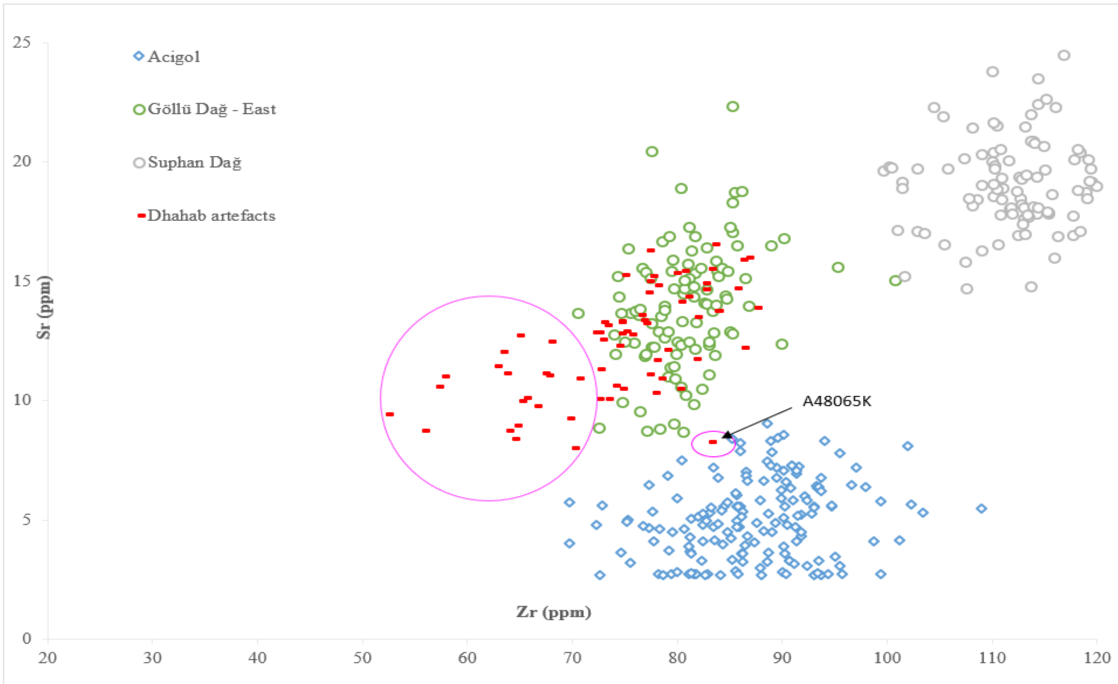


Figure 6.4.2: Line graph sourcing artefact outliers seen in Figure 6.4.1

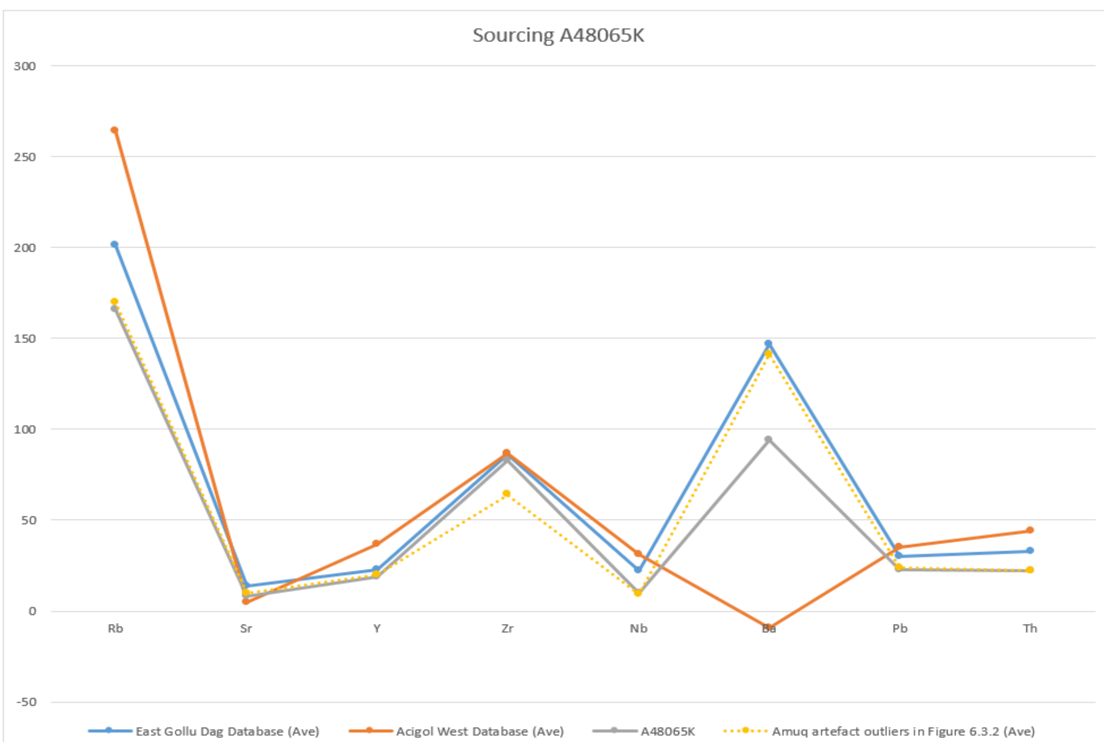


Table: 6.4.1: Elemental ppm values used for Figure 6.4.2.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
East Göllü Dağ Database (Av)	201	14	23	86	22	147	30	33
Acigöl West Database (Av)	264	5	37	87	31	-9	35	44
A48065K	166	8	19	83	10	94	23	22
Amuq artefact outliers in Figure 6.4.2 (Av)	170	10	20	64	9	141	24	22

Figure 6.4.3: Close up of Figure 6.4.0 of artefacts from Tell Dhahab.

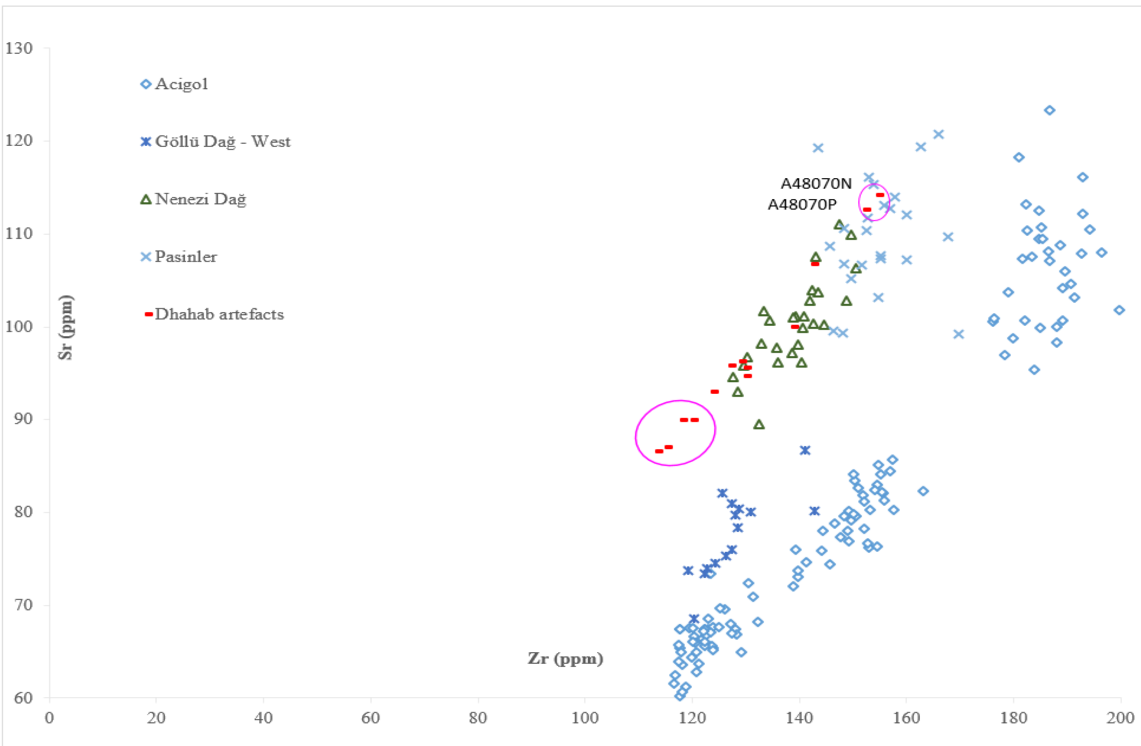


Figure 6.4.4: Line graph sourcing two artefact outliers seen in Figure 6.4.3.

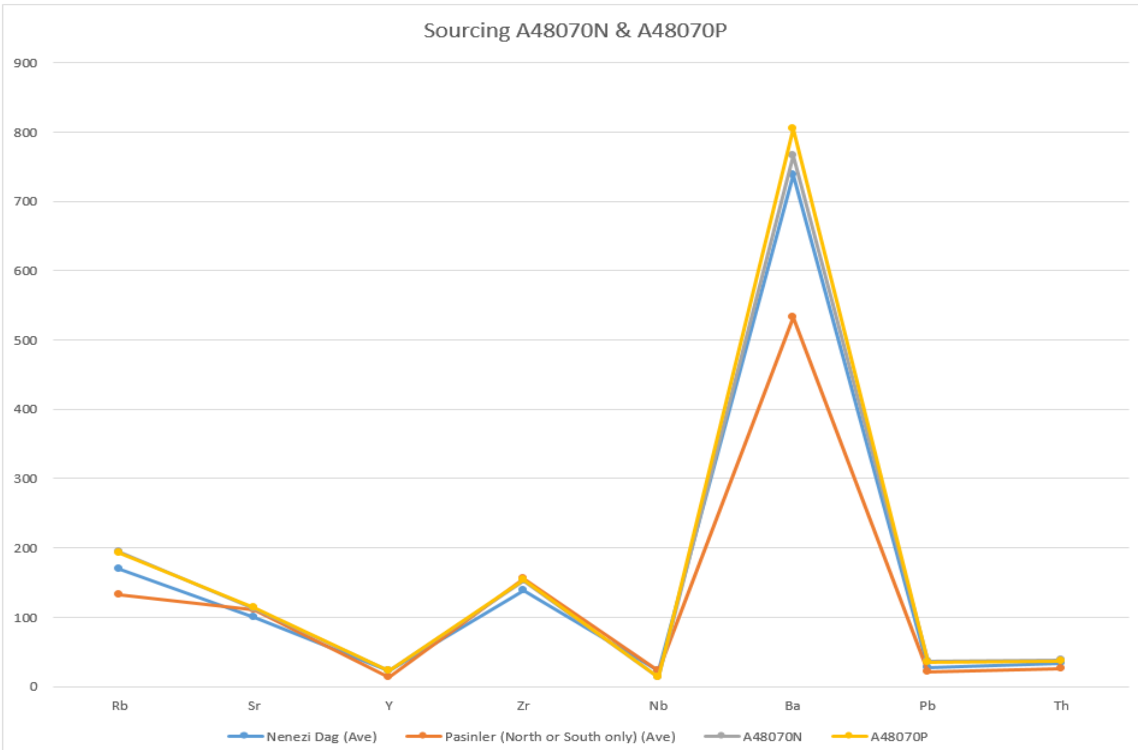


Table 6.4.2: Elemental ppm values used for Figure 6.4.4.

Elements	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
Nenezi Dağ (Av)	169	100	23	139	22	738	28	33
Pasinler (North or South only) (Av)	133	110	13	155	22	533	21	26
A48070N	194	113	22	152	13	766	37	38
A48070P	192	114	22	154	14	804	35	36

Figure 6.4.5: Close up of Figure 6.4.0 of artefacts from Tell Dhahab.

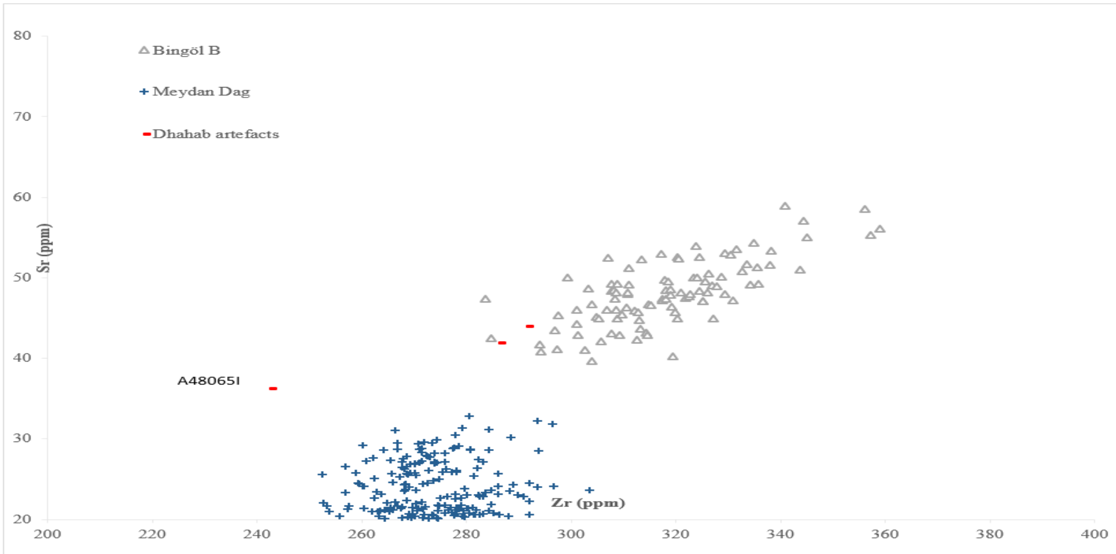


Figure 6.4.6: Zr vs Y plot from Khalidi et al. 2009, used for distinguishing Meydan Dağ and Bingöl B for A48065I.

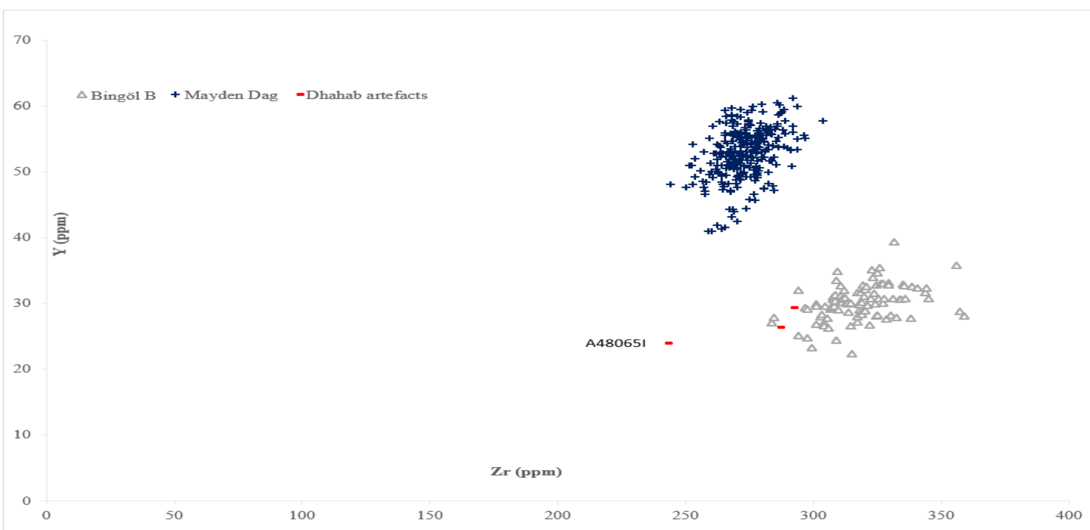


Figure 6.4.7: Ba vs Zr plot from Khalidi et al. 2009, used for distinguishing Meydan Dağ and Bingöl B for A48065I.

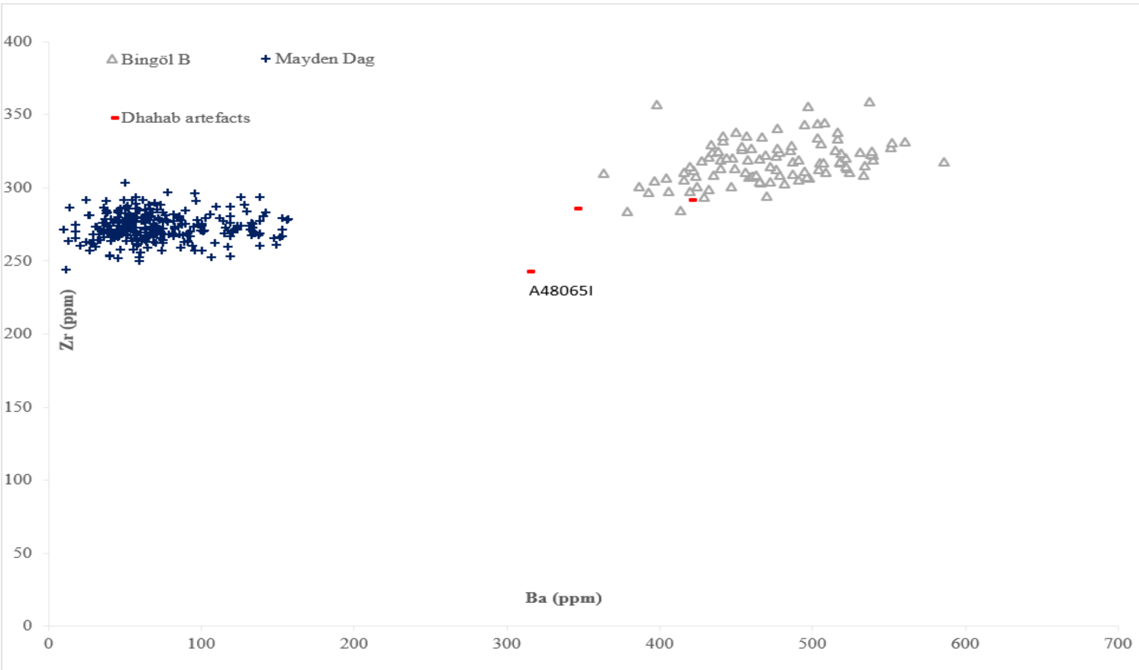
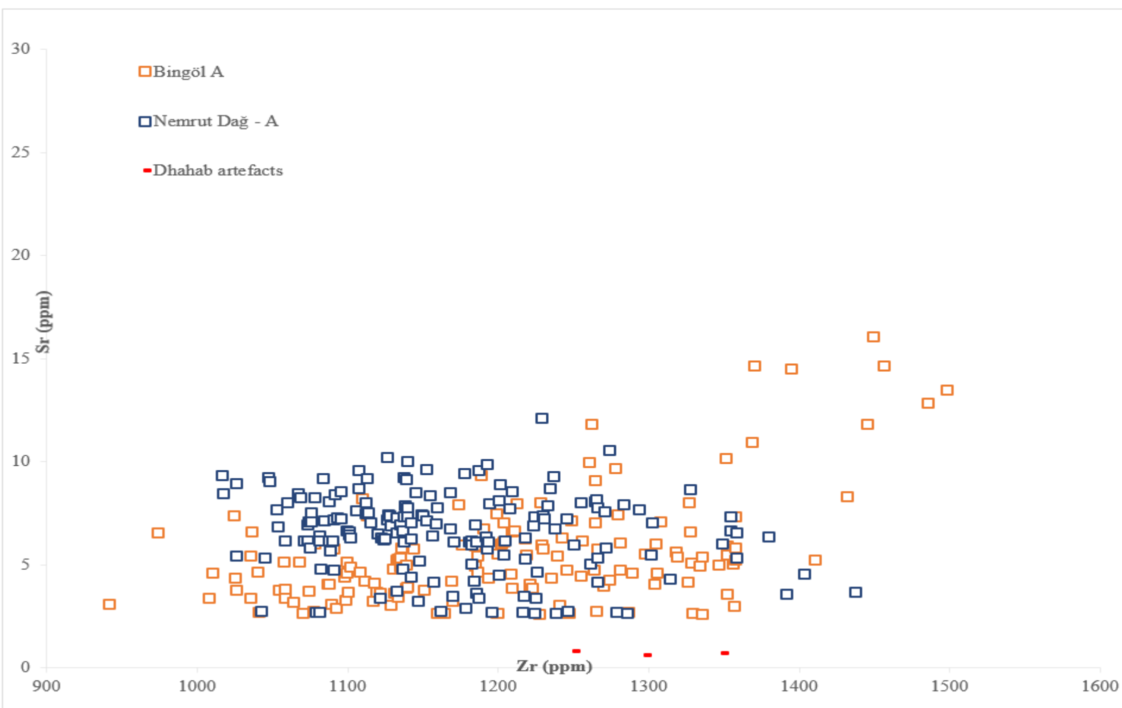


Figure 6.4.8: Close up of Figure 6.4.0 for peralkalines.



6.8 Chapter 6 Plates

Plate 6.1.1: East Göllü Dağ specimens from the sample collection.

Plate 6.1.2: East Göllü Dağ specimens from the sample collection, backlit.

Plate 6.1.3: West Göllü Dağ specimen from the sample collection.

Plate 6.1.4: West Göllü Dağ specimen from the sample collection, backlit.

Plate 6.1.5: Acigöl Post-Caldera East specimens from the sample collection.

Plate 6.1.6: Acigöl Post-Caldera East specimens from the sample collection, backlit.

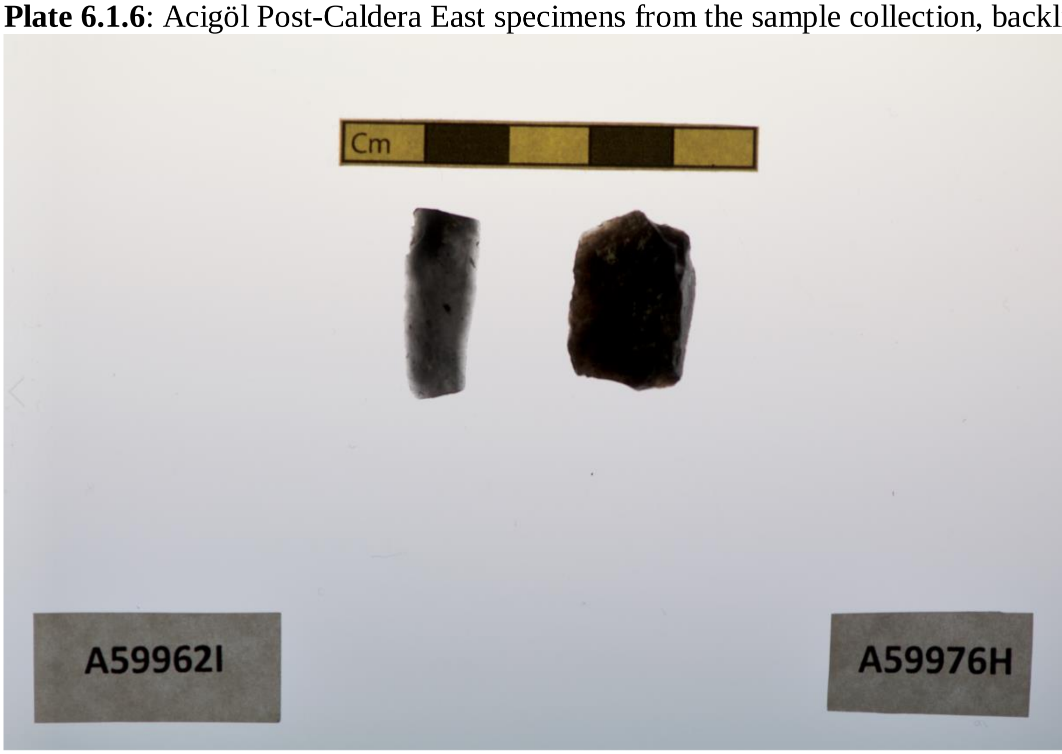


Plate 6.1.7: Nenezi Dağ specimens from the sample collection.

