VITREOUS MATERIAL CRAFTING IN THE SECOND MILLENNIUM B.C.: GLASS, FAIENCE, AND FRIT PRODUCTION AT TELL ATCHANA, ANCIENT ALALAKH

by

Gonca Dardeniz

A Dissertation Submitted to the Graduate School of Social Sciences & Humanities

in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

in

Archaeology and History of Art

Koç University

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VOLUME I: TEXT

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I hereby declare that the copyright of the publication of any of the archaeological material from Tell Atchana, ancient Alalakh coming from 2004–2014 excavation campaigns belongs to Professor K. Aslıhan Yener. All the results of the archaeometric analysis and ideas presented in this dissertation are copyright of the author.

To all my grandparents,
let all their souls rest in peace…

ABSTRACT

This dissertation explores the vitreous corpora (glass, faience, frit) of Tell Atchana, ancient Alalakh, which is located in the Amuq Valley (Turkey) and settled during the Middle and Late Bronze Ages. Glass, faience, and frit artifacts in the collections of the Hatay Archaeology Museum (Hatay, Turkey) and in the British Museum (London, UK) unearthed at the site between 1936–1939 and 1946–1949 excavation campaigns by Sir Leonard Woolley are reassessed in this study. The vitreous materials recovered at the 2004–2014 excavation seasons directed by Prof. Dr. K. Aslıhan Yener are investigated, and the complete vitreous corpora of Tell Atchana, ancient Alalakh is provided. The catalogue of this dissertation introduces 394 new object entries from 2004–2014 Alalakh excavations as well as it documents 23 unknown and undefined artifacts investigated in the Hatay Archaeology Museum.

In this study, a set of archaeometric analyses were conducted by using scanning electron microscope electron dispersive X-rays (SEM–EDX), inductively coupled plasma mass spectrometer (ICP–MS), X-ray fluorescence (XRF), X-ray diffraction (XRD), and strontium (Sr) and neodymium (Nd) isotopes to illuminate chemical characterization and production technologies of faience, frit and especially glass artifacts of the settlement.

By investigating vitreous materials of Tell Atchana, ancient Alalakh as the case site, this dissertation discusses the access and use of raw materials by the artisans, organization and interaction of craftspeople in workshop areas, and social status of artisans. Emergence and exchange of technological ideas and innovations as well as why and how technological knowledge was spread are reviewed within the social structure of the second millennium B.C. Anatolia, Levant, Syria, Egypt, and Mesopotamia.

Keywords: Glass, faience, frit, Tell Atchana, Alalakh, Anatolia, second millennium B.C., vitreous materials, vitreous industries, archaeometry, scanning electron microscope electron dispersive X-rays (SEM–EDX), inductively coupled plasma mass spectrometer (ICP–MS), X-ray fluorescence (XRF), X-ray diffraction (XRD), strontium (Sr) and neodymium (Nd) isotopes, craftspeople, multi functional workshops, integrated production technologies.

ÖZET

Bu doktora tezinde, Amik Ovası'nda bulunan ve Orta ve Geç Tunç Çağları boyunca yerleşim görmüş olan Açana Höyük, eski adıyla Alalah kentinin vitrifiye malzeme (cam, fayans, frit) topluluğu incelenmektedir. Bu çalışma kapsamında, 1936–1939 ve 1946–1949 seneleri arasında Sir Leonard Woolley tarafından höyükte ortaya çıkarılan ve bugün başta Hatay Arkeoloji Müzesi ve Londra The British Museum depolarında ve sergilerinde yer alan cam, fayans ve frit eserler tekrar değerlendirilmiş, 2004–2014 seneleri arasında Prof. Dr. K. Aslıhan Yener başkanlığında yerleşimde ortaya çıkarılan vitrifiye mallardan elde edilen bilgiler ışığında Açana Höyük/Alalah kentinin vitrifiye malzeme korpusu bir arada sunulmuştur. Bu doktora çalışmasında 2004–2014 Alalah kazılarında ortaya çıkarılan 394 yeni eser kataloglanmış ve Hatay Arkeoloji Müzelerinde yer alan 23 adet bilinmeyen ve tanımlanmamış olarak kayıtlara geçmiş eserin dökümantasyonu yapılmıştır.