Plate 6.1.8: Nenezi Dağ specimens from the sample collection, backlit.

Plate 6.1.9: Peralkaline specimens from the sample collection.

Plate 6.1.10: Peralkaline specimens from the sample collection, backlit.

Plate 6.1.11: Bingöl B specimens from the sample collection.

Plate 6.1.12: Bingöl B specimens from the sample collection, backlit.

Plate 6.1.13: Meydan Dağ specimen from the sample collection.

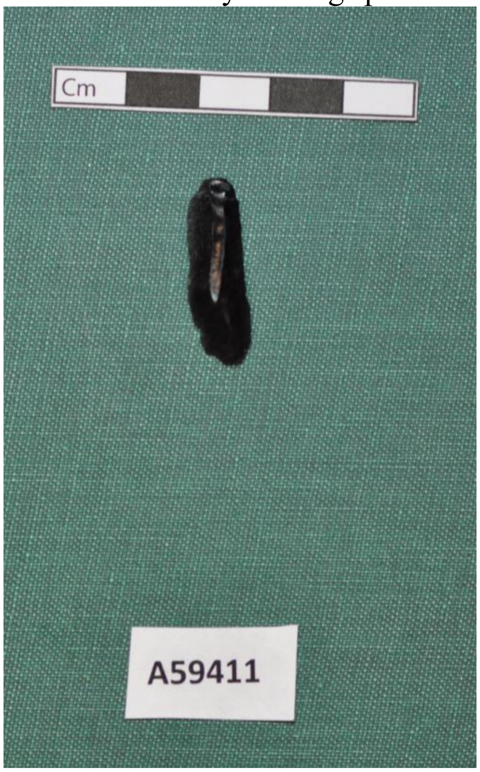


Plate 6.1.14: Meydan Dağ specimen from the sample collection, backlit.

Plate 6.1.15: Meydan Dağ-like specimens from the sample collection.

Plate 6.1.16: Meydan Dağ-like specimens from the sample collection, backlit.

Plate 6.1.17: Sarıkamış specimen from the sample collection.

Plate 6.1.18: Sarıkamış specimen from the sample collection, backlit.

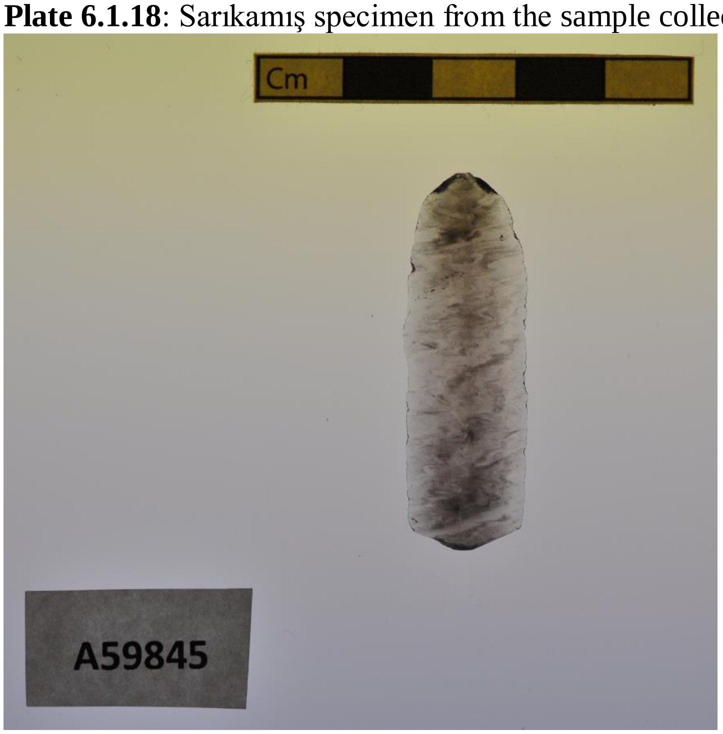


Plate 6.1.19: Pasinler specimens from the sample collection.

Plate 6.1.20: Pasinler specimens from the sample collection, backlit.

Chapter 7: Tool Typology and Technology

7.0 Introduction

This chapter details a techno-typological study of the Amuq Valley obsidian assemblage. Such an analysis contributes greatly to the interpretation of the source study presented in the previous chapter, as it produces a far more complete picture of obsidian consumption practices through deep-time. Lithic specialists now appreciate the importance of techno-typological characterization alongside source characterization as it can provide a more detailed reconstruction of socio-economic traditions through time and space (Carter et al. 2013a:563). In sum, techno-typology studies offer the archaeologist relevant information on *how* (in what form) the raw obsidian was procured and circulated with respect to individual source type. This leads to reproducing consumption practices for individual settlements or regions like the Amuq Valley which allow archaeologists to argue for the existence of socio-economic connections between communities (Carter et al. 2017:308).

As indicated above, the primary objective for techno-typological studies is to initially detail what kinds of knapping traditions are represented in the assemblage (e.g. percussion flakes from multidirectional cores, pressure bladelets from unipolar nuclei etc.) and the types of tools being made upon these blanks (e.g. end-scraper on flake, denticulate on blade etc.). When this information is integrated with the chemical sourcing data, it is possible to say what kinds of artefacts were being made from a particular raw material, and as to whether such implements were being made locally (as evidenced by diagnostic, associated manufacturing debris), or were procured ready-made. As such it might be possible to elucidate particular traditions (raw material :: knapping technique :: tool type correlations). This information leads to an understanding of material acquisition to a site, what form was the obsidian in upon arrival (raw material, prepared cores, prepared blanks, or finished products to name a few) (Carter et al. 2006:895). Ultimately one should aim to map these traditions across space and time in order to investigate close relations between communities via common traditions (Carter et al. 2013a). To complete this procedure, I have turned to Dr. Carter for his expertise in lithic analysis for assistance with documentation and interpretation.

Ideally, a techno-typological study would also entail the site context from whence assemblages were recovered to see if there were further patterns in consumption (e.g. only non-locally produced skilled opposed platform blades fashioned into projectiles made of raw material X were found in burials). Unfortunately, for the Amuq Valley obsidian collection, lithic artefacts during the time of their excavation in the early 20th century, were not retrieved with this level of documentation. This means that the entire collection studied for this thesis has no intra-site contextual information. There is some evidence from Tell Kurdu for spatial differences in the distribution of obsidian colour (Özbal et al. 2004), however, these details cannot be applied to the artefacts of the sample collection concerning this project.

Together, interpretations on material acquisition, source preference and production context, allow archaeologists to make inferences on the nature of obsidian exchange relations to a particular site. In other words, one can investigate a particular site's level of participation or contribution to the Near Eastern obsidian trade network as a whole. In certain cases, this leads to discussions of political relations, economic strategies, and/or individual persons responsible (trading posts, merchants, nomadic travellers, etc.). This level of insight, however, is not always achievable depending on previous archaeological knowledge of the regional trade relations for that focus area. For this study, my interests lie with the more general inquiry of the supra-regional socio-economic relationships of the Amuq Valley with neighbouring communities to understand in what way the Amuq Valley was a part of the greater obsidian network of the Near East.

All sites and obsidian sources mentioned in this chapter can be referred to in **Figure 7.1**.

7.1 Obsidian technologies in the Neolithic Near East

In the Near East since the PPNB, there have been a number of lithic technologies (Kozlowski & Aurench 2005), two of which were used in tandem in the Amuq Valley. The more dominant of these modes is the PPNB pressure flaking technique producing shorter, narrower, finer and more standardised blades and bladelets. While the lack of cortical debris and distinctive core initiation pieces from settlements suggest that the initial stages of this tradition were performed at the sources, there are a number of sites with evidence for the procurement of preformed/part reduced pressure blade cores, and their subsequent on-site reduction either by locals and/or itinerant specialists. Once prepared cores are imported to communities, sequential blade removal can be performed on-site by specialists or locals (see examples below). Such obsidian consumption patterns are seen across the Near East throughout the PPNB to Neolithic periods with varying degrees of on-site completion and core exhaustion depending on distance from obsidian source regions.

For example, at Early-Late Neolithic (ca. 6500-6000 BCE) Çatalhöyük in the Konya Plain, there is good evidence for the on-site production of pressure blades from Cappadocian obsidians, the process commencing with preformed and/or part-worked cores (Carter and Milić 2013:497-498); there is also evidence for the community's access to occasional end-products made of more distant eastern (peralkaline) obsidians (Carter et al. 2008:903-904). The same patterns are found across the Levant during the Late Neolithic in the north at Tell el-Kerkh 2 in the Rouj Basin (ca. 6000 BCE) (Maeda 2003:176-177), and in the south at Sha'ar Hagolan (6400-6000 BCE) (Carter et al. 2017:308). Meanwhile, in North East Syria, Tell Kashkashok II (Late Neolithic) (Nishiaki 2000) situated between the Euphrates and Tigris rivers, as well as Qdeir 1 (7100-5720 cal BCE) (Orange et al. 2019) in the Middle-Euphrates, were primarily receiving Lake Van obsidian as prepared cores.

The second, less frequent tradition comprised the manufacture of relatively long blades using a percussive knapping technique from cores prepared with two opposing striking platforms (cf. Barzilai 2006:29). This skilled 'opposed platform' or 'bidirectional' technology resulted in the production of relatively long and thick blades, with those having a trapezoidal cross section being the preferred blanks for projectile (spearhead) manufacture, not least the Amuq and Byblos variants (cf. Barzilai 2010:6; Gopher 1994). In many instances we see the end-products of this technology being procured by communities ready-made, as for example at the Late Neolithic (7000-6200 BCE) sites of Yumuktepe in Cilicia (Altinbilek-Algül 2011:15-19), and Tell el Kerkh 2 in the Rouj Basin

(Maeda 2003:176-177). At larger sites however, such as Çatalhöyük in Central Anatolia during the PPNB to Late Neolithic (7400-6200 BCE) (Carter et al. 2006:905-906; Carter and Milić 2013:497-498) these bipolar products are often imported as preforms for on-site completion. It is not inconceivable that the manufacture of these opposed platform blades occurred at seasonal, specialist quarry-based workshops; the existence of such an *atelier* is well-detailed at Kaletepe-Kömürcü at Göllü Dağ dating to the early PPNB (Binder and Balkan-Atlı 2001).

All of this is to say that by the end of the sixth millennium, certain people of the surrounding areas to the Amuq Valley were heavily involved with the obsidian trade network and that this system not only directed the distribution of material types, but also played an important role for how production technologies were distributed. As soon as occupation began at the start of the sixth millennium (Phase A), the Amuq Valley, as it appears with Tell al-Judaidah, was immediately incorporated into the obsidian trade network, receiving materials from Cappadocia and Lake Van. Furthermore, the arrival of these materials were in similar production form to supra-regional neighbours in the Rouj Basin and Domuztepe. From this point forward, and under the intentions of this research project, the Amuq Valley will lead us to a firmer understanding of the socio-economic role of Northern Levant with concern to the connectivity of the obsidian trade network across the Near East.

7.2 Technologies in the Amuq Valley

7.2.1 Pressure flaked blade technology

The pressure flaked blade tradition is the most common technology in the Amuq Valley. Analysing the presence and quantity of the different blanks of the reduction sequence within each assemblage will indicate the stage of production performed at any given location.

The reduction method for this technology is to remove series of blades from a single platform concentrically around a core (Nishiaki 2000). This commences with outer flakes removing most or possibly all of the cortex, followed by crested blades which create a false ridge directing the fracture wave of secondary series blades down a preferential path. Once the core is reduced in this manner, it is ready for secondary blade removal. It is during this stage that end products are created, including prismatic blades or blades, which can later be modified into other tool types such as scrapers and burins.

In the following sub-sections, I have described all the categories of blades, flakes, and cores represented in the Amuq Valley obsidian collection. Not all stages of the production sequence is represented in this collection, therefore, not all blade and flake types in a complete production series will be discussed. For all categories, however, it will include details of material types, temporal context and additional features or most pertinent remarks. For a compiled view of recorded observations on technology type for all artefacts in the sample collection, please refer to **Table 7.2.0.** (Please note that the complete record of techno-typology of the sample collection has been excluded from **Table 7.2.0** and only data specifically referenced in this thesis is presented.)

7.2.1.i Cores

There are a total of seventeen artefacts recorded as pieces that can be described as a core **(Table 7.2.0)**. In 15 instances these can clearly be defined as pressure blade cores, the other two being of indeterminate technology due to their fragmentary and/or heavily reduced nature. One of the blade cores, A59982A, has 5% cortex. Cores appear throughout the Amuq Sequence, mostly from Tell al-Judaidah Phase A/B (n=3), Phase G (n=4), one from the Second Mixed Range, and two from unknown temporal context. Only one was retrieved from Tell Kurdu, Phase E while the remaining six cores belong to Tell Dhahab. Nearly half of these are made of East Göllü Dağ obsidian (n=8). The rest are made of Nenezi Dağ (n=5), Bingöl B (n=2) or Nemrut Dağ (n=1). All of these cores appear to have been exhausted before their discard, i.e. these artefacts reflect the final stages of blade production.

7.2.1.ii Secondary series blades

Secondary series blades make up the second largest grouping for typology of the pressure flaking technology with twenty-eight artefacts. Products of this type are removed consecutively to crested blades and are distinguishable by their dorsal ridges that show negative scaring previously removed products (Carter 2010:153). This category only considers blades with remnant cresting (n=18) and blades with remnant cortex (n=10). Secondary series blades were recovered throughout the Amuq Sequence at all sites. For Tell al-Judaidah, they were found in Phase A/B (n=4), First Mixed Range (n=1), Phase G (n=4) and one of unknown temporal context. At Tell Kurdu they were recovered from Phases C and E (n=1 and n=7 respectively). Finally, ten came from Tell Dhahab. Most of these artefacts were made of East Göllü Dağ obsidian (n=18), Nenezi Dağ (n=5), Nemrut

Dağ (n=3) and Bingöl B (n=2). The presence of such blanks at these sites *might* attest to most of the blade manufacturing sequence occurring on-site, though these blades represent good working tools in their own right, and could thus circulate as end-products.

7.2.1.iii Rejuvenation pieces

There are seventeen rejuvenation pieces in total. This group considers all pieces in the Amuq Valley sample collection which show evidence of rejuvenation for a flake, blade or core tablet. More specific details for area of rejuvenation (face or back) are included in **Table 7.2.0**. These pieces were recovered from Tell al-Judaidah in Phase A/B (n=4) and Phase G (n=7), Tell Kurdu, Phase C (n=1), Phase D (n=1) and Phase E (n=2), and Tell Dhahab (n=2). Most or all of the artefacts from respective phases are made of East Göllü Dağ obsidian (total n=13). The remaining artefacts are made of Acigöl, Bingöl B and Nemrut Dağ. The presence of these items suggests strongly that core reduction – and maintenance – was indeed occurring at these sites at certain periods.

7.2.2 Products of opposed platform technology

Of the sample collection, only fourteen artefacts belong to this bipolar lithic tradition, all being made of Cappadocian raw materials. Eleven of these are points or projectile fragments; there was also a notched example, one with linear retouch and an unmodified piece. Nine artefacts from this tradition are found at Tell Judaidah in Phase A (n=3), Phase F (n=1), Phase G (n=3) and Second Mixed Range (n=1), with another without temporal context. The other five belong to Tell Dhahab. All of the products mentioned in this section are made of East Göllü Dağ obsidian save three from Tell al-Judaidah which are made of Nenezi Dağ.

From Tell Dhahab, A45770 and A45772 are complete or partial unifacial Amuq points. Three others from Tell al-Judaidah, A45494, A45491, and A59027, are all unifacial points most likely of the Amuq tradition. There is also a fourth possible Amuq point, A45771, from Tell Dhahab with a large use scare down the front, however, this piece could also be a Byblos point.

Three artefacts, A60007 (made of Nenezi Dağ), A60009, and A45470, have been categorized as points but are fragmented remains of either a mid-section or base. One point, A59089 has no other telling features for further designation and finally, A58942 (made of Nenezi Dağ) is a trifacial long point.

The remaining artefacts are a retouched blade (A48063Y), a notched blade, (A60027) and a classic example for an opposed platform blade, A59976G (made of Nenezi Dağ). This final artefact is also the only piece with no evidence of use and retouch.

Given that this tradition is represented by end-products and/or modified versions thereof, it suggests strongly that the inhabitants of the Amuq Valley – in keeping with long-term supra-regional traditions, were in the habit of procuring products of this technology type in ready-made forms pointing to their reliance on other communities or foreign specialists for their manufacture.

7.2.3 Additional products

7.2.3.i Flakes

Only two artefacts, A59398 and A48063V are designated flakes, both of which were categorized as a tertiary flake (F3), i.e. having no cortex. Both are also made of East Göllü Dağ obsidian. The former was recovered at Tell Kurdu, Phase E while the second is from Tell Dhahab.

7.2.3.ii Blade-like flakes

Blade-like flakes include flakes possessing blade-like features and can represent various stages of flake removal; in this instance they are all believed to derive from pressure-blade manufacturing traditions. In the Amuq Valley sample collection, there are fourteen blade-like flake artefacts. All pertain to either a secondary (F2) or tertiary (F3) stage while two have been detailed as blade-like flake core pieces. Eleven of the artefacts are made of East Göllü Dağ obsidian with the remaining three made of Nenezi Dağ and Nemrut Dağ. The majority of the blade-like flakes were recovered from Tell al-Judaidah in Phase A/B (n=1), First Mixed Range (n=1), Phase F (n=1) and Phase G (n=4). The rest were recovered at Tell Dhahab (n=7).

These blanks can again be interpreted as mainly relating to on-site manufacturing activity, though such pieces can also be employed as tools in their own right.

7.2.3.iii Prismatic blades

Prismatic blades, i.e. the trapezoidal-sectioned, parallel margin end-products, compose the vast majority of the Amuq Valley obsidian sample collection with a total of 198 examples (68% of the total assemblage). Prismatic blades are found in all phases of the

Amuq Sequence including one found in the Second Mixed Range. Phases with the highest concentration of prismatic blades are Phase G (n=48), Phase E (n=41) and Phase A (n=26), however, a large portion (n=58) were also recovered from Tell Dhahab with no known temporal context. The remaining phases, Phase C, D, F and H, are represented by relatively smaller amounts, (n=12, 5, 4 and 3 respectively). There was also a single prismatic blades recovered from Tell al-Judaidah with no temporal context.

The prismatic blades are also represented by all obsidian source varieties recorded in Chapter 6 of the Amuq Valley sample collection. As is the case across all typologies, most of the artefacts are made of East Göllü Dağ obsidian (n=108). The next most common source material for prismatic blades is Bingöl B (n=34), followed by Nenezi Dağ (n=28), and then Nemrut Dağ (n=17). For five of the ten source materials recorded in the Amuq Valley, it so happens that their artefacts are only produced into prismatic blades. In other words, for all artefacts made of West Göllü Dağ (n=1), Bingöl A (n=2), Meydan Dağ (n=4), Sarıkamış (n=1) or Pasinler (n=2) material, only prismatic blades are represented. The same could be said for the single prismatic blade made of Acigöl Post Caldera East as the second Acigöl artefact, from Ante Caldera East, is a rejuvenation piece.

Of note are three artefacts from this typology group that have additional features/remarks. Two are from Tell Judaidah Phase G. The first, A60000, is detailed as a 'plunging blade' made of Nenezi Dağ obsidian (a mistake product that one often associated with the end of manufacturing sequence), while the second, A59860, is recorded as a 'blade end sequence' made of East Göllü Dağ. The third, from Tell Kurdu Phase E, made of Bingöl B (A59393) is a possible sickle blade on the basis of its denticulation, a deliberate form of tool modification (Table 7.2.0). In the Levantine Neolithic, Copeland (1979 as cited by Nishiaki 2000:49) has noted that blades were often deliberately snapped to make regular sized/straight-edged sickle elements which may be the case for this artefact.

Further analysis of the prismatic blades were performed to determine changes in dimension between source types as well as between Amuq Phases. These observations were made based on width and thickness measurements (cm) to obtain mean and standard deviation. Calculations were done for each phase within each source type and for each source type within each phase. All findings have been recorded in **Figures 7.2.1** and **7.2.2**, as well as in **Tables 7.2.1-7.2.40.** For prismatic blade width variability in source type per Amuq Phase, see **Tables 7.2.1-7.2.10**. For thickness variability in source type per Amuq Phase, see **Tables 7.2.11-7.2.20**. For width variability throughout time for each source type see, **Tables 7.2.21- 7.2.30**. Finally, for thickness variability throughout time for each source type see, **Tables 7.2.31-7.2.40**. Furthermore, two plots were created, the first representing the total mean of width and thickness for each source type regardless of temporal context, and the second representing the total mean of each phase regardless of source type (**Figures 7.2.3** and **7.2.4**).

In certain cases, some of the means are represented by only one width and thickness dimension due to that phase or temporal category being made up of only a single artefact. In fact, in almost every instance where the largest and smallest means for width and thickness dimensions are marked on the plot, these positions are represented by either one of these single artefact groups, or by a group made up of a significantly smaller number of artefacts. For example, in **Figure 7.2.1** plotting dimensions by source, the four extremes of width and thickness means are captured by West Göllü Dağ (n=1), Sarıkamış (n=1), Acigöl (n=1) and Pasinler (n=2). Likewise, in **Figure 7.2.2** plotting dimensions by phase, the extremes are captured by Second Mixed Range (n=1), Phase H (n=3), and Phase C (n=12).

Meanwhile, as is to be expected, category groups with a mean represented by many artefacts are found on the plots central amongst the other categories meaning their mean values fall in between the dimension extremes. For example, in **Figure 7.2.2** plotting dimensions by phase, the category means represented by the largest number of artefacts, East Göllü Dağ (n=108) and Bingöl B (n=34), are situated in the middle of the other mean points.

In the end, all tables and figures demonstrate that size dimension of prismatic blade production was uniform in the Amuq Valley regardless of the source material used or their temporal context within the Amuq Sequence. This unchanging pattern indicates the survival of a continuous community of practice through deep-time (Carter et al. 2019 Ein el-Jarba in production). In short, this suggests that some of these raw materials were being worked by the same craftspeople in the Amuq Valley (specifically EGD, NZD, BB, and NMD based on the presence of cores and/or other forms of manufacturing debris), while those pressure blades seemingly procured ready-made of the same four obsidian materials mentioned above, were produced by knappers using pressure flaking tradition either within the northern Levant, or closer to the sources.

7.2.4 Additional comments

7.2.4.i Cortex

Among the sample collection of Amuq Valley obsidian, there are very few pieces with remaining cortex. Only fifteen artefacts possess cortex, the average surface amount present being 30%. This is mostly found on secondary series blades (n=9) followed by blade-like flakes (n=3) and rejuvenated pieces and cores (n=2 and n=1 respectively). Lastly, all products with remaining cortex are made from East Göllü Dağ save for thirteen pieces. These are a secondary series blade made of Nenzi Dağ (A59128), a rejuvenation piece made of Bingöl B (A45488) and finally, a blade-like flake made of Nenezi Dağ (A48086) (**Table 7.2.41**).

7.2.4.ii Usewear and retouch

Of the entire sample collection all artefacts show evidence of usewear based on macroscopic observation save for twenty-three (8%), nearly all of which are core pieces. Other artefacts with no usewear include, three blade-like flakes (A48074S, A59960B, and A59951) one secondary blade (A48065F), and three prismatic blades (A48065Q, A48065W and A48065X). This suggests that obsidian as an exotic material was used frugally in the Amuq Valley, indicating that its importation was a costly, if not, infrequent luxury.

Interestingly, however, among those with usewear (n=265), only eighty-two show evidence of retouch (31%). Looking at prismatic blades alone (n=195), only fifty-five (28%) have been retouched. This included specimens made of East and West Göllü Dağ. Nenezi Dağ, Bingöl A and B, and Nemrut Dağ. Retouching appears in all phases for this tool type. The most common tool type with retouch is the opposed platform blades with 93% retouched, all of which made exclusively of East Göllü Dağ and Nenezi Dağ.

7.3 Review of consumption patterns by obsidian type

Following the techno-typological results presented above, this section comprises a brief review of obsidian consumption traditions in the Amuq Valley over time by raw material type. The review is organised by source region, beginning with the most abundant material types.

7.3.1 East Göllü Dağ

The obsidian from East Göllü Dağ has long been appreciated as the most important sources exploited at distance throughout prehistory in the Near East (Chataigner 1998). Throughout the periods under discussion, we see clear evidence for our Amuq Valley communities procuring this obsidian in the form of prepared and/or part-initiated pressure-blade cores that were then reduced on site for the manufacture of fine prismatic blades (**Table 7.3.0**). This raw material is also represented by a few large opposed platform blades that were procured ready-made, blanks that were typically employed for making projectiles (some likely circulated as finished products). Their absence from the First Mixed Range is likely due to sample size. The same cannot be said for Phases C-E assemblages, however, this will be covered in proceeding section.

7.3.2 Nenezi Dağ

Although Nenezi Dağ obsidian is typically less abundant in Near Eastern contexts than East Göllü Dağ products (Altinbilek-Algül 2011), it was still used in tandem throughout the Neolithic (and beyond) by communities throughout the Levant (Carter et al. 2011:142). It is thus not surprising that our analyses have detailed the presence of artefacts made from Nenezi Dağ obsidian in the Amuq Valley from Phase A onwards. In general one can state that this raw material's consumption is directly comparable to how most of the East Göllü Dağ obsidian was being used by these communities, i.e. the on-site production of pressure blades from imported cores, together with the procurement of ready-made opposed platform blanks (**Table 7.3.0**). That said, the use of this raw material – with regard to both knapping traditions – is more sporadic than consumption history of East Göllü Dağ obsidian, with only the assemblages from Phases A and G being directly comparable. Indeed, Nenezi Dağ obsidian was entirely absent from our artefact samples of Phases B-C, E-F and I-J, while in Phases D and H it is represented exclusively in the form of finished pressure blades.

7.3.3 Acıgöl and West Göllü Dağ

The circulation of these two sources' raw materials are described as limited in their distribution (Chataigner 1998). In the Amuq Valley, they only appear during Phase A in the form of finished pressure blades together with a single core rejuvenation flake of Acigol Ante-Caldera East obsidian, suggesting that perhaps, some limited on-site use of this rarer Cappadocian material (**Table 7.3.0**).

7.3.4 Bingöl B

According to Chataigner (1998) Bingöl B, a Lake Van region obsidian, tends to be more prevalent in Neolithic chipped stone assemblages from sites in Northern

Mesopotamia, the Middle-Euphrates and the eastern wing of the Fertile Crescent, then eventually being procured by communities throughout the Levant towards the end of the Ubaid period onwards (5th millennium). Our Amuq Valley data serves to somewhat reconfigure that claimed pattern, with artefacts of Bingöl B obsidian being the second best represented raw material in the assemblages after East Göllü Dağ products, present since Phase A and absent only periodically during Phase F. Our results suggest that this obsidian was initially accessed in the form of ready-made pressure blades until Phase G when we have evidence for on-site production (**Table 7.3.0**).

7.3.5 Bingöl A and Nemrut Dağ

Prior to this study, these peralkaline obsidians of the Lake Van region had been documented at Levantine sites dating from the Late Neolithic onwards (Chataigner 1998). In the Amuq Valley they appear at a slightly later Chalcolithic date, namely Phases C and E, and subsequently, only reappear briefly in Phase G. Of the two, Nemrut Dağ is said to be of poorer knapping quality than Bingöl A (Robin et al 2016), yet, there is a higher volume of the former in the Amuq Valley (refer to **Table 6.0.1**). Ultimately, only the Nemrut Dağ data provides evidence for on-site production of pressure blades while Bingöl A obsidian seems to have been procued by these communities only in the form of finished products in Phase E and G (**Table 7.3.0**).

7.3.6 Meydan Dağ

Hitherto, Meydan Dağ obsidian was only believed to have circulated as far south as the Levant from the Late Chalcolithic (Renfrew, Dixon and Cann 1966). The Amuq Valley data fits this pattern, it making its only appearance in Phase E, represented exclusively in the form of ready-made pressure blades (**Table 7.3.0**).

7.3.7 Sarıkamış and Pasinler

Previously recorded as far south as Domuztepe in the Halaf Period (Frahm, Campbell and Healey 2016b), obsidian from the North-East Anatolian source of Sarıkamış does not appear until the "Final Halaf" as reported by Delerue (2007:200&459). From the sample collection, Sarıkamış appears at Phase G, i.e. very late in our prehistoric sequence. The raw material is represented by a single pressure blade (**Table 7.3.0**). As for Pasinler, another North-East Anatolian obsidian mainly used by local Transcaucasian communities during the Bronze Age (Chataigner 1998), this is present in the Amuq Valley in Phases C and E. As with Sarıkamış obsidian, this raw material is only present in the form of single pressure blades in these phases (**Table 7.3.0**).

7.4 Summary of diachronic obsidian consumption traditions in the Amuq Valley

When observing the circulation trends of raw materials from the three major obsidian regions of Cappadocia (Central Anatolia), Lake Van (East Anatolia) and North-East Anatolia, a number of deep-time observations can be made. An overview of these points is made below, while a more in-depth discussion of consumption patterns is reserved for Chapter 8.

Of the Cappadocian raw material, finished products, in the form of prismatic blades, are nearly always present alongside evidence for on-site production, the exceptions being where assemblage size of a particular Phase and material type is significantly small; an example being West Göllü Dağ, Phase A, n=1) (see **Tables 6.0.1** and **7.3.0** for cross comparison). This suggests that the people of the Amuq Valley were likely producing their own finished products consistently throughout deep-time from Phases A-H. In particular, on-site production of Cappadocian obsidian was most diverse across material types during Phase A before consumption became restricted primarily to East Göllü Dağ followed by a comeback of Nenezi Dag in Phase G.

When viewing Lake Van materials, evidence for on-site production is less apparent, and interestingly, favours Nemrut Dağ obsidian, despite Bingöl B being more abundant in the assemblages of Tell Kurdu and Tell al-Judaidah (see **Tables 6.0.1** and **7.3.0** for cross comparison). In general, Lake Van materials are only present in the Amuq Sequence when in the form of prismatic blades save for one core of Bingöl B being found in the Second Mixed Range. This suggests that circulation of materials from the Lake Van region were restricted to communities in Northern Levant as mainly finished products – more on this will be discussed in the proceeding chapter.

As for artefacts of North-East Anatolian obsidian, these appear singularly in respective Phases and are unsurprisingly all finished products (prismatic blades) (**Table 7.3.0**), leading to the notion that obsidian from the Transcaucasian region was too peripheral in terms of geo-political connectivity with the Amuq Valley to be imported in a raw or even pre-formed state (more in Chapter 8).

On another note, it is only with Cappadocian materials (EGD and NZD) that artefacts of the opposed platform technology are present. Furthermore, these products are all finished forms which suggests that the people of the Amuq Valley did not practice this knapping tradition, however, did receive it throughout deep-time. Instead, it points to a small scale exchange of finished and/or modified end-products, mainly spearheads imported specifically to the community of Tell al-Judaidah (and Tell Dhahab) as these products only appear during Phases A, F and G, before and after Chalcolithic occupations of Tell Kurdu.

In sum, what we tend to see in the Amuq Valley is inhabitants primarily procuring obsidian from Cappadocia (EGD and NZD) and the Lake Van region (BA/B and MD) in the form of preformed and/or part-reduced pressure blade cores that were then reduced using pressure flaking technology on-site by local craftspeople and/or those individuals who brought the obsidian to the site(s) for the production of prismatic blades.

Evidence to support this idea arises with respect to a few different elements. Firstly, there are no initiation flakes or crested blades present in the sample collection which points to initial core preparation being performed off-site before any distribution into the Amuq Valley. Although it may be possible that such items for core preparation are in unexcavated ground in the Amuq Valley, the former hypothesis is more likely as partial off-site production at Tell Kurdu and Domuztepe has been suggested before by Healey (2007). Supporting this are a number of secondary series blades as well as a few tertiary flakes in the sample collection which both point to on-site knapping of the later stages in blade production.

Lastly, there are a few pieces in the Amuq Valley sample collection which have noticeably high amounts of cortex present (namely a blade-like flake from Tell Dhahab with 75% cortex, A48086, **Table 7.2.41**). Furthermore, this table shows that percentage of cortex present in the Amuq Valley sample collection does not diminish over time. This suggests that on-site production was still practiced to some degree during all phases of obsidian consumption. For the most part, this on-site production was used for East Göllü Dağ obsidian, however, interestingly, Nemrut Dağ and Bingöl B are included among pieces with cortex while the piece mentioned earlier from Tell Dhahab, A48086, with the highest amount of cortex, was made of Nenezi Dağ.

Finally, amongst the prismatic blades, represented by every obsidian material type recorded in this study, there is an overall homogeneity regardless of source material and temporal context. As seen in the charts and tables mentioned above in section *7.2.3.iii,* the standard deviation for width and thickness changed no more than 0.20cm between sequential phases. This tells us there was no apparent differentiation in treatment for particular obsidian materials nor a dramatic change in technological traditions throughout deep-time.

The proceeding chapter will now combine the findings of the chemical characterization and techno-typological studies to form a discussion on the deep-time socio-economic relations of the Amuq Valley study sites with its neighbouring regions in the Near East.

7.5 Chapter 7 Tables and Figures

Table 7.2.0: Technology type for all artefacts in sample collection. (See abbreviation key below.)

No.	Artefact	Site	Phase	Source	Blank Type	Cortex	L (cm)	W (cm)	Th (cm)	Use	Cond	Retouch	Interpretative category
1	A45462	J	H	BB	BL PD	0	1.99	1.13	0.15	YES	LESS DULL	NO	
2	A45466	J	G	EGD	BL PD	0	3.9	0.92	0.2	YES	LESS DULL	NO	
3	A45470	J	SMR	EGD	BL BI	0	2.71	2.24	0.51	YES	DULL	YES	retouched blade / point base?
4	A45471	J	SMR	EGD	BL PD	0	3.69	1.13	0.34	YES	DULL	YES	backed blade
5	A45472	J	H	BB	BL PD	0	1.96	1.11	0.25	YES	DULL	NO	
6	A45476A	J	G	NMD	BL PD	0	3.44	0.88	0.27	YES	DULL	NO	
7	A45476B	J	?	EGD	BL SEC	0	2.85	0.61	0.16	YES	DULL	NO	
8	A45478A	J	G	BB	BL PD	0	2.55	0.82	0.14	YES	DULL	NO	
9	A45481A	J	?	EGD	CORE	0	2.6	0.94	0.76	NO	LESS DULL	NO	
10	A45481B	J	?	EGD	BL PD	0	0.91	0.73	0.19	YES	DULL	NO	
11	A45482	J	H	NZD	BL PD	0	3.11	1.58	0.29	YES	DULL	YES	backed blade
12	A45487	J	?	EGD	CORE	0	3.94	1.72	1.47	NO	DULL	NO	
13	A45488	J	G	BB	REJ	35	4.1	2.59	0.11	YES	DULL	YES	end-scraper/denticulate
14	A45490	J	G	NMD	BL PD	0	4.24	2.02	0.5	YES	DULL	NO	
15	A45491	J	G	EGD	BL BI	0	5.25	1.35	0.65	UNK	DULL	YES	unifacial point (long Amuq?)
16	A45494	J	?	EGD	BL BI	0	3.68	2.05	0.89	YES	DULL	YES	unifacial point (long Amuq?), impact damage
17	A58942	J	G	NZD	BL BI	0	4.18	1.01	0.91	YES	DULL	YES	trifacial long point
18	A59011	J	SMR	BB	CORE	0	4.84	1.83	0.81	NO	DULL	NO	p/f core worked 50%

19	A59027	J	G	EGD	BL BI	0	3.21	2.2	0.88	UNK	DULL	YES	unifacial (Amuq point?)
20	A59845	J	G	SKS	BL PD	0	3.98	1.3	0.24	YES	DULL	NO	
21	A59846	J	G	NMD	BL PD	0	5.31	0.94	0.18	YES	DULL	NO	
22	A59847	J	G	EGD	BL PD	0	3.81	0.84	0.28	YES	DULL	NO	
23	A59849	J	G	NZD	CORE	0	2.82	0.99	0.93	NO	DULL	NO	p/f core worked 50% w/ two plunging blades (exhausted)
24	A59850	J	G	EGD	BL PD	0	2.93	0.76	0.27	YES	DULL	NO	
25	A59851	J	G	EGD	BL PD	0	4.01	1.06	0.28	YES	DULL	NO	
26	A59852	J	G	BB	BL PD	0	3.06	1.09	0.24	YES	DULL	NO	
27	A59853	J	G	EGD	BL PD	0	3.04	1.27	0.42	YES	DULL	YES	retouched blade (linear)
28	A59854	J	G	NMD	REJ	0	4.7	1.69	0.7	YES	DULL	NO	
29	A59856	J	G	EGD	REJ	0	3.79	3.69	0.37	YES	DULL	YES	denticulated/retouched flake
30	A59860	J	G	EGD	BL PD	0	3.71	0.67	0.21	YES	DULL	NO	
31	A59862	J	G	NMD	BL SEC	0	5.28	1.38	0.37	YES	DULL	NO	
32	A59863	J	G	BB	BL PD	0	4.32	1.55	0.38	YES	DULL	NO	
33	A59864	J	G	EGD	REJ	0	2.57	2.57	0.51	YES	DULL	NO	
34	A59865	J	G	EGD	REJ	0	2.86	2.86	0.42	YES	DULL	NO	
35	A59867	J	G	BB	CORE	0	4	2.27	1.07	YES	DULL	NO	piece esquillee on frag
36	A59868	J	G	NZD	BL PD	0	3.45	0.61	0.21	YES	DULL	NO	
37	A59870	J	G	EGD	BL PD	0	2.48	1.37	0.28	YES	DULL	YES	denticulate (worn)
38	A59871	J	G	BB	BL PD	0	3.64	0.99	0.21	YES	DULL	YES	denticulate (worn)
39	A59873	J	G	NZD	BL PD	0	4.07	1.44	0.34	YES	DULL	NO	

40	A59874	J	G	EGD	BL PD	0	3.5	1.01	0.29	YES	DULL	NO	
41	A59875	J	G	EGD	REJ	0	3.1	1.68	0.28	YES	DULL	YES	backed blade
42	A59877	J	G	NZD	BL SEC	0	2.39	1.3	0.34	YES	DULL	NO	
43	A59878	J	G	EGD	BL PD	0	3.89	0.63	0.15	YES	DULL	NO	
44	A59881	J	G	BB	BL PD	0	2.86	1.24	0.28	YES	DULL	NO	
45	A59882	J	G	NZD	BL PD	0	4.82	0.91	0.38	YES	DULL	NO	
46	A59883	J	G	NMD	BL PD	0	5.62	1.68	0.3	YES	DULL	YES	backed blade
47	A59886	J	G	EGD	BL PD	0	2.94	0.84	0.2	YES	DULL	NO	
48	A59889	J	G	NMD	BL PD	0	3.06	0.89	0.34	YES	DULL	YES	
49	A59892	J	G	BB	BL PD	0	3.93	1.39	0.53	YES	DULL	YES	notched blade
50	A59895	J	G	BB	BL PD	0	3.45	1.18	0.25	YES	DULL	NO	
51	A59897	J	G	EGD	BL PD	0	3.4	1.51	0.12	YES	DULL	NO	
52	A59899	J	G	NZD	BL PD	0	2.52	1.01	0.35	YES	DULL	NO	
53	A59901	J	G	NZD	BL PD	0	3.27	1.95	0.3	YES	DULL	NO	
54	A59904	J	G	NZD	BL SEC	0	2.36	1.1	0.25	YES	DULL	YES	backed blade
55	A59905	J	G	BB	BL PD	0	1.69	0.99	0.23	YES	DULL	NO	
56	A59907	J	G	NZD	CORE	0	2.98	1.79	1.53	NO	DULL	NO	p/f blade core 1/3 circumference (exhausted)
57	A59909	J	G	EGD	REJ	0	2.54	2.64	0.33	YES	DULL	YES	backed blade
58	A59910	J	G	NZD	BL PD	0	2.93	1.08	0.2	YES	DULL	YES	notched blade
59	A59913	J	G	NZD	BL PD	0	2.81	1.73	0.35	YES	DULL	NO	
60	A59914	J	G	NMD	BL PD	0	2.53	1.5	0.23	YES	DULL	NO	
61	A59919	J	G	EGD	BL PD	0	3.38	1.16	0.29	YES	DULL	NO	

62	A59923	J	G	EGD	CORE	0	1.9	1.29	0.99	NO	DULL	NO	p/f blade core 1/3 circumference (exhausted)
63	A59924	J	G	BB	BL PD	0	4.27	1.15	0.21	YES	DULL	NO	
64	A59928	J	G	EGD	B/F	0	2.38	2.61	0.44	YES	DULL	YES	notched blade / blade-like flake
65	A59930	J	G	NZD	BL PD	0	2.22	0.81	0.26	YES	DULL	NO	
66	A59935	J	G	NZD	BL PD	0	2.22	1.3	0.44	YES	DULL	NO	
67	A59937	J	G	NZD	BL PD	0	2.97	1.2	0.3	YES	DULL	NO	
68	A59938	J	G	NZD	BL SEC	0	4.16	0.76	0.32	YES	DULL	NO	
69	A59947	J	G	BB	BL PD	0	2.3	1.1	0.15	YES	DULL	NO	
70	A59951	J	G	NZD	B/F	0	3.97	1.24	1.23	NO	DULL	YES	scraper on distal end of exhausted core (at end a b/f3 core)
71	A59957	J	F	EGD	BL PD	0	2.63	0.74	0.22	YES	DULL	YES	perforator
72	A59959	J	F	EGD	BL PD	0	2.64	1.08	0.26	YES	DULL	NO	
73	A59960B	J	FMR	EGD	B/F	0	3.14	2.63	1.3	NO	DULL	YES	scraper on distal end of exhausted core (at end a b/f3 core)
74	A59961B	J	FMR	EGD	BL SEC	0	4.39	1.1	0.38	YES	DULL	NO	
75	A59962A	J	A	EGD	BL SEC	50	3.18	0.98	0.38	YES	DULL	NO	
76	A59962B	J	A	EGD	BL PD	0	2.86	1.32	0.2	YES	DULL	YES	retouched blade
77	A59962C	J	A	NZD	BL PD	0	2.85	1.23	0.26	YES	DULL	YES	notched blade
78	A59962D	J	A	WGD	BL PD	0	2.52	1.13	0.33	YES	DULL	YES	retouched blade
79	A59962E	J	A	NZD	BL PD	0	3.45	0.94	0.23	YES	DULL	NO	
80	A59962F	J	A	EGD	BL PD	0	2.04	0.98	0.29	YES	LESS DULL	NO	

82	A59962H	J	A	NZD	BL PD	0	1.67	0.72	0.16	YES	DULL	NO	
83	A59962I	J	A	ApcE	BL PD	0	2.11	0.81	0.21	YES	DULL	NO	
84	A59962J	J	A	NZD	BL SEC	0	2.23	0.98	0.33	YES	DULL	NO	
85	A59962K	J	A	EGD	BL PD	0	1.82	1.09	0.27	YES	DULL	NO	
86	A59963A	J	A	EGD	BL PD	0	4.01	2.32	0.49	YES	DULL	YES	notched blade
87	A59963B	J	A	EGD	BL SEC	0	3.43	1.33	0.46	YES	DULL	NO	
88	A59963C	J	A	EGD	REJ	0	4.01	2.62	0.39	YES	DULL	YES	retouched flake off face of p/f blade core
89	A59963D	J	A	EGD	B/F	0	2.81	2.02	0.46	YES	DULL	NO	
90	A59976F	J	A	NZD	CORE	0	2.15	2.1	0.99	NO	DULL	NO	base of p/f blade core
91	A59976G	J	A	NZD	BL BI	0	4.36	2.65	0.91	YES	DULL	NO	classic NNZD opposed platform blade, & possible impact damage (but no retouch)
92	A59976H	J	A	AacE	REJ	0	1.31	1.96	0.59	YES	DULL	NO	possible percussion blade fragment that hinged?
93	A59977A	J	A	EGD	BL PD	0	1.76	0.98	0.2	YES	DULL	YES	retouched blade
94	A59977B	J	A	EGD	BL PD	0	2.76	0.58	0.14	YES	DULL	NO	
95	A59977C	J	A	EGD	BL PD	0	3.14	0.9	0.19	YES	DULL	NO	
96	A59977D	J	A	EGD	BL PD	0	2.61	0.89	0.2	YES	DULL	NO	
97	A59977I	J	A	EGD	BL SEC	0	3.86	0.79	0.2	YES	DULL	NO	
98	A59977J	J	A	EGD	BL PD	0	2.14	1.01	0.16	YES	DULL	NO	
99	A59977K	J	A	EGD	BL PD	0	1.78	1.74	0.3	YES	DULL	YES	backed blade
100	A59977L	J	A	EGD	BL PD	0	2.61	1.1	0.18	YES	DULL	NO	
101	A59977M	J	A	EGD	BL PD	0	4.54	0.96	0.3	YES	DULL	NO	

102	A59977N	J	A	EGD	BL PD	0	3.21	1.2	0.26	YES	DULL	NO	
103	A59977O	J	A	EGD	BL PD	0	1.46	0.86	0.16	YES	DULL	NO	
104	A59982A	J	A	EGD	CORE	5	2.91	2.38	1.26	NO	DULL	NO	p/f blade core, original platform removed, new late one added; 50% of circumference
105	A59982B	J	A	BB	BL PD	0	4.32	1.01	0.21	YES	DULL	NO	
106	A59982C	J	A	NZD	CORE	0	1.61	1.82	0.93	NO	DULL	NO	p/f blade core exhausted
107	A59982D	J	A	EGD	REJ	0	2.6	2.01	0.39	YES	DULL	NO	
108	A59996	J	G	EGD	BL PD	0	2.4	0.82	0.18	YES	DULL	NO	
109	A59997	J	G	EGD	B/F	30	2.71	1.6	0.68	YES	DULL	NO	
110	A59998	J	G	BA	BL PD	0	3.67	2.1	0.36	YES	DULL	YES	backed / retouched blade
111	A59999	J	G	EGD	BL PD	0	3.04	1.2	0.25	YES	DULL	YES	denticulated blade
112	A60000	J	G	NZD	BL PD	0	4.06	1.1	0.37	YES	DULL	YES	notched blade
113	A60001	J	G	EGD	BL PD	0	2.63	1.06	0.35	YES	DULL	YES	notched blade
114	A60002	J	G	EGD	BL PD	0	3.2	1.45	0.34	YES	DULL	YES	backed blade
115	A60003	J	G	NMD	B/F	0	4.62	2.12	0.79	YES	DULL	NO	exhausted core/chunk?
116	A60004	J	G	EGD	BL PD	0	4.11	0.59	0.36	YES	DULL	YES	Abu Maadi point?
117	A60005	J	G	EGD	BL PD	0	3.29	0.63	0.18	YES	DULL	NO	
118	A60006	J	G	EGD	BL PD	0	2.1	1.02	0.32	YES	DULL	YES	notched blade
119	A60007	J	A	NZD	BL BI	0	2.3	1.48	0.61	YES	DULL	YES	mid-section of used/broken point?
120	A60008	J	A	EGD	BL PD	0	2.99	0.93	0.23	YES	DULL	YES	backed blade
121	A60009	J	F	EGD	BL BI	0	1.84	1.67	0.6	YES	DULL	YES	mid-section of broken point?