Bu doktora çalışmasının arkeometrik safhasında taramalı elektron mikroskobu elektron saçınımlı X-Işını (SEM–EDX), indüktif eşleşmiş argon plazma kütle spektroskopisi (ICP–MS), X-ışını floresansı (XRF), X-ışını difraksiyonu (XRD) ve stronsiyum (Sr) ve neodimyum (Nd) izotopları yöntemleri bir arada kullanılarak başta yerleşimin cam buluntuları olmak üzere, fayans ve frit malzemelerin kimyasal karakterizasyonu ve üretim teknolojileri aydınlatılmaya çalışılmıştır.

Vitrifiye malzemelerin Açana Höyük/Alalah kenti özelinde arkeolojik ve arkeometrik olarak değerlendirilmesi ile dönemin zanaatkarların hammaddeye ulaşım ve işleme yöntemleri, zanaatkarların işlik alan içerisindeki iş bölümü ve teşkilatlanması, sosyal statüleri gibi konuların yanı sıra M.Ö. II. Binyıl'da özellikle Anadolu, Levant, Suriye, Mısır ve Mezopotamya arası teknolojik fikir ve buluşların ortaya çıkması ve dolaşımı ile üretim teknolojilerine dair bilgilerin neden ve nasıl yayılmış olabileceğine dair görüşlere dönemin sosyal yapısı içerisinde değinilmiştir.

Anahtar sözcükler: Cam, fayans, frit, Açana Höyük, Alalah, Anadolu, M.Ö. İkinci Binyıl, vitrifiye malzemeler, vitrifiye teknolojiler, arkeometri, taramalı elektron mikroskobu elektron saçınımlı X-Işını (SEM–EDX), indüktif eşleşmiş argon plazma kütle spektroskopisi (ICP–MS), X-ışını floresansı (XRF), X-ışını difraksiyonu (XRD) ve stronsiyum (Sr) ve neodimyum (Nd) izotopları, zanaatkarlar, çok işlevli işlik alanlar, entegre üretim teknolojileri

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LIST OF ABBREVIATIONS

AVRP: Amuq Valley Regional Projects
bknz: bakınız
B.C.: Before Christ
BM: The British Museum
ca: circa
EBA: Early Bronze Age
EDX: Electron dispersive X-rays
LBA: Late Bronze Age
MBA: Middle Bronze Age
ICP–MS: Inductively coupled plasma-mass spectrometer
SEM: Scanning electron microscope
w%: weight percent
XRD: X-ray diffraction
XRF: X-ray fluorescence

CHAPTER I:

INTRODUCTION

1.1 Prelude

Archaeological and archaeometric studies on the vitreous assemblages, namely frit, faience, and glass, of the second millennium B.C. have increased over the last fifty years. Earlier studies, mainly based on empiric listing and categorization of the artifacts based on typology, color, and occasionally major elements, have now evolved into sophisticated research including high-end analytical methods in order to complete our understanding of the composition, technology, and origin of vitreous materials. The new line of interdisciplinary research combining archaeology and archaeometry also has triggered innovative ideas not only for material culture studies but also for theories on the transfer of technological knowledge, innovations by craftspeople, and the operation of workshops.

Among the second millennium B.C. settlements of the Near East, Tell Atchana, the ancient city of Alalakh, has an astonishing vitreous material corpus. Distributed among the Hatay Archaeology Museum, the British Museum, the Ashmolean Museum, and the University College London collections, the vitreous artifacts from the site include some of the earliest and unique examples of their kind. More than 2,000 frit, faience, and glass artifacts were found within the Middle and

Late Bronze Ages (ca. 1650–1200 B.C.) strata of the mound. Some research has been done on the selected artifacts (Barag 1970, 1985; Peltenburg 1971; Yener 2010a; Brill and Stapleton 2012; Henderson 2013), but there has not been comprehensive research interpreting the corpus as a whole.