122	A60010	J	F	EGD	BL PD	0	2.01	1.21	0.26	YES	DULL	YES	retouched blade
123	A60014	J	F	EGD	BL PD	0	2.84	1.61	0.35	YES	DULL	YES	backed blade
124	A60018	J	A	EGD	BL PD	0	2.71	0.89	0.29	YES	DULL	YES	notched blade
125	A60019	J	A	NZD	BL PD	0	1.9	1.23	0.17	YES	DULL	YES	backed blade
126	A60021	J	F	EGD	B/F	0	0.79	2.25	0.27	YES	DULL	YES	backed blade???
127	A60027	J	A	EGD	BL BI	0	2.24	1.74	0.58	YES	DULL	YES	notched blade
128	A60028	J	A	EGD	BL PD	0	2.05	0.84	0.2	YES	DULL	YES	backed blade
129	A60029	J	A	EGD	REJ	20	1.78	1.47	0.29	YES	DULL	YES	notched blade
130	A60030	J	A	NZD	BL PD	0	2.14	1.15	0.32	YES	DULL	YES	notched blade
131	A45770	D	?	EGD	BL BI	0	2.99	1.76	0.45	YES	DULL	YES	Amuq point, unifacial
132	A45771	D	?	EGD	BL BI	0	4.94	2.31	1.05	YES	DULL	YES	either Byblos or Amuq point with large use-scar down front
133	A45772	D	?	EGD	BL BI	0	3.59	1.16	0.47	YES	DULL	YES	Amuq point tip, unifacial
134	A48063C	D	?	EGD	CORE	0	2.04	1.52	0.16	NO	DULL	NO	p/f core 50%
135	A48063E	D	?	EGD	CORE	0	2.74	1.69	1.39	NO	DULL	NO	p/f core 50%
136	A48063O	D	?	EGD	REJ	0	3.95	1.41	0.46	YES	DULL	NO	back of core
137	A48063P	D	?	EGD	CORE	0	2.94	1.64	0.91	NO	DULL	NO	
138	A48063Q	D	?	EGD	CORE	0	4.2	1.31	1.12	NO	DULL	NO	
139	A48063U	D	?	EGD	B/F	20	6.8	2.26	0.89	YES	DULL	NO	
140	A48063V	D	?	EGD	Flake	0	3.13	4.63	1.14	YES	DULL	NO	
141	A48063Y	D	?	EGD	BL BI	0	4.26	2.09	0.51	YES	DULL	YES	retouched blade
142	A48063Z	D	?	NMD	CORE	0	4.29	2.44	1.62	USED?	LESS DULL	NO	
143	A48065A	D	?	NZD	BL PD	0	1.32	1.02	0.23	YES	DULL	NO	

144	A48065B	D	?	NZD	BL SEC	0	1.56	0.83	0.15	YES	DULL	NO	
145	A48065C	D	?	EGD	BL PD	0	1.42	1.44	0.22	YES	DULL	NO	
146	A48065D	D	?	BB	BL PD	0	1.6	0.9	0.18	YES	DULL	NO	
147	A48065E	D	?	EGD	BL PD	0	1.58	0.73	0.19	YES	DULL	NO	
148	A48065F	D	?	EGD	BL SEC	0	1.98	0.68	0.17	NO	LESS DULL	NO	
149	A48065G	D	?	EGD	BL PD	0	1.31	1.04	0.14	YES	DULL	YES	backed blade
150	A48065H	D	?	NZD	BL PD	0	1.46	0.86	0.21	YES	DULL	NO	
151	A48065I	D	?	BB	BL PD	0	1.18	0.61	0.2	YES	LESS DULL	NO	
152	A48065J	D	?	NZD	BL PD	0	1.13	1.37	0.23	YES	DULL	NO	
153	A48065K	D	?	EGD	BL PD	0	1.88	0.68	0.17	YES	LESS DULL	NO	
154	A48065L	D	?	NZD	BL PD	0	1.35	0.93	0.15	YES	DULL	NO	
155	A48065M	D	?	NZD	BL PD	0	1.73	0.85	0.26	YES	DULL	YES	backed blade/point?
156	A48065N	D	?	NZD	BL PD	0	1.46	0.72	0.2	YES	DULL	NO	
157	A48065O	D	?	EGD	BL PD	0	1.3	0.71	0.22	YES	LESS DULL	NO	
158	A48065P	D	?	EGD	BL PD	0	1.85	0.73	0.2	YES	DULL	NO	
159	A48065Q	D	?	NZD	BL PD	0	1.76	0.67	0.25	NO	DULL	NO	
160	A48065R	D	?	EGD	BL PD	0	1.98	0.79	0.12	YES	DULL	NO	
161	A48065S	D	?	EGD	BL PD	0	1.77	1.11	0.23	YES	DULL	NO	
162	A48065T	D	?	EGD	BL PD	0	1.56	0.8	0.15	YES	DULL	NO	
163	A48065U	D	?	EGD	BL PD	0	1.12	0.85	0.18	YES	DULL	NO	
164	A48065V	D	?	EGD	BL PD	0	1.56	1	0.21	YES	DULL	NO	
165	A48065W	D	?	EGD	BL PD	0	1.73	0.72	0.17	NO	LESS DULL	NO	
166	A48065X	D	?	EGD	BL PD	0	1.78	0.77	0.17	NO	LESS DULL	NO	
167	A48065Y	D	?	EGD	BL PD	0	1.46	0.71	0.15	YES	DULL	NO	

168	A48065Z	D	?	EGD	BL PD	0	1.91	0.66	0.13	YES	DULL	NO	
169	A48070A	D	?	EGD	BL PD	0	3.55	1.41	0.29	YES	DULL	YES	backed blade
170	A48070B	D	?	EGD	BL PD	0	2.57	1.15	0.31	YES	DULL	YES	backed blade
171	A48070C	D	?	EGD	BL SEC	0	3.16	2.31	0.26	YES	DULL	NO	
172	A48070D	D	?	EGD	BL PD	0	2.83	1.01	0.15	YES	DULL	YES	retouched blade
173	A48070E	D	?	EGD	BL PD	0	2.98	0.96	0.19	YES	DULL	NO	
174	A48070F	D	?	EGD	REJ	0	3.52	2.08	0.61	YES	DULL	YES	backed blade
175	A48070G	D	?	EGD	BL PD	0	2.56	1.07	0.3	YES	DULL	NO	
176	A48070H	D	?	EGD	BL PD	0	4.21	1.08	0.18	YES	DULL	YES	backed blade
177	A48070I	D	?	EGD	BL PD	0	2.91	1.03	0.18	YES	DULL	NO	
178	A48070J	D	?	EGD	BL PD	0	2.86	1.06	0.2	YES	DULL	NO	
179	A48070K	D	?	EGD	BL PD	0	3.85	1.63	0.48	YES	DULL	NO	
180	A48070L	D	?	EGD	BL PD	0	3.2	1.11	0.34	YES	DULL	NO	
181	A48070M	D	?	EGD	BL PD	0	3.33	1.1	0.28	YES	DULL	NO	
182	A48070N	D	?	NZD	BL PD	0	2.06	1.28	0.22	YES	DULL	NO	
183	A48070O	D	?	EGD	BL PD	0	2.83	1.25	0.29	YES	DULL	NO	
184	A48070P	D	?	NZD	BL PD	0	2.09	1.16	0.28	YES	DULL	NO	
185	A48070Q	D	?	EGD	BL PD	0	3.36	0.51	0.21	YES	DULL	NO	
186	A48070R	D	?	EGD	BL PD	0	3.07	1.13	0.31	YES	DULL	YES	retouched blade
187	A48070S	D	?	NZD	CORE	0	2.32	1.37	0.7	NO	DULL	NO	
188	A48070U	D	?	EGD	BL PD	0	3.1	1.5	0.39	YES	DULL	NO	
189	A48070W	D	?	EGD	BL PD	0	2.67	1.19	0.32	YES	DULL	NO	
190	A48070X	D	?	EGD	BL PD	0	3.54	1.55	0.41	YES	DULL	NO	
191	A48070Y	D	?	NZD	BL PD	0	2.34	0.99	0.2	YES	DULL	NO	

192	A48074A	D	?	EGD	BL PD	0	4.39	0.89	0.15	YES	DULL	NO	
193	A48074B	D	?	EGD	BL SEC	0	3.24	1.03	0.2	YES	DULL	YES	notched blade
194	A48074C	D	?	EGD	BL PD	0	4.17	1.32	0.15	YES	DULL	NO	
195	A48074D	D	?	EGD	BL PD	0	3.76	0.94	0.21	YES	DULL	NO	
196	A48074E	D	?	EGD	B/F	0	3.86	1.14	0.67	YES	DULL	YES	side-scraper
197	A48074F	D	?	EGD	BL SEC	55	4.61	1.19	0.38	YES	DULL	NO	
198	A48074G	D	?	EGD	BL SEC	0	5.39	0.76	0.26	YES	DULL	NO	
199	A48074H	D	?	EGD	BL SEC	30	4.52	0.7	0.27	YES	DULL	NO	
200	A48074I	D	?	BB	BL PD	0	3.14	0.64	0.22	YES	DULL	NO	
201	A48074J	D	?	EGD	BL PD	0	2.66	1.31	0.37	YES	DULL	YES	notched blade
202	A48074K	D	?	EGD	BL SEC	35	2.78	1.21	0.37	YES	DULL	NO	
203	A48074L	D	?	EGD	BL PD	0	3.15	0.65	0.31	YES	DULL	NO	
204	A48074M	D	?	EGD	BL PD	0	3.05	0.89	0.21	YES	DULL	NO	
205	A48074N	D	?	EGD	BL PD	0	3.85	1.18	0.43	YES	DULL	NO	
206	A48074O	D	?	EGD	B/F	0	4.51	BROKEN	0.24	YES	DULL	YES	side-scraper
207	A48074P	D	?	NMD	BL PD	0	4.43	1.02	0.31	YES	DULL	NO	
208	A48074Q	D	?	EGD	BL SEC	0	3.79	1.14	0.68	YES	DULL	NO	
209	A48074R	D	?	EGD	BL SEC	20	4.52	1.39	0.42	YES	DULL	NO	
210	A48074S	D	?	EGD	B/F	0	2.84	0.61	0.4	NO	DULL	NO	
211	A48074T	D	?	EGD	BL PD	0	2.47	0.87	0.39	YES	DULL	YES	retouched blade
212	A59103	K	C	EGD	BL PD	0	4.31	0.82	0.25	YES	DULL	NO	
212	A48075L	D	?	NMD	BL PD	0	3.99	1.09	0.22	YES	DULL	NO	
213	A48081	D	?	EGD	BL PD	0	3.3	0.94	0.18	YES	DULL	NO	
214	A48082	D	?	EGD	B/F	0	3.63	2.24	0.3	YES	DULL	NO	

215	A48083	D	?	EGD	B/F	0	2.13	1.37	0.19	YES	DULL	NO	
216	A48085	D	?	EGD	BL PD	0	3.12	1.33	0.2	YES	DULL	NO	
217	A48086	D	?	NZD	B/F	75	3.14	1.96	0.36	YES	DULL	NO	
218	A59089	D	?	EGD	BL BI	0	5.79	1.34	0.93	YES	DULL	YES	point
219	A59099	K	C	BB	BL PD	0	2.36	0.97	0.25	YES	DULL	NO	
220	A59102	K	C	BB	BL PD	0	3.08	1.01	0.15	YES	DULL	NO	
222	A59106	K	C	BB	BL PD	0	2.12	0.88	0.23	YES	DULL	NO	
223	A59108	K	C	EGD	BL PD	0	2.82	1.34	0.22	YES	DULL	NO	
224	A59109	K	C	EGD	BL PD	0	2.03	1.04	0.14	YES	DULL	NO	
225	A59113	K	C	BB	BL PD	0	3.32	0.81	0.14	YES	DULL	NO	
226	A59114	K	C	NMD	BL PD	0	3.23	0.86	0.18	YES	DULL	NO	
227	A59118	K	C	PAS	BL PD	0	4.36	1.16	0.17	YES	DULL	NO	
228	A59119	K	C	BB	BL PD	0	2.72	0.76	0.25	YES	DULL	NO	
229	A59120	K	C	NMD	BL PD	0	4.39	1.2	0.2	YES	DULL	YES	notched blade
230	A59127	K	C	BB	BL PD	0	3.41	0.95	0.17	YES	DULL	YES	backed blade
231	A59128	K	C	NMD	BL SEC	20	2.92	0.82	0.17	YES	DULL	NO	
232	A59132	K	C	EGD	REJ	0	3.26	1.81	0.5	YES	DULL	NO	remnant crest
233	A59245	K	D	EGD	REJ	0	3.83	3.32	0.89	YES	LESS DULL	NO	piece esquillee/flake core on thick blade core tablet
234	A59246	K	D	BB	BL PD	0	3.45	2.52	0.56	YES	DULL	YES	retouched blade
235	A59248	K	D	EGD	BL PD	0	2.47	1.27	0.27	YES	DULL	NO	
236	A59249	K	D	NZD	BL PD	0	2.6	0.84	0.26	YES	DULL	NO	
237	A59252	K	D	EGD	BL PD	0	2.79	1.05	0.2	YES	DULL	NO	
238	A59256	K	D	BB	BL PD	0	4.77	0.99	0.21	YES	DULL	NO	

239	A59344	K	E	BB	BL PD	0	4.24	0.99	0.27	YES	DULL	NO	
240	A59347	K	E	BB	BL SEC	0	2.71	1.2	0.34	YES	DULL	YES	backed & retouched blade
241	A59352	K	E	BB	BL PD	0	3.25	1.43	0.21	YES	DULL	YES	denticulated blade
242	A59355	K	E	BB	BL PD	0	3.04	1.03	0.17	YES	DULL	NO	
243	A59365	K	E	EGD	BL PD	0	2.7	0.57	0.2	YES	DULL	NO	
244	A59367	K	E	EGD	BL PD	0	3.1	1.26	0.2	YES	DULL	NO	
245	A59372	K	E	EGD	BL PD	0	4.01	1.55	0.2	YES	DULL	YES	retouched blade
246	A59373	K	E	EGD	BL PD	0	5.55	1.51	0.27	YES	DULL	NO	
247	A59379	K	E	EGD	BL PD	0	2.62	0.86	0.17	YES	DULL	NO	
248	A59387	K	E	MD	BL PD	0	2.15	0.93	0.2	YES	DULL	NO	
249	A59391	K	E	EGD	BL SEC	35	2.68	1.06	0.27	YES	DULL	YES	retouched blade
250	A59392	K	E	EGD	BL PD	0	2.61	0.81	0.23	YES	DULL	YES	backed blade
251	A59393	K	E	BB	BL PD	0	2.27	2.03	0.49	YES	DULL	YES	denticulated blade
252	A59398	K	E	EGD	Flake	0	2.28	1.36	0.63	NO	DULL	NO	
253	A59400	K	E	EGD	BL SEC	10	3.25	1.1	0.23	YES	DULL	NO	
254	A59402	K	E	MD	BL PD	0	3.76	1.24	0.27	YES	DULL	NO	
255	A59403	K	E	NMD	BL PD	0	3.66	1.14	0.3	YES	DULL	NO	
256	A59404	K	E	BA	BL PD	0	2.71	1.21	0.16	YES	DULL	YES	notched (denticulated?) blade
257	A59411	K	E	MD	BL PD	0	2.35	0.78	0.24	YES	DULL	YES	backed blade
258	A59417	K	E	BB	BL PD	0	2.43	1	0.11	YES	DULL	NO	
259	A59426	K	E	EGD	BL PD	0	2.26	1.71	0.25	YES	DULL	YES	denticulated blade
260	A59429	K	E	NMD	BL PD	0	3	0.81	0.26	YES	DULL	NO	
261	A59437	K	E	EGD	BL PD	0	3.53	0.78	0.26	YES	DULL	NO	

262	A59439	K	E	EGD	BL PD	0	3.09	1.07	0.2	YES	DULL	NO	
263	A59440	K	E	NMD	BL PD	0	3.56	1.16	0.26	YES	DULL	NO	
264	A59443	K	E	BB	BL PD	0	3.41	1.1	0.27	YES	DULL	NO	
265	A59446	K	E	NMD	BL PD	0	3.45	0.83	0.21	YES	DULL	NO	
266	A59458	K	E	BB	BL PD	0	1.38	1.76	0.23	YES	DULL	YES	piece esquillee
267	A59463	K	E	PAS	BL PD	0	2.46	0.8	0.16	YES	DULL	NO	
268	A59468	K	E	NMD	BL PD	0	3.3	1.77	0.29	YES	DULL	NO	
269	A59469	K	E	EGD	BL PD	0	3.76	1.22	0.2	YES	DULL	YES	
270	A59472	K	E	BB	BL SEC	0	3.82	1.1	0.63	YES	DULL	NO	notched blade
271	A59482	K	E	EGD	BL PD	0	4.34	1.29	0.23	YES	DULL	NO	
272	A59490	K	E	BB	BL PD	0	2.25	0.93	0.19	YES	DULL	NO	
273	A59496	K	E	EGD	BL PD	0	1.87	0.72	0.15	YES	DULL	NO	
274	A59498	K	E	EGD	BL PD	0	3.59	0.89	0.19	YES	DULL	NO	
275	A59501	K	E	EGD	BL PD	0	2.05	1.67	0.49	YES	DULL	YES	notched blade
276	A59505	K	E	NMD	BL PD	0	2.19	1.52	0.24	YES	DULL	YES	backed blade
277	A59508	K	E	EGD	BL PD	0	2.78	1.97	0.47	YES	DULL	YES	retouched blade
278	A59510	K	E	BB	BL PD	0	2.28	0.8	0.25	YES	DULL	NO	
279	A59511	K	E	EGD	REJ	0	3.98	1.89	0.31	YES	DULL	NO	
280	A59518	K	E	EGD	BL SEC	20	2.18	1.55	0.22	YES	DULL	NO	
281	A59521	K	E	NMD	BL SEC	0	3.63	1.03	0.23	YES	DULL	NO	
282	A59529	K	E	BB	BL PD	0	2.22	1.13	0.17	YES	DULL	NO	
283	A59533	K	E	EGD	BL SEC	0	3.03	1.8	0.38	YES	DULL	NO	
284	A59539	K	E	EGD	BL PD	0	3.06	1.7	0.37	YES	DULL	NO	

285	A59540	K	E	BB	CORE	0	4.03	1.65	0.95	NO	DULL	NO	plunging blade on p/f core
286	A59542	K	E	BB	REJ	0	2.66	2.97	0.68	YES	DULL	YES	end-scraper
287	A59545	K	E	NMD	BL PD	0	2.63	0.81	0.18	YES	DULL	NO	
288	A59547	K	E	EGD	BL PD	0	2.25	1.5	0.27	YES	DULL	YES	retouched blade
289	A59550	K	E	MD	BL PD	0	2.99	1.13	0.16	YES	DULL	NO	
290	A59553	K	E	EGD	BL PD	0	2.99	1.12	0.16	YES	DULL	NO	

Abbreviation key for Table 6.0.0a.

Site: **J**=Tell al-Judaidah; **D**=Tell Dhahab; **K**=Tell Kurdu

Source: **EGD**=East Göllu Dağ; **WGD**=West Göllu Dağ; **NZD**=Nenezi Dag; **ApcE**=Acigöl Post-Caldera East; **AacE**=Acigöl Ante-Caldera East; **AW**=Acigöl West; **BB**= Bingöl B; **BA/NMD**=Bingöl A/Nemrut Dag; **MD**=Meydan Dağ; **SKS**=Sarıkamış; **PAS**=Pasinler.

Table 7.2.1: Width variability of Phase A/B prismatic blades per source type.

Phase A/B	BL PD n=	Source m=	Source s.d.=
Acigöl	1	0.81	
East Göllü Dağ	18	1.09	0.28
Nenezi Dağ	5	1.05	0.20
West Göllü Dağ	1	1.13	
Bingöl B	1	1.01	
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase A/B Sources	**26**	**1.07**	**0.33**

Table 7.2.2: Width variability of Phase C prismatic blades per source type.

Phase C	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	3	1.06	0.37
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	6	0.90	0.09
Bingöl A	0		
Nemrut Dağ	2	1.03	0.17
Meydan Dağ	0		
Pasinler	1	1.16	
Sarıkamış	0		
All Phase C Sources	**12**	**0.98**	**0.17**

Table 7.2.3: Width variability of Phase D prismatic blades per source type.

Phase D	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	2	1.16	0.11
Nenezi Dağ	1	0.84	
West Göllü Dağ	0		
Bingöl B	2	1.76	0.77
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase D Sources	**3**	**1.25**	**0.38**

Table 7.2.4: Width variability of Phase E prismatic blades per source type.

Phase E	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	18	1.23	0.40
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	10	1.22	0.38
Bingöl A	1	1.21	
Nemrut Dağ	7	1.15	0.35
Meydan Dağ	4	1.04	0.18
Pasinler	1	0.80	
Sarıkamış	0		
All Phase E Sources	**41**	**1.18**	**0.37**

Table 7.2.5: Width variability of Phase F prismatic blades per source type.

Phase F	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	4	1.16	0.31
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	0		
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase F Sources	**4**	**1.16**	**0.31**

Table 7.2.6: Width variability of Phase G prismatic blades per source type.

Phase G	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	19	0.99	0.28
Nenezi Dağ	11	1.95	0.84
West Göllü Dağ	0		
Bingöl B	10	1.15	0.20
Bingöl A	1	2.10	
Nemrut Dağ	6	1.32	0.44
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	1	1.30	
All Phase G Sources	**48**	**1.14**	**0.86**

Table 7.2.7: Width variability of Phase H prismatic blades per source type.

Phase H	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	0		
Nenezi Dağ	1	1.58	
West Göllü Dağ	0		
Bingöl B	2	1.12	0.01
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase H Sources	**3**	**1.27**	**0.22**

Table 7.2.8: Width variability of SMR prismatic blades per source type.

Phase SMR	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	1	1.13	
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	0		
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All SMR Sources	**1**	**1.13**	

Table 7.2.9: Width variability of Tell Dhahab prismatic blades per source type.

Unkn Ph from Tell Dhahab	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	42	1.02	0.27
Nenezi Dağ	10	0.99	0.22
West Göllü Dağ	0		
Bingöl B	3	0.72	0.13
Bingöl A	0		
Nemrut Dağ	2	1.06	0.50
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Tell Dhahab Sources	**57**	**1.00**	**0.26**

Table 7.2.10: Width variability of Tell al-Judaidah (unknown temporal context) prismatic blades per source type.

Unkn Ph from Tell Judaidah	BL PD n=	Width m=	Thickness m=
East Göllü Dağ	1	0.73	0.19

Table 7.2.11: Thickness variability of Phase A/B prismatic blades per source type.

Phase A/B	BL PD n=	Source m=	Source s.d.=
Acigöl	1	0.21	
East Göllü Dağ	18	0.22	0.05715
Nenezi Dağ	5	0.23	0.0187
West Göllü Dağ	1	0.33	
Bingöl B	1	0.21	
Bingöl A	0		
Nemrut Dağ	0		

Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase A/B Sources	**26**	**0.24**	**0.07**

Table 7.2.12: Thickness variability of Phase C prismatic blades per source type.

Phase C	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	3	0.20	0.04643
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	6	0.20	0.1135
Bingöl A	0		
Nemrut Dağ	2	0.19	0.01
Meydan Dağ	0		
Pasinler	1	0.17	
Sarıkamış	0		
All Phase C Sources	**12**	**0.20**	**0.04**

Table 7.2.13: Thickness variability of Phase D prismatic blades per source type.

Phase D	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	2	0.24	0.035
Nenezi Dağ	1	0.26	
West Göllü Dağ	0		
Bingöl B	2	0.39	0.175
Bingöl A	0		
Nemrut Dağ	0		

Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase D Sources	**5**	**0.30**	**0.13**

Table 7.2.14: Thickness variability of Phase E prismatic blades per source type.

Phase E	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	18	0.25	0.09507
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	10	0.24	0.09718
Bingöl A	1	0.16	
Nemrut Dağ	7	0.25	0.03943
Meydan Dağ	4	0.22	0.04146
Pasinler	1	0.16	
Sarıkamış	0		
All Phase E Sources	**41**	**0.24**	**0.08**

Table 7.2.15: Thickness variability of Phase F prismatic blades per source type.

Phase F	BL PD n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	4	0.27	0.04763
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	0		
Bingöl A	0		
Nemrut Dağ	0		

Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase F Sources	**4**	**0.27**	**0.05**

Table 7.2.16: Thickness variability of Phase G prismatic blades per source type.

Phase G	Source n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	19	0.27	0.07005
Nenezi Dağ	11	0.32	0.06978
West Göllü Dağ	0		
Bingöl B	10	0.26	0.10980
Bingöl A	1	0.36	
Nemrut Dağ	6	0.30	0.10143
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	1	0.24	
All Phase G Sources	**48**	**0.28**	**0.09**

Table 7.2.17: Thickness variability of Phase H prismatic blades per source type.

Phase H	Source n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	0		
Nenezi Dağ	1	0.29	
West Göllü Dağ	0		
Bingöl B	2	0.2	0.05
Bingöl A	0		
Nemrut Dağ	0		

Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Phase H Sources	**3**	**0.23**	**0.06**

Table 7.2.18: Thickness variability of Phase A/B prismatic blades per source type.

Phase SMR	Source n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	1	0.34	
Nenezi Dağ	0		
West Göllü Dağ	0		
Bingöl B	0		
Bingöl A	0		
Nemrut Dağ	0		
Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All SMR Sources	**1**	**0.34**	

Table 7.2.19: Thickness variability of Tell Dhahab prismatic blades per source type.

Unkn Ph from Tell Dhahab	Source n=	Source m=	Source s.d.=
Acigöl	0		
East Göllü Dağ	42	0.24	0.09529
Nenezi Dağ	10	0.22	0.03466
West Göllü Dağ	0		
Bingöl B	3	0.2	0.01632
Bingöl A	0		
Nemrut Dağ	2	0.27	0.045

Meydan Dağ	0		
Pasinler	0		
Sarıkamış	0		
All Tell Dhahab Sources	**57**	**0.24**	**0.08**

Table 7.2.20: Thickness variability of Tell al-Judaidah prismatic blades per source type.

Unkn Ph from Tell Judaidah	n=	Width m=	Thickness m=
East Göllü Dağ	1	0.73	0.19

Table 7.2.21: Width variability of Acigöl prismatic blades across all Amuq Phases.

Acigöl	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	0.81	
Phase C	0		
Phase D	0		
Phase E	0		
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**0.81**	

Table 7.2.22: Width variability of East Göllü Dağ prismatic blades across all Amuq Phases.

East Göllü Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	18	1.09	0.28
Phase C	3	1.06	0.37
Phase D	2	1.16	0.11

Phase E	18	1.23	0.40
Phase F	4	1.16	0.31
Phase G	19	0.99	0.28
Phase H	0		
SMR	1	1.13	
Unkn Dhahab	42	1.02	0.27
Unkn Judaidah	1	0.73	
All Phases	**108**	**1.07**	**0.32**

Table 7.2.23: Width variability of Nenezi Dağ prismatic blades across all Amuq Phases.

Nenezi Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	5	1.05	0.20
Phase C	0		
Phase D	1	0.84	
Phase E	0		
Phase F	0		
Phase G	11	1.95	0.84
Phase H	1	1.58	
SMR	0		
Unkn Dhahab	10	0.99	0.22
Unkn Judaidah	0		
All Phases	**28**	**1.20**	**0.33**

Table 7.2.24: Width variability of West Göllü Dağ prismatic blades across all Amuq Phases.

West Göllü Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	1.13	
Phase C	0		
Phase D	0		

Phase E	0		
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**1.13**	

Table 7.2.25: Width variability of Bingöl B prismatic blades across all Amuq Phases.

Bingöl B	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	1.01	
Phase C	6	0.90	0.09
Phase D	2	1.76	0.77
Phase E	0		
Phase F	0		
Phase G	10	1.15	0.20
Phase H	2	1.12	0.01
SMR	0		
Unkn Dhahab	3	0.72	0.13
Unkn Judaidah	0		
All Phases	**34**	**1.12**	**0.38**

Table 7.2.26: Width variability of Bingöl A prismatic blades across all Amuq Phases.

Bingöl A	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		

Phase E	1	1.21	
Phase F	0		
Phase G	1	2.10	
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**2**	**1.66**	**0.45**

Table 7.2.27: Width variability of Nemrut Dağ prismatic blades across all Amuq Phases.

Nemrut Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	2	1.03	0.17
Phase D	0		
Phase E	7	1.15	0.35
Phase F	0		
Phase G	6	1.32	0.44
Phase H	0		
SMR	0		
Unkn Dhahab	2	1.06	0.50
Unkn Judaidah	0		
All Phases	**17**	**1.18**	**0.37**

Table 7.2.28: Width variability of Meydan Dağ prismatic blades across all Amuq Phases.

Meydan Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		

Phase E	4	1.04	0.18
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**4**	**1.04**	**0.18**

Table 7.2.29: Width variability of Sarıkamış prismatic blades across all Amuq Phases.

Sarıkamış	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		
Phase E	0		
Phase F	0		
Phase G	1	1.30	
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**1.30**	

Table 7.2.30: Width variability of Pasinler prismatic blades across all Amuq Phases.

Pasinler	BL PD n=	Phase m=	Phase s.d.=
Phase A/B			
Phase C	1	1.16	
Phase D			

Phase E	1	0.80	
Phase F			
Phase G			
Phase H			
SMR			
Unkn Dhahab			
Unkn Judaidah			
All Phases	**2**	**0.98**	**0.18**

Table 7.2.31: Thickness variability of Acigöl prismatic blades across all Amuq Phases.

Acigöl	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	0.21	
Phase C	0		
Phase D	0		
Phase E	0		
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**0.21**	

Table 7.2.32: Thickness variability of East Göllü Dağ prismatic blades across all Amuq Phases.

East Göllü Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	18	0.24	0.08
Phase C	3	0.20	0.05
Phase D	2	0.24	0.04

Phase E	18	0.25	0.10
Phase F	4	0.25	0.05
Phase G	19	0.26	0.08
Phase H	0		
SMR	1	0.34	
Unkn Dhahab	42	0.24	0.09
Unkn Judaidah	1	0.19	
All Phases	**108**	**0.25**	**0.09**

Table 7.2.33: Thickness variability of Nenezi Dağ prismatic blades across all Amuq Phases.

Nenezi Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	5	0.23	0.06
Phase C	0		
Phase D	1	0.26	
Phase E	0		
Phase F	0		
Phase G	11	0.32	0.07
Phase H	1	0.29	
SMR	0		
Unkn Dhahab	10	0.22	0.03
Unkn Judaidah	0		
All Phases	**28**	**0.27**	**0.07**

Table 7.2.34: Thickness variability of West Göllü Dağ prismatic blades across all Amuq Phases.

West Göllü Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	0.33	
Phase C	0		
Phase D	0		

Phase E	0		
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**0.33**	

Table 7.2.35: Thickness variability of Bingöl B prismatic blades across all Amuq Phases.

Bingöl B	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	1	0.21	
Phase C	6	0.20	0.05
Phase D	2	0.39	0.18
Phase E	0	0.24	0.10
Phase F	0		
Phase G	10	0.20	0.05
Phase H	2		
SMR	0		
Unkn Dhahab	3	0.20	0.02
Unkn Judaidah	0		
All Phases	**34**	**0.24**	**0.10**

Table 7.2.36: Thickness variability of Bingöl A prismatic blades across all Amuq Phases.

Bingöl A	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		

Phase E	1	0.16	
Phase F	0		
Phase G	1	0.36	
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**2**	**0.26**	**0.09**

Table 7.2.37: Thickness variability of Nemrut Dağ prismatic blades across all Amuq Phases.

Nemrut Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	2	0.19	0.01
Phase D	0		
Phase E	7	0.25	0.04
Phase F	0		
Phase G	6	0.30	0.10
Phase H	0		
SMR	0		
Unkn Dhahab	2	0.27	0.05
Unkn Judaidah	0		
All Phases	**17**	**0.26**	**0.08**

Table 7.2.38: Thickness variability of Meydan Dağ prismatic blades across all Amuq Phases.

Meydan Dağ	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		

Phase E	4	0.22	0.04
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**4**	**0.22**	**0.04**

Table 7.2.39: Thickness variability of Sarıkamış prismatic blades across all Amuq Phases.

Sarıkamış	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	0		
Phase D	0		
Phase E	0		
Phase F	0		
Phase G	1	0.24	
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**1**	**0.24**	

Table 7.2.40: Thickness variability of Pasinler prismatic blades across all Amuq Phases.

Pasinler	BL PD n=	Phase m=	Phase s.d.=
Phase A/B	0		
Phase C	1	0.17	
Phase D	0		

Phase E	1	0.16	
Phase F	0		
Phase G	0		
Phase H	0		
SMR	0		
Unkn Dhahab	0		
Unkn Judaidah	0		
All Phases	**2**	**0.17**	**0.01**

Table 7.2.41: List of all artefacts with cortex.

Site	Artefact	Phase	Source	Typology	Cortex (%)
Tell Judaidah	A59982A	A	East Göllü Dağ	CORE	5
Tell Judaidah	A60029	A	East Göllü Dağ	REJ	20
Tell Judaidah	A59962A	A	East Göllü Dağ	BL SEC	50
Tell Kurdu	A59128	C	Nemrut Dağ	BL SEC	20
Tell Kurdu	A59400	E	East Göllü Dağ	BL SEC	10
Tell Kurdu	A59518	E	East Göllü Dağ	BL SEC	20
Tell Kurdu	A59391	E	East Göllü Dağ	BL SEC	35
Tell Judaidah	A59997	G	East Göllü Dağ	B/F	30
Tell Judaidah	A45488	G	Bingol B	REJ	35
Tell Dhahab	A48063U	Unkn	East Göllü Dağ	B/F	20
Tell Dhahab	A48074R	Unkn	East Göllü Dağ	BL SEC	20
Tell Dhahab	A48074H	Unkn	East Göllü Dağ	BL SEC	30
Tell Dhahab	A48074K	Unkn	East Göllü Dağ	BL SEC	35
Tell Dhahab	A48074F	Unkn	East Göllü Dağ	BL SEC	55
Tell Dhahab	A48086	Unkn	Nenezi Dag	B/F	75

Table 7.3.0: Chronological distribution of techno-typology for obsidian materials in the Amuq Valley, distinguishing between finished products and evidence for on-site production.

Chronologies				Source Regions									
				Cappadocia				Lake Van area				North East Anatolia	
Absl. Date (BCE)	Archae. Period	Cult. Pr.	Amuq Phase	A	EGD	WGD	NZD	BA	BB	NMD	MD	SKS	PSL
Uknwn	Early Bronze Age	Early Dynastic	SMR		◊ θ				▲				
			I and J										
2900-2400			H				◊		◊				
3500-2700		Uruk Expansion	G		◊ θ ▲		◊ θ ▲	◊	◊ ▲	◊ ▲		◊	
4500-3500	Late Chalco/ EBA	Early Uruk	F		◊ θ ▲								
4800-4300	Chalcolithic	Ubaid	E		◊ ▲			◊	◊	◊ ▲	◊		◊
5200-4800		Halaf-Ubaid	D		◊ ▲		◊		◊				
5700-52000		Halaf	C		◊ ▲				◊	◊ ▲			◊
Unknwn	Late Neolithic	Halaf-ish with Hassuna	FMR		▲								
5500-5000			B										
6000-5500			A	◊ ▲	◊ θ ▲	◊	◊ θ ▲		◊				
Tell al-Judaidah Unknown Phases					◊ θ ▲								
Tell Dhahab Unknown Phases					◊ θ ▲		◊ ▲		◊	◊ ▲			

Legend	Pressure-flaking technology	Opposed platform technology
Evidence for on-site production	▲	N/A
Finished products	◊ (prismatic blades)	θ

Figure 7.1: The Near East with relevant sites and obsidian sources.

Relevant sites: 1-Yumuktepe; 2-Rouj Basin; 3-Çatalhöyük; 4-Domuztepe; 5-Kaletepe-Kömürcü; 6-Sha'ar Hagolan; 7-Tell Kashkashok II; 8-Qdeir 1.

Relevant obsidian sources: 1-Acigöl; 2- Göllü Dağ; 3-Nenezi Dağ; 4-Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

Figure 7.2.1: Dimensions of prismatic blades across Amuq Phases.

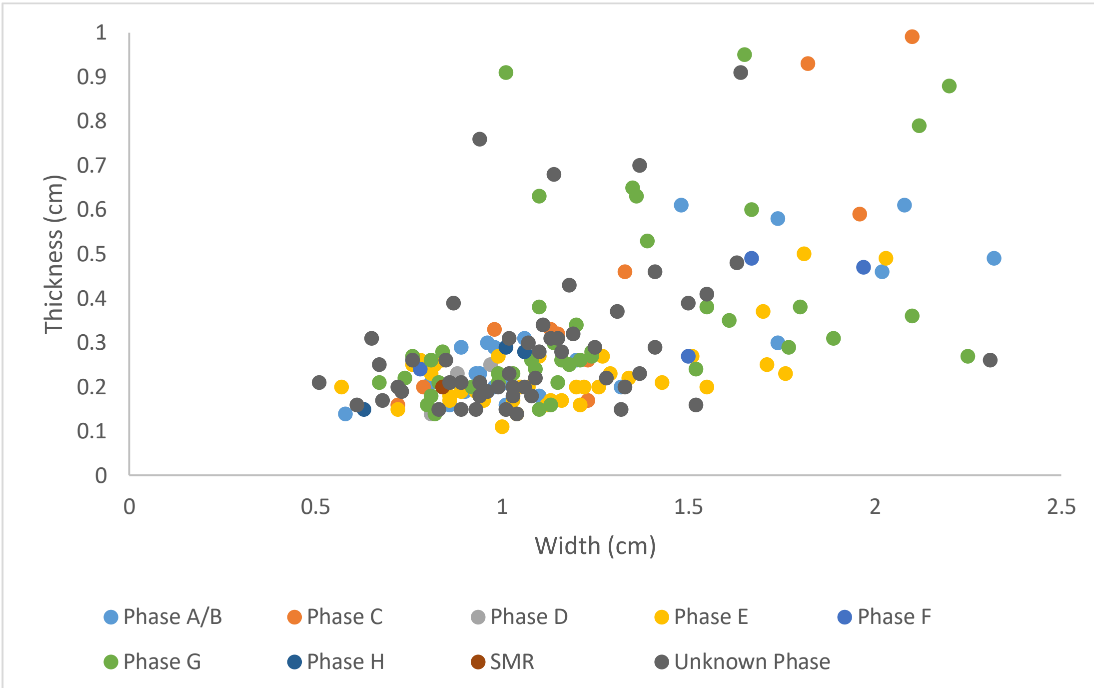


Figure 7.2.2: Dimensions of prismatic blade across material types.

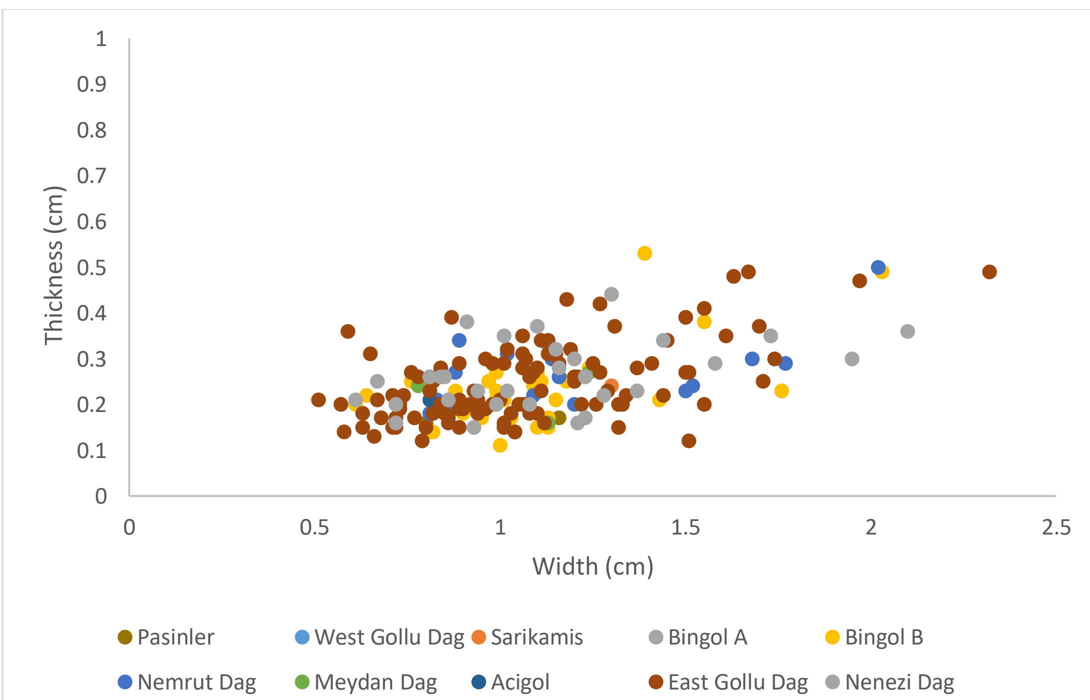


Figure 7.2.3: Comparing dimension means for prismatic blades per source type.

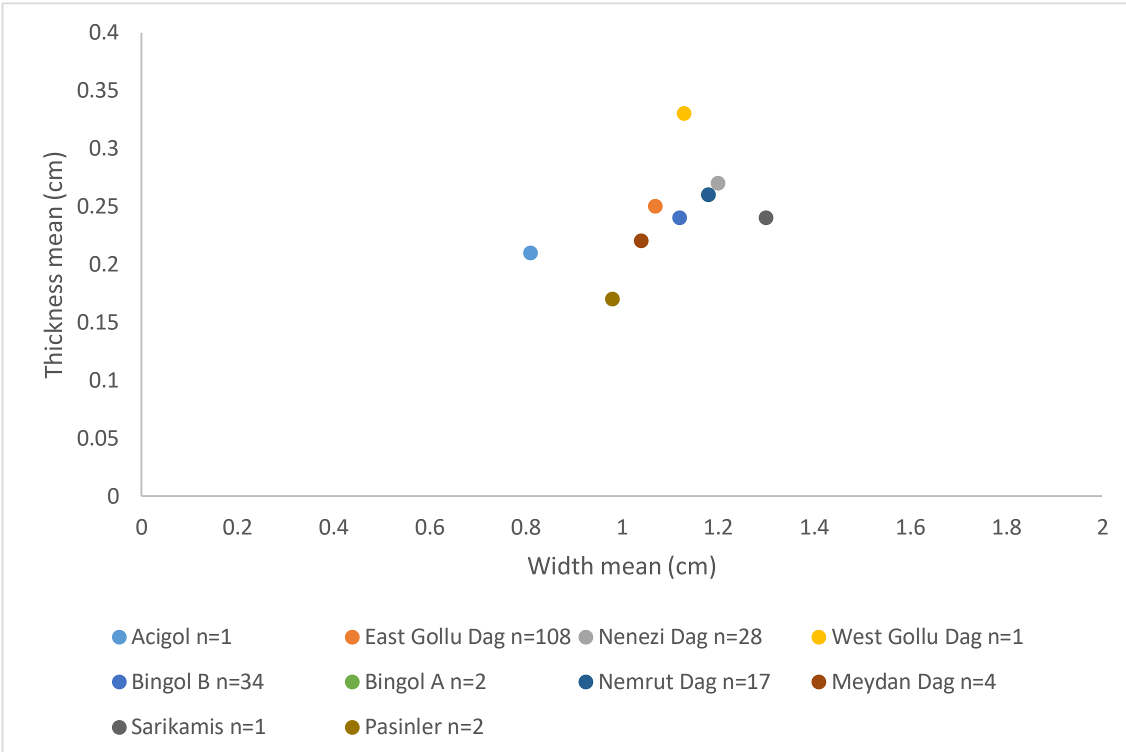


Figure 7.2.4: Comparing dimension means for prismatic blades per Amuq Phase.

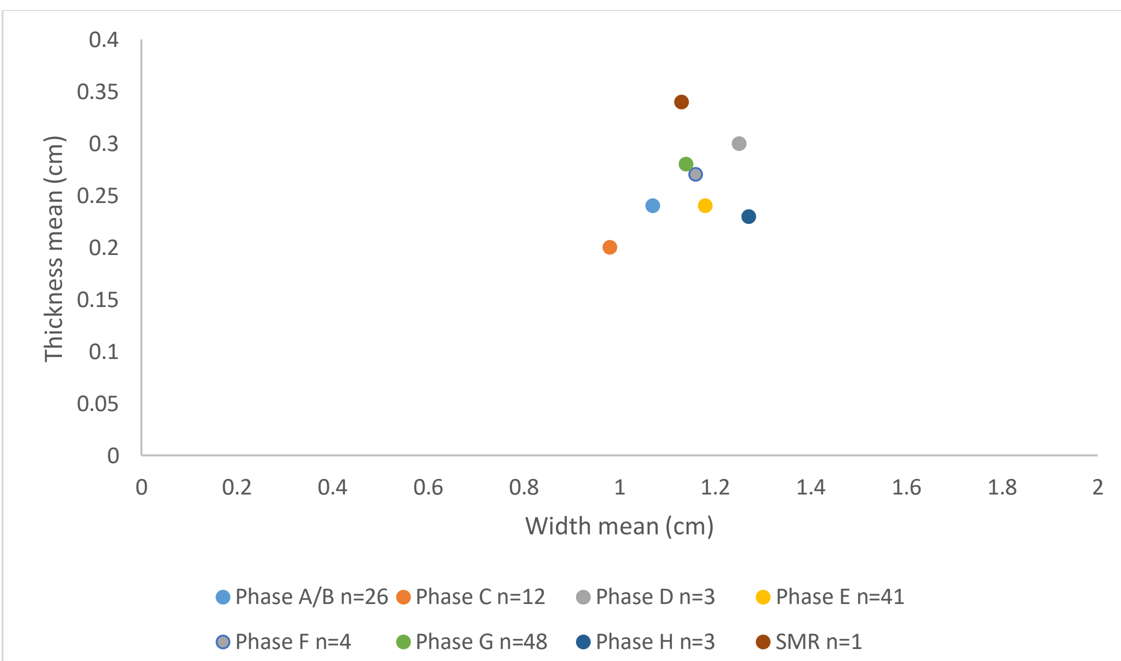


Figure 7.3.1: East Göllü Dağ blank variability (%).

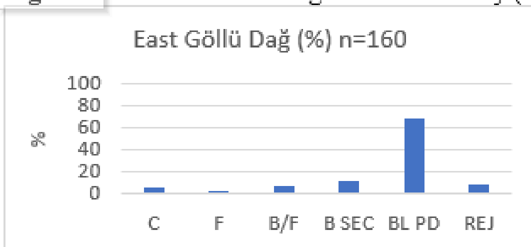


Figure 7.3.2: Nenezi Dağ blank variability (%).

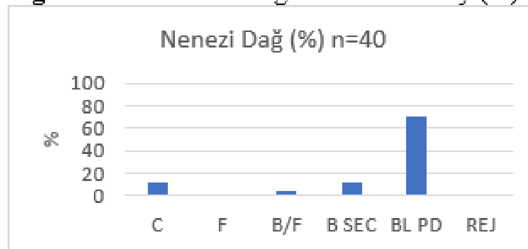


Figure 7.3.3: Bingöl B blank variability (%).

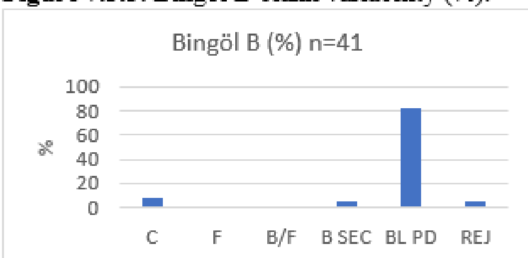


Figure 7.3.4: Nemrut Dağ blank variability (%).

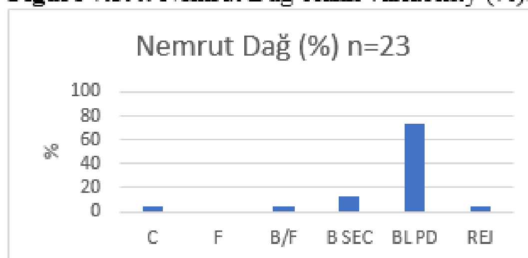


Figure 7.3.5: Acigöl blank variability (%).

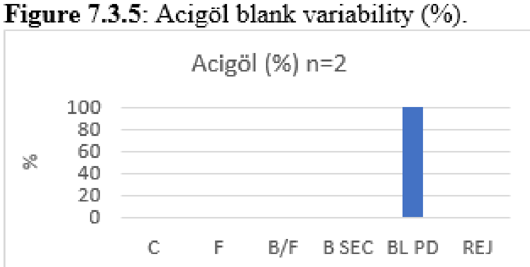


Figure 7.3.6: West Göllü Dağ blank variability (%).

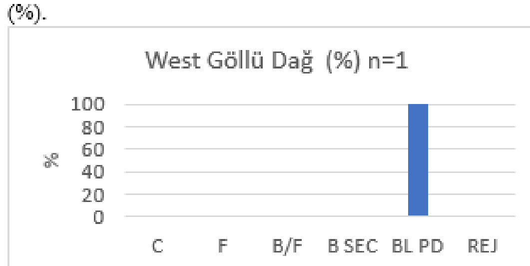


Figure 7.3.7: Bingöl A blank variability (%).

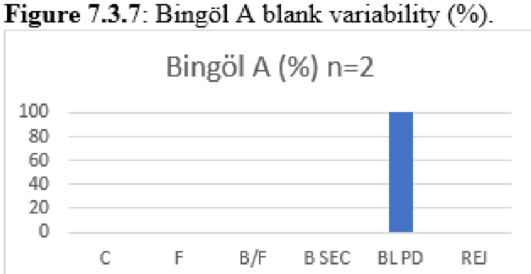


Figure 7.3.8: Meydan Dağ blank variability (%).

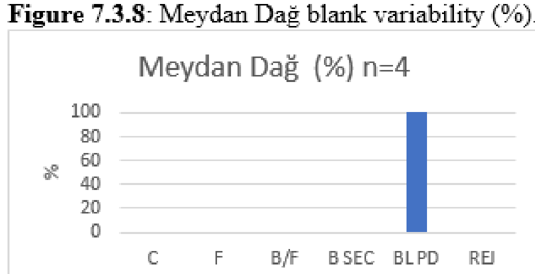


Figure 7.3.9: Sarıkamış blank variability (%).

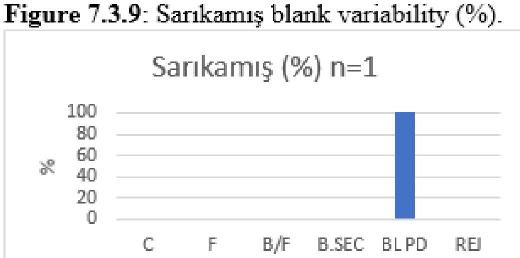


Figure 7.3.10: Pasinler blank variability (%).

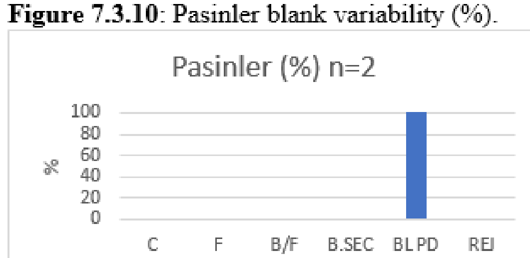


Figure 7.4.1: Phase A/B blank variability (%).

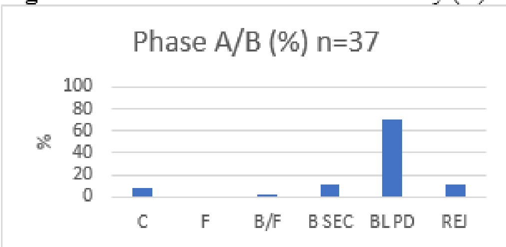


Figure 7.4.2: First Mixed Range blank variability (%).

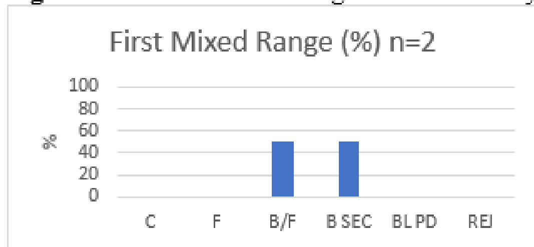


Figure 7.4.3: Phase C blank variability (%).

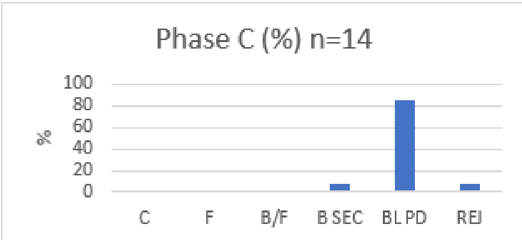


Figure 7.4.4: Phase D blank variability (%).

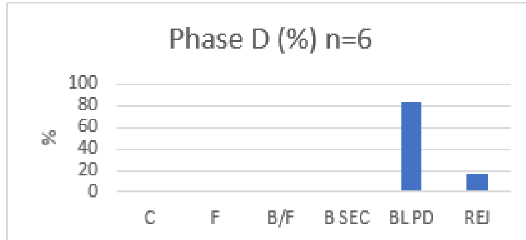


Figure 7.4.5: Phase E blank variability (%).

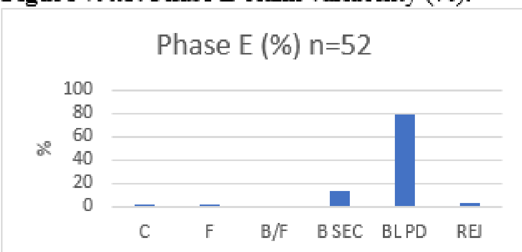


Figure 7.4.6: Phase F blank variability (%).

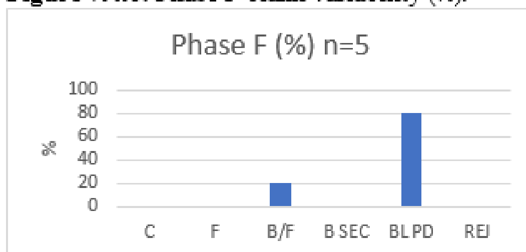


Figure 7.4.7: Phase G blank variability (%).

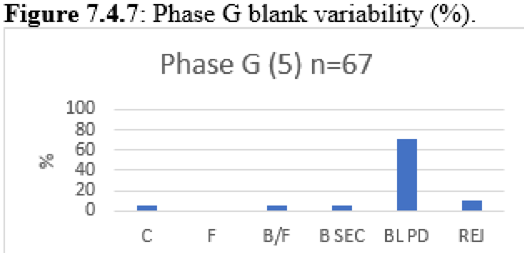


Figure 7.4.8: Phase H blank variability (%).

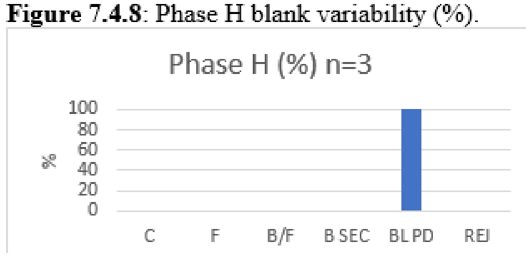
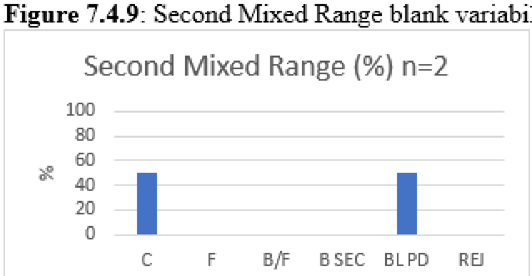


Figure 7.4.9: Second Mixed Range blank variability (%).



Chapter 8: Discussion

8.0 Introduction

In Chapter 2, I presented an archaeological history of the Amuq Valley. This included a detailed review of the material culture reported by Braidwood and Braidwood (1960) as evidence for socio-economic interactions of Phases A to H of the Amuq Sequence with neighbouring regions in the Near East. Now, I will integrate the results of Chapter 6 and Chapter 7, to discuss the significance of these findings within the larger context of obsidian exchange traditions in the Near East between the Late Neolithic and Early Bronze Age (6000 BCE-2400 BCE).

Following my theoretical methodology outlined in Chapter 4, this discussion will integrate comparisons in consumption patterns of spacio-temporally relevant assemblages from supra-regional communities surrounding the Amuq Valley, as well as consider relevant features in concurrent cultural and/or political developments throughout the Near East over the periods of interest. To remind the reader, this multi-scalar time methodology – a re-interpretation of Braudelian time layered with elements of Sewell’s structural theory – is purposed on an as needed basis to enrich the deep-time narrative of obsidian consumption patterns in the Amuq Valley. Furthermore, as explained in Chapter 4, employing this methodology will serve the discussion by integrating these consumption patterns of obsidian as socio-economic patterns within the greater obsidian trade network of the Near East.

This discussion will therefore focus on the socio-economic nature of obsidian consumption as seen from the Amuq Valley and how it connects to the larger obsidian trade network of the Near East. Ultimately it is my aim to study these consumption habits through time as a proxy means of gauging the local impact of major socio-economic developments occurring beyond the Amuq Valley in Mesopotamia and Transcaucasia.

This discussion commences with the first occupation in the Amuq Sequence, Phase A (6000 BCE), found at Tell al-Judaidah, and continues up to the final period of obsidian use in the region, i.e. the 'Second Mixed Range'. This analysis does not assume linear, evolutionary change (cf. Clark 1985: 180), but instead attempts to connect local obsidian consumption practices over time to major political developments events at the supra-regional level.

8.1 Beginnings of obsidian trade in the Amuq Valley

While obsidian exchange attests to supra-regional connectivity in the Near East since the 11th millennium cal. BCE, one can witness significant changes in these networks of interaction during the 6th millennium cal. BCE (Binder 2002). It is within this context – looking at regional time – that we see the first settlement occupations in the Amuq Valley at Tell al-Judaidah (Phase A, 6000 BCE). From the outset these people began to participate in those deep-time exchange networks, those which are observed through archaeological time and speak to obsidian consumption practices of the Neolithic. This led to Levantine peoples (communities observed at regional time) accessing obsidian from the central Anatolian sources of Cappadocia, hundreds of kilometres to the northwest (**Table 6.0.1**). In its earliest period at the local level of time, (Phase A), obsidian from East Göllü Dağ and Nenezi Dağ was being procured in the form of large ready-made blades from an opposed platform technology (the blanks for spearheads), or as pre-formed/part-reduced cores for the on-site production of pressure-flaked blades and bladelets. We also see an abundance of prismatic blade use.

Returning to a perspective of regional time, there is, concurrent to Phase A yet supra-regionally to the east in northern Mesopotamia, the earliest iteration of the so-called Halaf culture (ca. 6100 BCE, see **Table 4.1**). Yet, for the duration of the 6th millennium, while this culture was expanding in territory and influence, Tell al-Judaidah remained on the periphery, both geographically and politically, of this phenomenon. We see this mainly in the ceramic traditions found in the Amuq Valley based on a number of observations detailed in **Chapter 2** (cf. Braidwood and Braidwood 1960). In keeping with a local perspective and observing changes at this temporal scale, this was also discovered at much the same time at Ras Shamra (roughly 70 km south) and Yumuktepe (80 km north-west as the crow flies) (**Figure 8.1**) where locally-made pottery was imitating Halaf forms and décor (de Contentson 1963:36; Thissen 2009:77-78). A second observation on shared pottery traditions was made by Restelli (2017:92) connecting Yumuktepe with the Tell Aray 2 in the Rouj Basin (38km south of the Amuq Valley) (**Figure 8.1**) and Tell al-Judaidah during the First Mixed Range. What we cannot say at this time is whether each of these communities made their Halaf-like pottery from their respective local clays or whether there was an internal distribution of these imitation wares from the Amuq Valley to other communities in Northern Levant and Southern Anatolia.

Overall, when discussing these findings from a regional time perspective, many sites throughout Northern Mesopotamia reveal ceramics displaying a true style of Halafian painted ware (Hole 2013:79) which communities in Northern Levant, including the Amuq Valley, do not share.

When looking at obsidian consumption traditions from a regional time perspective as well, covering the 6th millennium, one notes again, a distinction between North Levantine practices and those of the Halaf world. The latter are dominated by Lake Van obsidian, in keeping with regional procurement traditions since the earliest Neolithic (Chataigner 1998). Interestingly, despite the Northern Levant being on the outskirts of the Halaf, this does not seem to be the case, with our analyses clearly showing a continuing preference for Cappadocian products – a preference observable even at from the deep-time perspective of the Neolithic – by the inhabitants of Tell al-Judaidah with minimal Lake Van products. When dropping to the scale of local time, one sees the same patterns in the Rouj Basin at the contemporary site of Tell Kerkh 2 (Maeda 2003).

Overall, it appears that communities in Northern Levant, particularly the Amuq Valley, Ras Shamra and Rouj Basin, and to some degree Yumuktepe in coastal south-central Anatolia, enjoyed close relations, as evidenced by common ceramic and obsidian traditions observable at the level of regional time. Arguably, the inhabitants of the Amuq Valley in Phase A held stronger socio-economic relationships with these neighbours than it did to supra-regional communities of the Halaf culture.

Lastly, amongst the Phase A assemblage is one artefact that stands out: A59982B, a pressure blade made of Bingöl B obsidian, which extends back in time the use of this source material in the region by some 2000 years (Chataigner 1998).

8.2 New directions in supra-regional connectivity

We shift now from the Phase A and B occupations at Tell al-Judaidah to the new Phase C settlement of Tell Kurdu ca. 5700 BCE, and with it, a marked increase of socio-economic connectivity with the Halaf world, connecting our local time perspective to a regional one. Mellaart (1975:145) describes Phase C in the Amuq Valley as reflecting "an abrupt change in culture". First, this is evidenced in the pottery which Braidwood and Braidwood (1960:146) now describe as true *Halaf Painted Ware*, material that is also now seen at Ras Shamra and, new site of interest for this discussion, Domuztepe, 139km north-east of the Amuq Valley, affiliated with the Halaf culture since the beginning of the 6th millennium (Carter, Campbell and Gauld 2003:129).

Secondly, we see a clear influence of Halafian lithic traditions in the Amuq Valley. The most obvious begins with Lake Van obsidian supplementing Cappadocian products as the dominant raw materials (**Table 6.0.1**), a characteristic of Halaf community consumption practices (Healey 2007:171) observable at the scale of regional time. In turn, Tell Kurdu obsidian artefacts are now described as being "typologically… similar to those found in other Halaf-related assemblages" (Özbal et al. 2004: 59), not least that of Domuztepe (**Figure 8.2**). From a local time perspective, these sites share common traits among artefacts produced using pressure-flaking technology, namely with their consistency in blade thinness and width measurements while said products also make up the majority of each site's obsidian assemblages (Campbell et al. 1999:415). Furthermore, the rate of retouched artefacts are both low, Domuztepe having 5% and Tell Kurdu (during Halaf Phases C & D) having 1.5%. Based on results of visual characterization studies and chemical sourcing, obsidian from Domuztepe has been matched to ten sources, including those from Armenia or North-East Anatolia (Healey and Campbell 2009; Frahm, Campbell and Healey 2016b).

Lastly, one of Domuztepe's common technological features "grinding of butts| (Campbell et al. 1999:415) was also recorded on five Amuq Valley products. Surprisingly, however, none of these come from Tell Kurdu. Four of these were from Tell al-Judaidah Phases G (A59853, A59846, and A59862) and H (A45482) made from East Göllü Dağ, Nenezi Dağ and Nemrut Dağ obsidian. The fifth came from Tell Dhahab (A48074N) made from East Göllü Dağ.

On the other hand, from another observation at the local level, comparative concentration studies for obsidian versus flint consumption at Tell Kurdu and Domuztepe revealed that the former was still unique from traditional Halaf. That is, obsidian quantities showed to be "significantly higher than at other Halaf period regional sites" (Bressy, Poupeau & Yener 2005:1562). In Campbell et al. (1999:414), these concentrations (following results from 1997 excavations) were compiled into a table which has been reproduced according to Amuq Phase (cf. **Table 8.2.1**). In the end, from a regional time perspective, it can be said that Tell Kurdu was certainly a regional variant of Halaf cultural practices.

While the community of Tell Kurdu was building these Halaf relations with the inhabitants of contemporary Domuztepe, so too were these supra-regional relations occurring elsewhere in the Northern Levant. As we have seen with Tell Kurdu, obsidian consumption is characterized by a dominance in Lake Van varieties over Cappadocian ones, while Tell al-Judaidah does not express this type of influence. The same pattern occurs just south of the Amuq Valley in the Rouj Basin. Tell Aray 1, a site contemporary with Tell Kurdu Phase C, is dominated by Lake Van obsidian all the while, Tell Kerkh 2 also in the Rouj Basin (contemporary to Tell al-Judaidah Phase A), Lake Van raw materials were rarely if ever imported (Maeda 2003). This suggests that select communities from respective areas in the Northern Levant may have been responsible for receiving these higher concentration of Lake Van materials. In other words, the integration of the Halaf culture from a regional time perspective is seen to arrive in the Northern Levant halfway through 6th millennium by way of establishing new communities such as Tell Kurdu in the Amuq Valley and Tell Aray 1 in the Rouj Basin rather than weaving these Halaf practices within those already existing at Tell al-Judaidah and Tell Kerkh 2 in their respective locals.

In turn, the north Levantine coastal community of Ras Shamra continues to show similar assemblages to the Amuq Valley, while simultaneously coming under a "sweep of Mesopotamian influence" (de Contenson 1963:36). This suggests that the Amuq Valley, being situated between Ras Shamra and Mesopotamia, may have acted as an intermediary for the Halafian expansion to regions in Northern Levant using Domuztepe as its gateway.

8.3 Peak of obsidian trade in the Amuq Valley

From an archaeological time perspective (deep-time) of the Amuq Sequence (Phases A-H only), obsidian consumption reached its highest rates ever during the Late Chalcolithic, by the final occupational phase of Tell Kurdu, Phase E, with a total of 230 artefacts recovered (**Table 2.0.1**). It is during this phase, from the local time perspective of Phase E, that we also see the first and only appearance (given the sample collection) of Meydan Dağ obsidian. Interestingly, this approximates local times when Meydan Dağ appears in communities in Northern Mesopotamia (sites: Chagar Bazar [Renfrew, Dixon and Cann 1966:40] and single specimens from Late Chalcolithic sites Tell Brak and Tell Hamoukar respectively [Khalidi et al. 2009]). Finally, Meydan Dağ has been recorded from contemporary local time periods at Domuztepe (Healey and Campbell 2014:88) and the Rouj Basin (Maeda 2009). On the other hand, Meydan Dağ has not been confirmed at any Middle-Euphrates communities during the later Halaf including Qdeir 1 (Orange 2012) and Halula (Pernicka, Keller and Cauvin 1997). And yet, Meydan Dağ has been recovered from Byblos in Southern Levant by the end of the 5th millennium BCE (Wright and Gordus 1969:77). What these occurrences from a perspective of local time show is a network of Meydan Dağ obsidian travelling over the course of a regional time perspective: from Northern Mesopotamia through the Levant, bypassing the Middle-Euphrates as it travels first to Domuztepe, then toward the Amuq Valley before descending southward (**Figure 8.3**).

What this means for the people of Tell Kurdu from a local time perspective, is continued supra-regional connections between Domuztepe, and Ras Shamra up to Phase E (4800-4300 BCE). This is also demonstrated through the common use of a bichrome and painted-orange pottery tradition at Post-Halaf Domuztepe, Ras Shamra (Campbell et al. 1999:407-412), and Tell Kurdu Phases D-E (Braidwood and Braidwood 1960). We also note the unique obsidian pendant recovered from Phase E Tell Kurdu (Braidwood 1960:220 [unfortunately not included in this study]); adornments such as pendants and beads are a new and characteristic form of obsidian consumption of the Halaf Culture, well-attested from contemporary Domuztepe and Ras Shamra IVA (Healey and Campbell 2014).

At the same time, however, returning to a regional perspective, the Amuq Valley was also forming stronger ties with the Ubaid cultural expansion (Caneva et al. 2012) matching Braidwood and Braidwood's description of Phase E as "overwhelmingly" of the Ubaid tradition (1960:511). In the end, this may explain the eventual re-connectivity at the end of the 5th millennium between the Amuq Valley and Yumuktepe based on the common appearance (from a local time perspective) of Ubaid style ceramics (also seen at Domuztepe [Campbell et al. 1999:407]). These vessels would have most likely traveled via the Middle-Euphrates where the Ubaid culture is noticeably present (Frangipane 2012) observable from regional time. In sum, the Amuq Valley can be understood as a bridge linking cultural traditions between southern coastal Anatolia (Yumuktepe), to areas East as far as Domuztepe and communities in Middle-Euphrates (**Figure 8.3**).

Overall, what we see from a deep-time perspective of this occupational period at Tell Kurdu from Phases C-E (5700-4300 BCE) of the Chalcolithic period, is that the Amuq Valley held an important role socio-economic bridge, first for the Halaf culture descending from Northern Mesopotamia to Southern Levant, followed by the Ubaid cultural spread from the Middle-Euphrates to the coastal south-central Anatolia.

8.4 Continuity alongside new technology

As the Chalcolithic period graduated into the Early Bronze Age, the Near East saw a number of changes take place, namely a technological replacement with the dawn of metallurgy, supported by the so-called Uruk Expansion (see below). The deep-time effects of this replacement is reflected at the local time perspective in the Amuq Valley with, occupation seemingly abandoning Tell Kurdu and re-flourishing at Tell al-Judaidah. This change marks the beginning of Phase F (4500-3500 BCE) -- Tell Kurdu showing no transition in contact from the final level in Phase E (Braidwood and Braidwood 1960:512). Even more indicative is the significant decrease in obsidian consumption at Phase F (**Table 2.0.1**), most likely a response to the dawn of metallurgy spreading across the Near East according observations of regional time.

After all, Lehner and Yener (2014) state that metal trade (essentially beginning by the mid to late Chalcolithic – roughly contemporary with Phase E and F) is characterized more by localized procurement. It is possible to conceive then that the new technology and traditions (ideas and know how) of metallurgy had spread across the Near East in a fashion more noticeable at the regional time perspective. That is, by the beginning of Phase F at Tell al-Judaidah, communities throughout the Near East had begun practicing localized procurement of metals, requiring the Amuq Valley to do the same if they were to continue this technology. In turn, their attention to exploiting local resources would have diminished the interest or need for exotic materials such as obsidian. This explains the marked drop in consumption rates of obsidian in the Amuq Valley at the local level by Late Chalcolithic (Phase E n=230; Phase F n=63 **Table 2.2**). Furthermore, this pattern can be explained by the fact that the Amuq Valley during this local time was considered a "resource area" (Lehner and Yener 2014:539) for copper and gold, again, negating the communities' interest or need for the high cost importation of long distance materials such as obsidian. Supporting this claim, the next nearest source area for metal outcrops was in the Taurus Mountains (**Figure 8.4**), suggesting that, any obsidian that was still being circulated into the Amuq Valley, would more likely have come from Cappadocia as these obsidian varieties are located amongst the Central Anatolian metal sources. As it happens, all six of the artefacts in the sample collection representing Phase F, come from East Göllü Dağ.

However, there is also the idea of the Uruk Expansion to consider obliging us to expand our perspective once again to examine deep-time developments during this archaeological period. As early as 3800 BCE, a second wave of culture and tradition, the Uruk culture, began spreading from its southern Mesopotamian homeland until the beginning of the 4th millennium BCE (~3100 BCE) (**Figure 8.4**). The north and eastward spread of Uruk cultural features has been generally interpreted as the result of a Mesopotamian elite exerting greater influence over those networks through which metals and other desired products were being procured in attempt to maintain socio-economic position (Campbell et al. 1999:417). This was allegedly achieved through their establishment of colonies and outposts in Upper Mesopotamia and Anatolia as a means for directing long-distance exchange networks southward (Algaze et al. 1989; Wright 2016). For example, it is claimed that it was the "itinerant potters" of the Uruk period rather than the pots themselves which are disseminating into territories across the Fertile Crescent (Wright 2016: 903; Healey and Campbell 2014). It is possible, that with the contribution of metal technology being practiced and socio-political efforts focused on the migration movements of potters from the south, that this subtracted resources from the obsidian trade network. In the end, the Amuq Valley can easily be described from this regional time perspective as an important point of convergence for the metal trade network, being a "pivotal area linking the coastal Mediterranean with the cultures of Syro-Anatolia" (Lehner and Yener 2014:544).

Continuing through the Early Bronze Age, Phase G, also occupied by Tell al-Judaidah (3500-2700 BCE), shows that obsidian consumption has nearly doubled (n=63) since Phase F (**Table 2.0.1**). This is still not nearly as impressive since Tell Kurdu's Phase E (4800-4300 BCE) (n=230), which concluded the Final Ubaid period, however, it does raise the question about the valley's supra-regional ties. Still from a regional time perspective, we can consider how Phase F is contemporary to the Early Transcaucasian Spread; a "widespread phenomenon" that encompassed the Caucasus, Eastern Anatolia, and Upper Euphrates by around 4250 BCE (Palumbi 2011:211). The phenomenon can be best recognized as a distinct ceramic tradition expressed in several heterogenous forms, Kura Araxes, and Red-Black Burnished to name a few (Wilkinson 2014:204). The spread commenced rapidly at first, moving across Northern Mesopotamia, then the Euphrates, until making sporadic appearances in the Levant as of Phase G in the Amuq Valley (Wilkinson 2014:204) (**Figure 8.4**).

It is not surprising, therefore, that Phase G consumption from Tell al-Judaidah begins receiving anew Eastern Anatolian obsidian as far as Sarıkamış, situated within the Transcaucasia region. Not only does the obsidian mark the arrival of this cultural phenomenon into the Amuq Valley, but pottery found in Phase G levels described by Wilkinson (2014:204) attest to the same observation. Thus, once more we see evidence of supra-regional connectivity, this time from as far as North-East Anatolia, make an impact on obsidian consumption patterns in the Amuq Valley.

8.5 The end of obsidian exchange in the Amuq Valley

As would eventually unfold over the course of a deep-time perspective, the Early Transcaucasian Spread retracted in territory, essentially cutting ties with the Uruk, extending only as far as Northern Mesopotamia (Wilkinson 2014:223). Meanwhile, metallurgy is only becoming more significant. Ultimately, the utilitarian advantages of lithic technology fades away even at the local time perspective, leaving little to no consumption of obsidian during Phases H (n=3), I (n=0), and J (n=0), before the Second Mixed Range procures three final artefacts (Table 2.0.1). Frangipane (1993) believes (as cited by Palumbi 2011) that any long distance trade, still occurring during the Early Bronze Age, was on the back of the obsidian trade network, which only survived thanks to the elitists who favoured the raw material as a symbol of wealth.

8.6 Summary

The deep-time narrative of obsidian consumption in the Amuq Valley could be described as on-going over a 3600 year period, with supra-regional influences, occurring at the regional level, instigating change at the local level. This discussion cannot, however, be summarized that simply as we have witnessed with the importance of recognizing supra-regional events as they translate into triggers for socio-economic relationships connecting the Amuq Valley through time and space into the greater prehistoric narrative of the Near East.

For the Amuq Valley, this narrative begins during the Late Neolithic, early Halaf period (Phase A and B), where socio-economic relationships were localized to the Northern Levant (Ras Shamra and the Rouj Basin) and southern coastal Anatolia (namely, Yumuktepe). During the Chalcolithic, at the peak of the Halaf period, the Amuq Valley formed a supra-regional relationship with Domuztepe, enabling a stronger appearance of the Northern Mesopotamian Halaf traditions to trickle down through the Northern Levant to previously interrelated neighbouring communities – with the exception of Yumuktepe. Instead, supra-regional relationship with Yumuktepe fell dormant until the rise of the Ubaid period, followed by the Uruk expansion when cultural traditions spread from Southern Mesopotamia to Central Anatolia through the Middle-Euphrates then Northern Levant, particularly, via the Amuq Valley. Finally, during the Early Bronze Age, we see a resurgence of connectivity with Northern Mesopotamia due to the Transcaucasian spread originating further north. Once again, the Amuq Valley becomes an intersection, connecting regions all the way from North-East Anatolia to Southern Levant. Eventually, the Amuq Valley's supra-regional connectivity returned to a similar spread of its original status in the Late Neolithic as metallurgy interrupts routes for long distance trade. In the end, the Amuq Valley served as a crossing point for cultural expansions to spread across the Near East either from Northern Mesopotamia to the Levant, or Southern Mesopotamia and Middle-Euphrates to Central Anatolia. Furthermore, these supra-regional connections were formed due to the long distance trade of cultural material such as obsidian. By observing these trade networks through deep-time, it is possible to rebuild the socio-economic landscape that characterized the Amuq Valley as an important region responsible for supra-regional connectivity throughout the Near East.

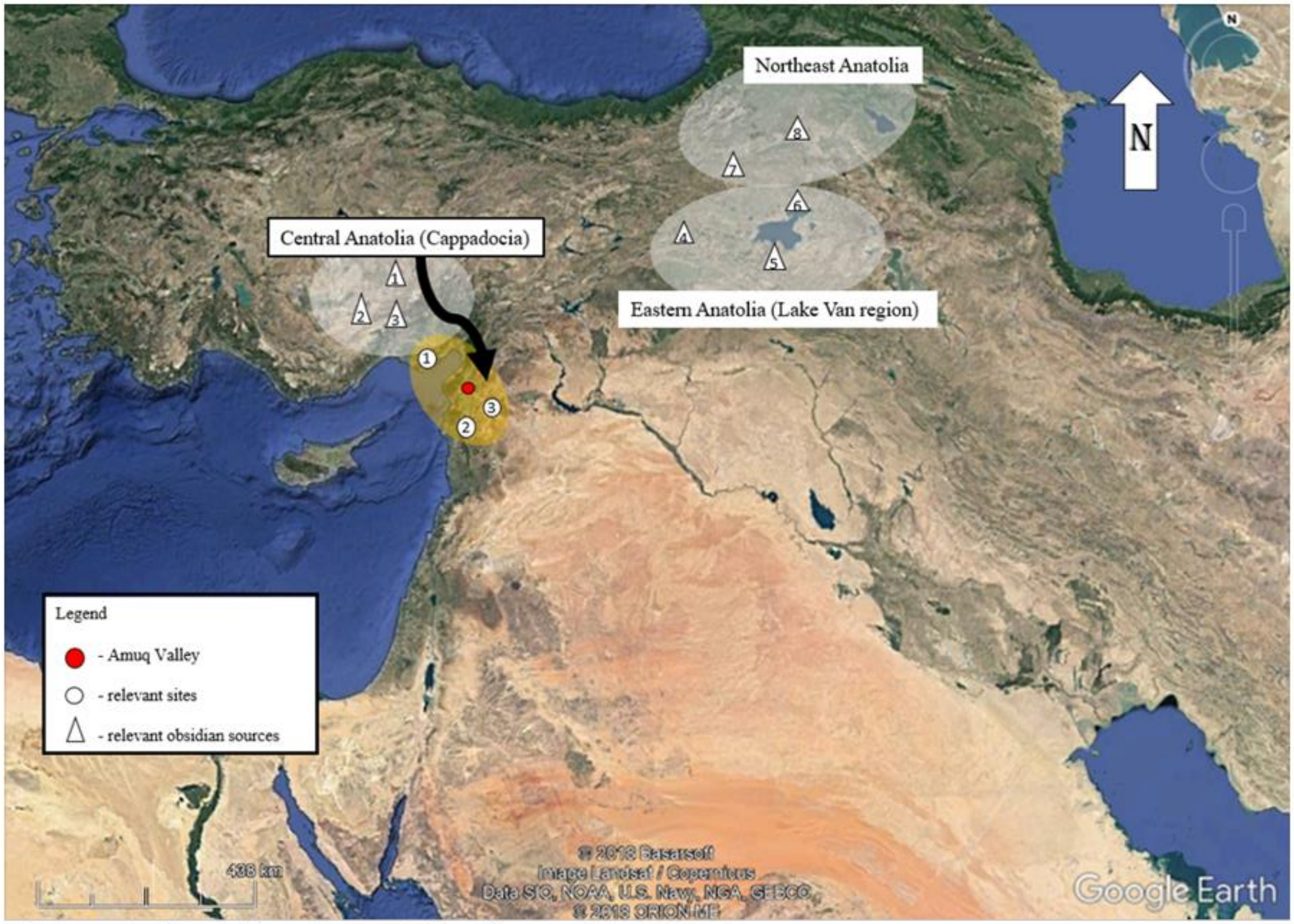
As we see the depth of interconnectivity between regions in the Near East, the Amuq Valley has become a facet for understanding the bigger picture of how a past unfolds. In the proceeding and final chapter of this thesis, I will conclude with further remarks on the nature of this facet and how it contributes to our current knowledge and appreciation for Near Eastern archaeology.

8.7 Chapter 8 Tables and Figures

Table 8.2.1: Concentrations of obsidian for total lithic consumption at sites Tell Kurdu and Domuztepe, retrieved from Campbell et al. 1999:414 based on 1997 excavations.

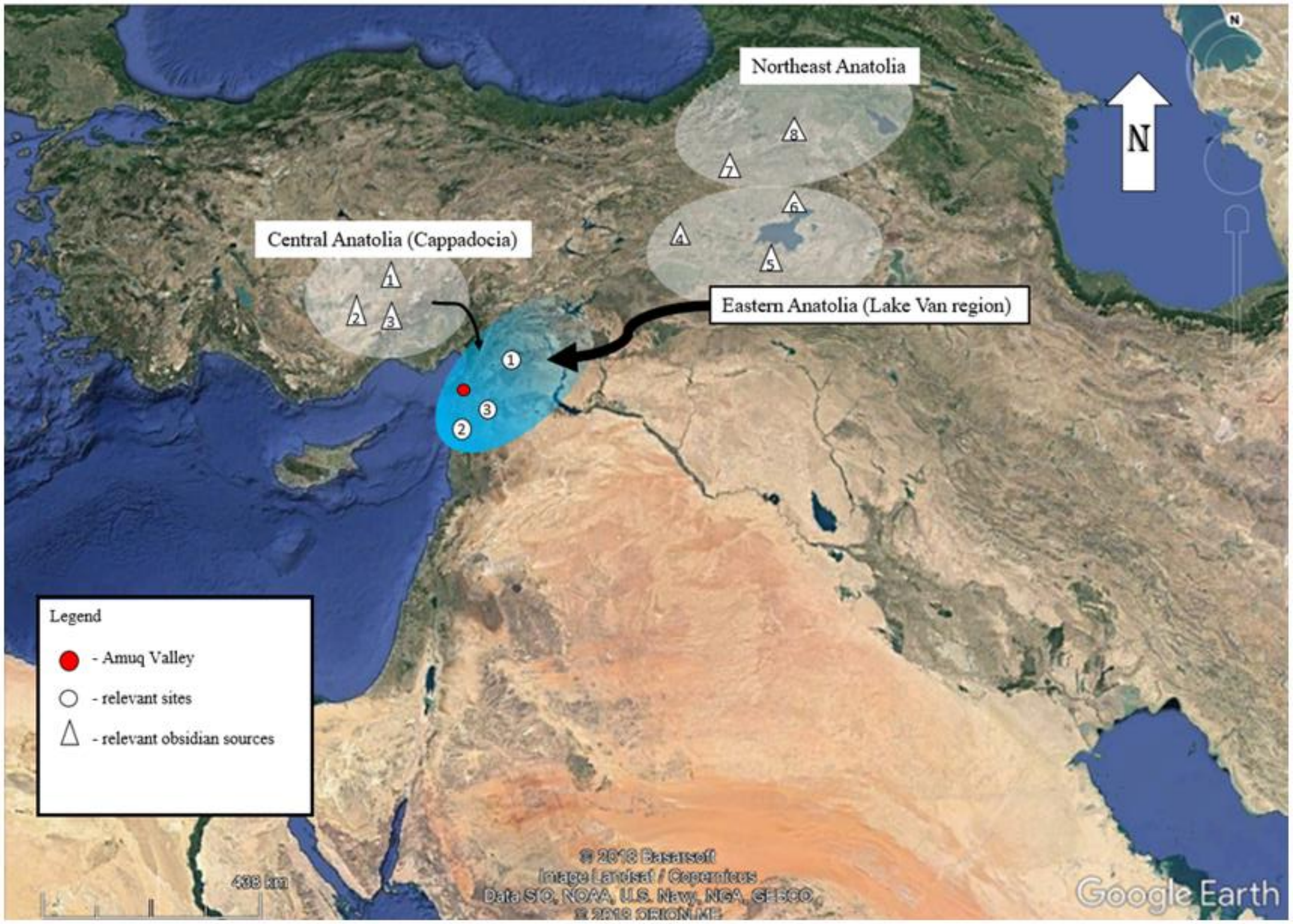
	Tell Kurdu	Domuztepe
Phase E (Post-Halaf B)	33%	19%
Phase D (Post-Halaf A)	24%	7%
Phase C (Late Halaf)	36%*	11%
*Özbal et al. 2004:56 and Healey 2010:56 record this as 23%.		

Figure 8.1: Socio-economic connectivity for the Amuq Valley during the Late Neolithic.



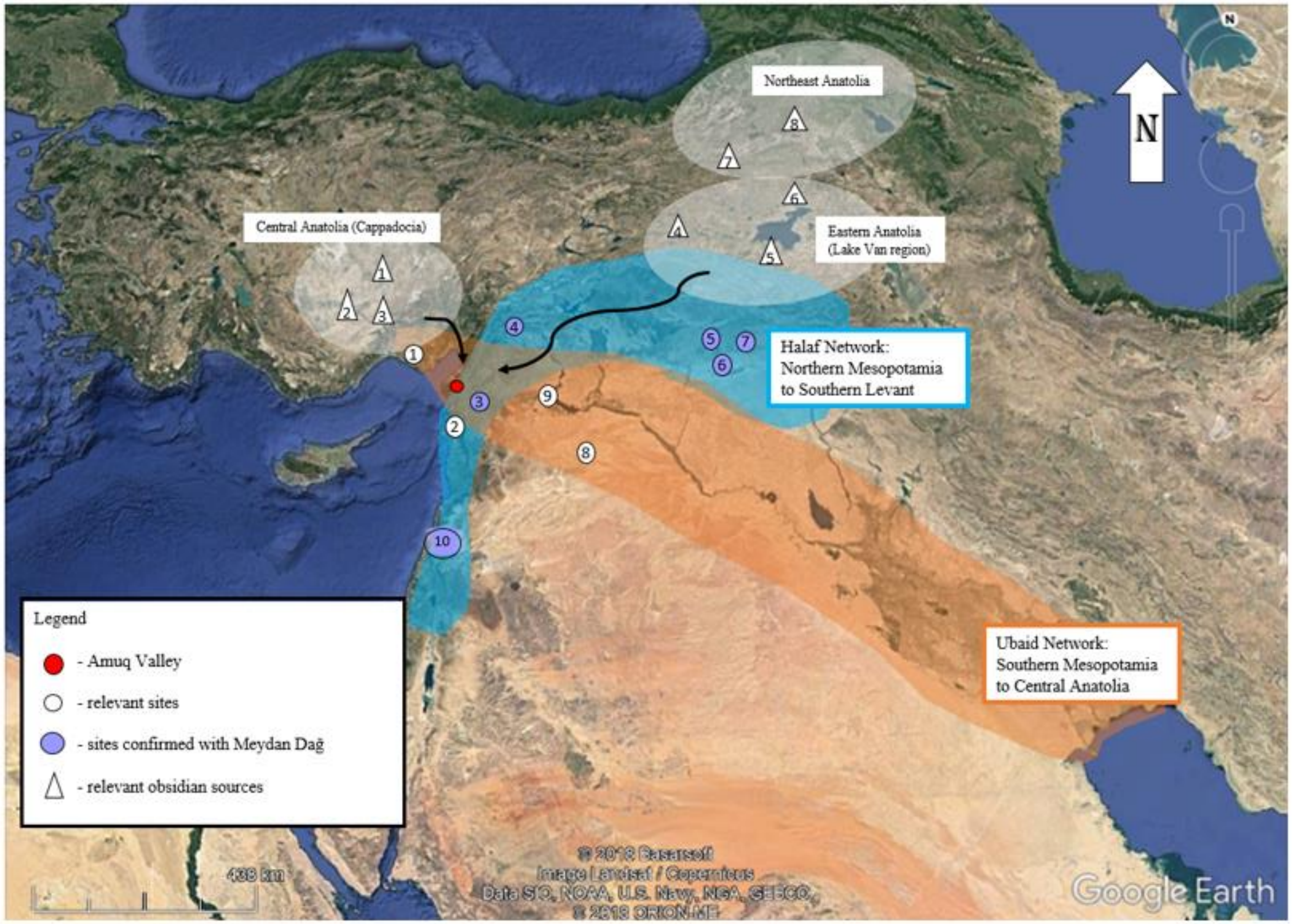
Relevant sites: 1-Yumuktepe; 2-Ras Shamra; 3-Rouj Basin.
Relevant obsidian sources: 1- Acigöl; 2-Göllü Dağ; 3-Nenezi Dağ; 4- Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

Figure 8.2: Socio-economic connectivity for the Amuq Valley during the Late Neolithic to Chalcolithic.



Relevant sites: 1-Domuztepe; 2-Ras Shamra; 3-Rouj Basin.
Relevant obsidian sources: 1- Acigöl; 2-Göllü Dağ; 3-Nenezi Dağ; 4- Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

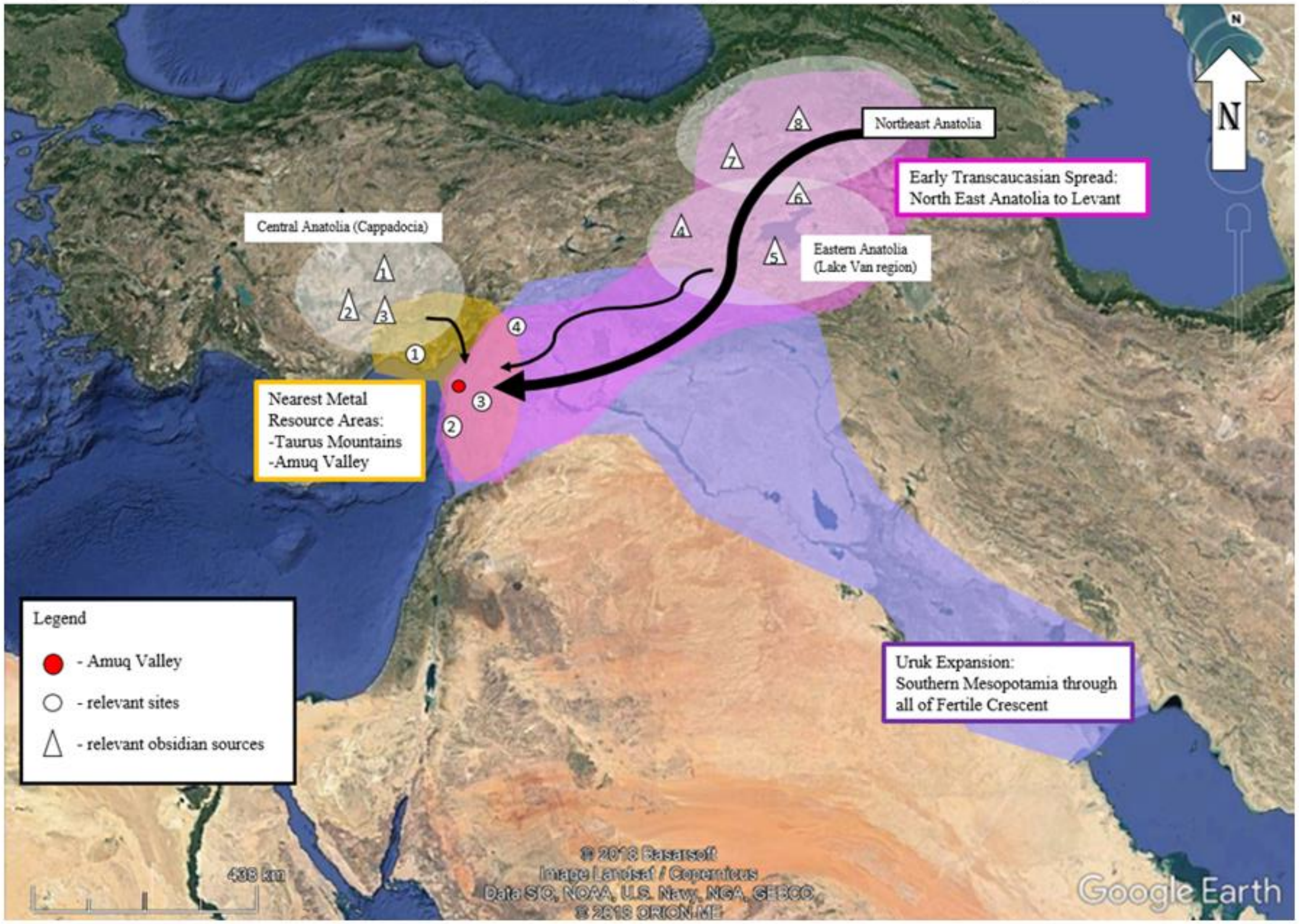
Figure 8.3: Socio-economic connectivity for the Amuq Valley during the Late Chalcolithic and Early Bronze Age.



Relevant sites: 1-Yumuktepe; 2-Ras Shamra; 3-Rouj Basin; 4-Domuztepe; 5-Chagar Bazar; 6-Tell Brak; 7-Tell Hamoukar; 8-Qdeir 1; 9-Halula; 10-Byblos.

Relevant obsidian sources: 1- Acigöl; 2-Göllü Dağ; 3-Nenezi Dağ; 4- Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

Figure 8.4: Socio-economic connectivity for the Amuq Valley during the Early Bronze Age.



Relevant sites: 1-Yumuktepe; 2-Ras Shamra; 3-Rouj Basin; 4-Domuztepe.
Relevant obsidian sources: 1- Acigöl; 2-Göllü Dağ; 3-Nenezi Dağ; 4- Bingöl; 5-Nemrut Dağ; 6-Meydan Dağ; 7-Pasinler; 8- Sarıkamış.

Chapter 9: Conclusion

The purpose of this thesis has been to throw light on the significance of the Amuq Valley's role as a bridge between regions, establishing socio-economic relationships across the Near East by generating discussions surrounding the nature and diachronic patterning of obsidian consumption. Identifying obsidian distribution and consumption patterns from XRF sourcing and techno-typological studies through a multi-scalar deep-time perspective, archaeologists can gain new perspectives on how communities across the Near East operated socially and economically with one another. Not only were these socio-economic relationships formed in part, because of the obsidian trade network, but also became a means for maintaining such long-distance relationships for other socio-economic purposes through deep-time. Long-distance trade is not meant to be used as a system for control of equal exchanges, but rather it is a system set in motion for producing "valuable long-term alliances" (Wilkinson 2014:219). Long-distance trade, in this sense, is a system utilized for creating and sustaining supra-regional relationships.

When looking at the Near East, obsidian was a constant resource that kept long-lasting supra-regional relationships in place. Although obsidian was desired for its intrinsic value over its agency as a socio-economic bridge between regions, its importance to the continuity of shared ideas, technologies and traditions cannot be overlooked. In a sense, the obsidian trade was a conduit for the micro-globalization of the Near East. Situated in a unique geographical location, the communities of the Amuq Valley were afforded the role for being a major intermediary contributing to the reach and circulation of these supra-regional relationships through deep-time.

With approximately 3600 years of obsidian consumption, the Amuq Valley during its early phases, thrived as a region of settlements, steadily growing and changing throughout time. From ceramic and lithic traditions to metallurgy, from the first sedentary communities to spawning urbanity, and from opportunistic long distance exchange to a proto-globalization of politically motivated and multi-systematic organism of trade, the Amuq Valley is more than just a hub of settlements in the Northern Levant set on the outskirts of major geo-political and cultural traditions. Rather, the Amuq Valley needs to be considered as an intersection of communications that help characterize Near Eastern trade as it dealt with the flow of people and cultural materials at large. After all, the Amuq Valley was not only a witness to more well-known developments of the Near East, but remained intact in terms of its continued occupation during the rise and fall of more powerful cultural complexes beginning with the Hassuna and the Halaf, followed by the Ubaid and then finally the Uruk with traces of the Early Transcaucasian Spread. What archaeology can learn from studying the Amuq Valley is the importance of its smaller settlement sizes, occupying a region in between larger ones, thereby acting as a conduit for socio-economic relationships in Near East.

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APPENDIX

Appendix A: Surface Contamination Experiment

A.A.1 Introduction

The purpose of conducting this experiment was to test the effects of surface contamination on the ppm values of individual elements measured during EDXRF analysis. The experiment was undertaken using four specimens of geological obsidian from a single Japanese source, all of varying sizes, and one arbitrarily chosen archaeological obsidian artefact from the Amuq Valley collection (A48063Y).

A.A.2 Methods

The experiment was undertaken in two parts. The first, Run A, analysed the four Japanese obsidian samples in a *clean* state (Table A.A.i). Preparation and analysis followed the standard protocols detailed in Chapter 5. Pictures were taken of these samples in their tray positions to record their exact orientation in order that we might reposition in the same manner in the second run. The purpose of this was an attempt to control as many variables as possible that arise when reanalysing the same surface multiple times.

The second set of analyses (Run B) involved adding different contaminants to the target-surface of three pieces of the Japanese obsidian, the fourth remaining clean to act as the control (Table A.A.i). In the end, four types of possible surface contaminants were chosen for testing, namely: adhesive tape, to replicate the possible contamination effect of the tape we use to attach our artefacts to the sample tray; Mylar film, to replicate the possible contamination effect of the sample cups we use to hold very small artefacts on the sample tray; nail polish, to replicate the possible contamination effect of the varnish used by the OIM to protect the inked artefact number; and finally the white ink, to replicate the possible contamination effect of the ink used by the OIM to mark the Amuq Valley artefacts.

Since the Amuq Valley collection was catalogued using an unknown brand of white corrector ink, it was impossible to replicate the exact conditions of its surface contamination on the Japanese obsidian samples. Therefore, it was at this point that A48063Y was added to Run B to stand in as the surface with white ink contamination. This artefact was chosen arbitrarily from the portion of the Amuq Valley collection which had not yet been tested and therefore, still had the original catalogue label on its surface.

As for the three other surface contaminants, they were applied to experiment samples 1-3 as detailed in Table A.A.i. One layer of each contaminant material was placed overtop the testing surface of these obsidian samples and replaced into their original positions on the tray. The last stage was to add the results of A48063Y once its surface had been cleaned and tested.

Table A.A.i: Order of samples tested for surface contamination experiment for Runs A and B.

Run A			**Run B**		
Sample	**Material**	**Tray position**	**Sample**	**Material**	**Tray position**
Exp1Clean	Japanese source	Run A Pos. 01	Exp1Tape	Japanese source	Run B Pos. 01
Exp2Clean	Japanese source	Run A Pos. 03	Exp2Mylar	Japanese source	Run B Pos. 03
Exp3Clean	Japanese source	Run A Pos. 05	Exp3Polish	Japanese source	Run B Pos. 05
Exp4Clean (Control)	Japanese source	Run A Pos. 07	Exp4Clean (Control)	Japanese source	Run B Pos. 07
			AmuqInk (A48063Y)	Anatolian source	Run B Pos. 08
RGM-2	Standard	Run A Pos. 08	RGM-2	Standard	Run B Pos. 09

Table A.ii: Results of experiment comparing Runs A and B with A48093Y's final data added.

Sample	Tray	Ti	Mn	Fe	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
Exp1Clean	Run A Pos. 01	861	213	12331	2	4	39	125	61	22	185	18	926	21	15
Exp1Tape	Run B Pos. 01	1088	219	10735	3	5	36	125	59	20	176	20	937	22	16
Exp2Clean	Run A Pos. 03	917	336	11352	2	3	40	133	63	21	180	26	1018	23	15
Exp2Mylar	Run B Pos. 03	875	321	11116	2	4	44	133	62	22	182	25	995	22	15
Exp3Clean	Run A Pos. 05	863	263	9939	3	3	38	126	61	20	180	21	961	21	15
Exp3Polish	Run B Pos. 05	809	291	9674	1	3	38	128	61	20	177	24	979	22	14
Exp4Clean (Control)	Run A Pos. 07	768	180	8580	3	4	37	116	57	20	167	16	894	19	13
Exp4Clean (Control)	Run B Pos. 07	769	179	8625	3	5	37	117	56	19	168	16	903	19	13
AmuqClean A48063Y	Run 13 Pos. 16	275	312	7378	4	2	22	193	10	24	73	17	142	24	24
AmuqInk A48063Y	Run B Pos. 08	2039	339	7721	2	4	471	207	11	25	78	22	148	31	26

A.A.3 Results

Results from EDXRF Runs A and B, along with the final results of A48063Y's cleaned surface are presented in Table A.A.ii. For each sample, the results of Run A and B were examined side by side. Line graphs were then created for each pair to visually represent the impact of these contaminants upon the elemental values (Figures A.A.i-v).

Starting with adhesive tape, the results showed that surface contamination from this material could mask (diminish) Fe values and slightly raise Ti values. Meanwhile, the white corrector ink caused raised values for Ti and Zn as was expected. Fortunately, Mylar film and nail polish were shown to have virtually no effect on the elemental profiles. Finally, for the control, no changes occurred between retesting a cleaned surface.

Figure A.A.i: Results of Experiment #1: Clean vs. taped surface.

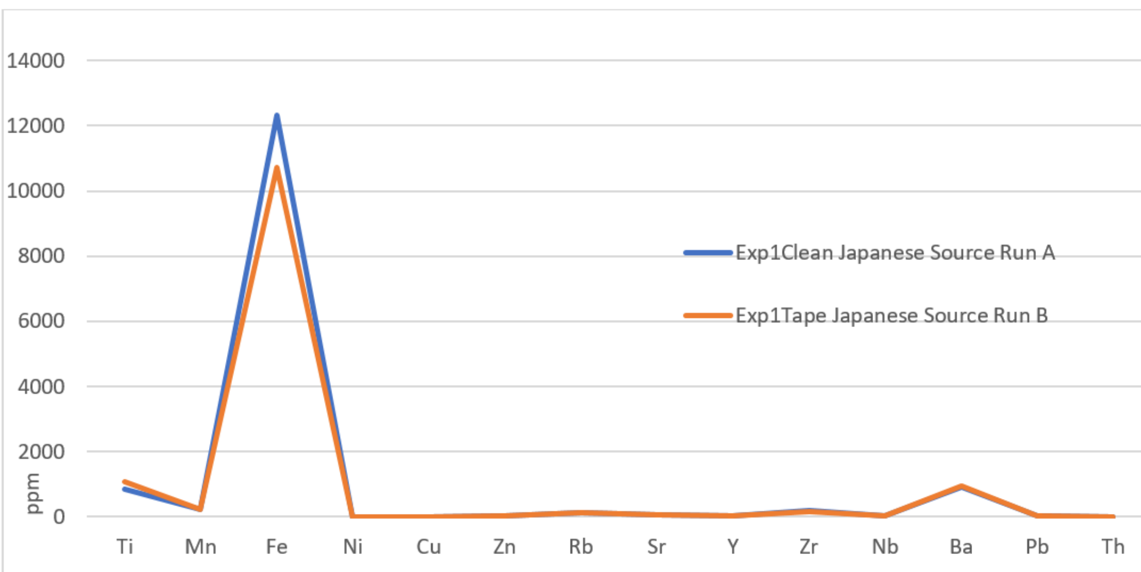


Figure A.A.ii: Results of Experiment #2: Clean vs. Mylar surface.

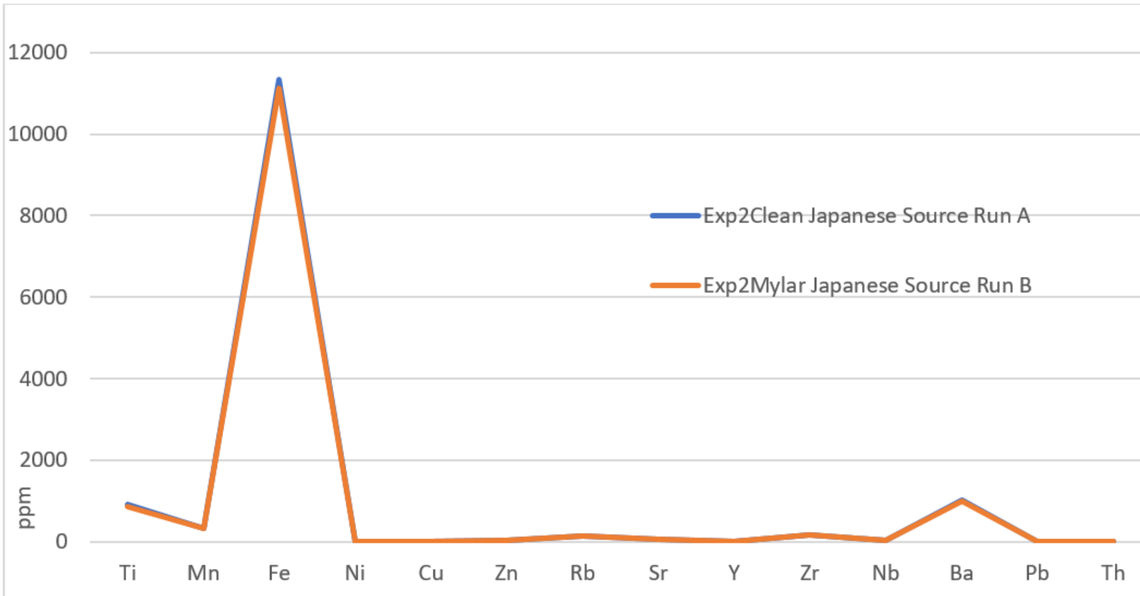


Figure A.A.iii: Results of Experiment #3: Clean vs. varnished surface.

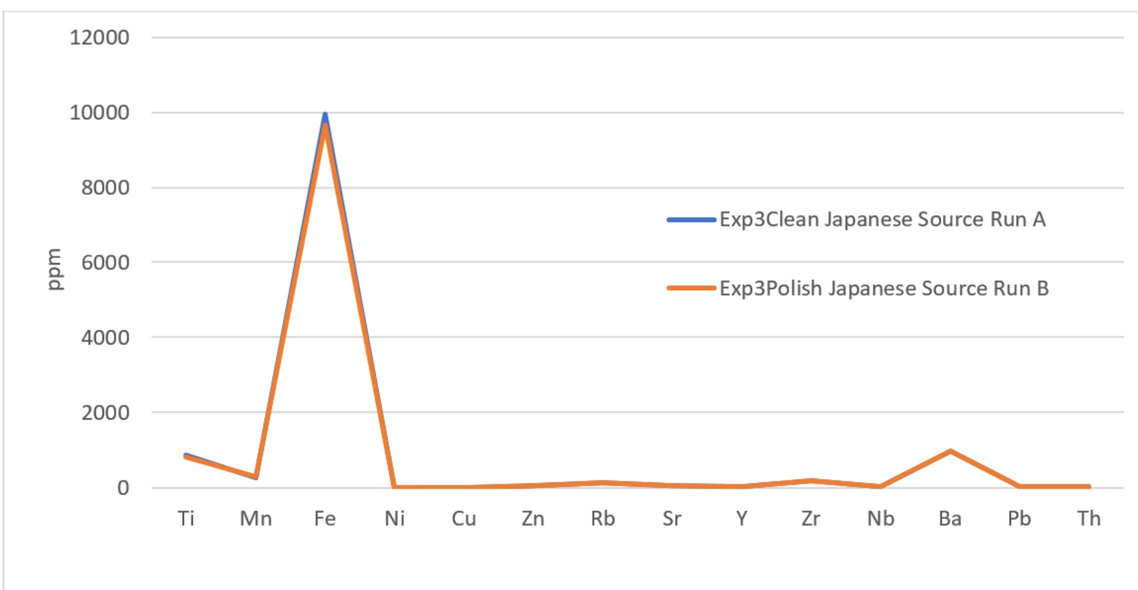


Figure A.A.iv: Results of Experiment #4: Clean (control) surface.

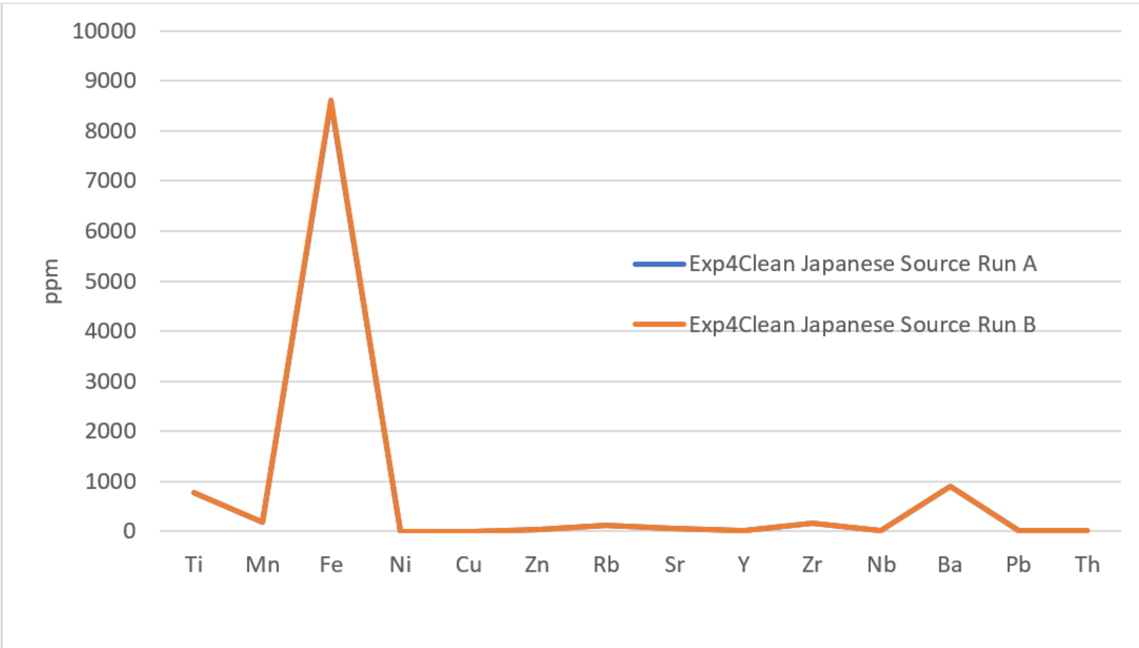
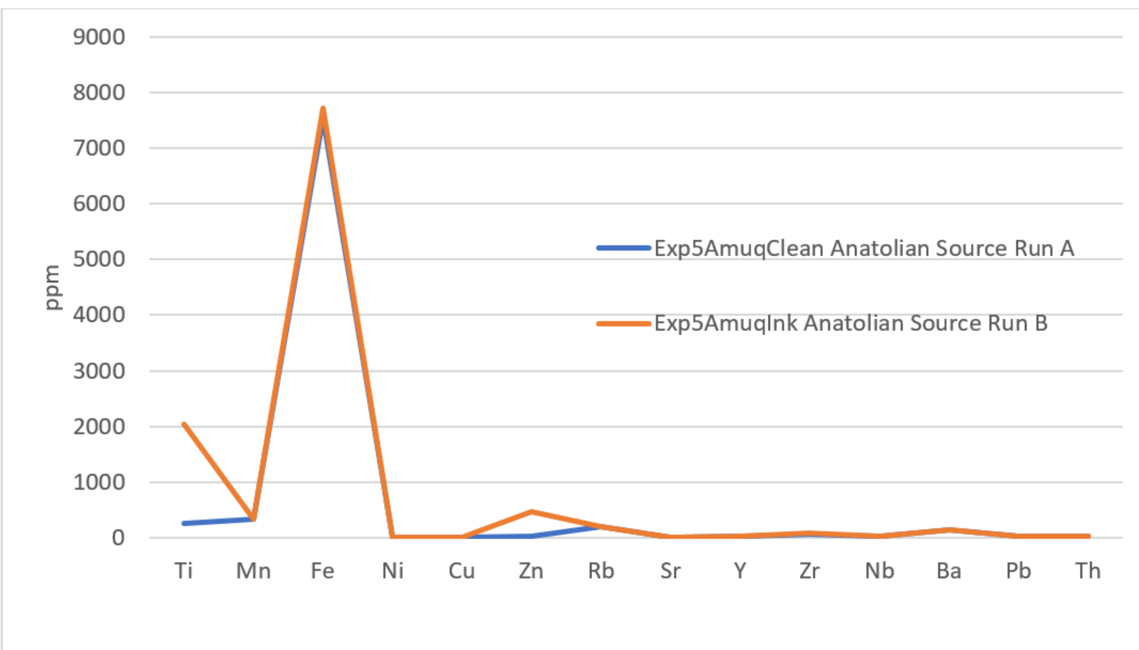


Figure A.A.v: Results of Experiment #5: Artefact A48063Y clean vs white ink surface.



A.A.4 Conclusion

As suspected, the cataloguing labels on the obsidian artefacts led to the elemental results being skewed from contamination of the white ink. Once the desired testing surface of an artefact is thoroughly cleaned, however, there are no lasting effects from residue that can interfere with the EDXRF analyses and the final values can be reliably used for further interrogation.