This dissertation presents the vitreous material corpus of the second millennium B.C. settlement, Tell Atchana, ancient Alalakh, by synthesizing archaeological and archaeometric data. The aim of the dissertation is to understand the technology, production methods, manipulation of raw materials, and integration of crafts within the region in the Middle and Late Bronze Ages. This study also focuses on how non-elites and artisans were integrated in the exchange and trade of vitreous luxury and elite objects and the function of Tell Atchana, ancient Alalakh, as a potential producer in the trade and exchange network of these goods in the second millennium B.C. To assess these goals and characterize the frit, faience, and glass artifacts of the site, multiple analytical techniques have been applied.

1.2 Why Vitreous Materials? Key Concepts and Definitions

The vitreous material corpus of Tell Atchana, ancient Alalakh, allows many questions to be asked regarding the chemical characteristics, the production technologies practiced, the possible transfer of techniques and technological knowledge, and the spread of innovations in the regions of Anatolia, the Levant, Syria, Mesopotamia, and Egypt during the second millennium B.C.

In order to have consistency and to establish a foundation for terms and definitions used throughout the dissertation, it is mandatory to provide explanations of the following: 1) the location of Tell Atchana, ancient Alalakh; 2) the neighboring geographical regions; and 3) vitreous material terminology.

1) Tell Atchana, ancient Alalakh, is located in the Amuq Valley of Hatay, Turkey. Geographically, this dissertation accepts the site as a part of northern Syria and southern Anatolia (fig. 1.1). The site is located in the southern part of the valley, thus situated close to the westward bend of the Orontes River. The plain connects well with the neighboring regions, namely Anatolia, inner Syria, the Levant, and Mesopotamia, as well as the Aegean Sea via the Orontes River and Cyprus (Yener 2005, 2010b). Even though the site is within the borders of Turkey and relates well with the neighboring regions, it is hard to define it as Anatolian, Syrian, Mesopotamian, or Levantine, and thus dedicating a single character to the site is quite problematic. As the following chapters discuss, the site has an idiosyncratic hybrid material culture, which also marks the vitreous material collections.

2) Throughout the dissertation, numerous comparative sites are used; therefore, clearly defining the regions on the basis of ancient settlement is necessary. This study follows Hans J. Nissen (1990) and Trevor Bryce (2014) as templates to delineate the borders of these regions.

Anatolia: Anatolia is also known geographically as Asia Minor, the Anatolian Peninsula, or the Anatolian Plateau and covers the westernmost protrusion of Asia. It is bordered by the Black Sea to the north, the Mediterranean Sea to the south, and the Aegean Sea to the west. The eastern part is bordered by the eastern Anatolian highlands and the Euphrates River where it moves into Mesopotamia (Mitchell 1995). This region, known as southeastern Turkey, is sometimes also referred to as Upper Mesopotamia or northern Mesopotamia. This study uses northern Mesopotamia. In the southeastern part of Anatolia, the Nur Mountains, which are a branch of the Amanus Mountains, geographically distinguish Anatolia from the plain of Syria by providing an almost 1,500 m high barrier (Hitti 1951: 31). Tell Atchana,

ancient Alalakh, which located in the southern part of the mountainous region, could be considered culturally both connected and distinct from central Anatolia. The Anatolian sites mentioned in this study include Acemhöyük, Alişar, Boğazköy/Hattusha, Çavlum, Gordion, Konya Karahöyük, Kültepe/Kanesh, Resuloğlu, Seyitömer, and Yanarlar.

Mesopotamia: The region covers the area between the Euphrates and Tigris Rivers limited by modern Iraq and northern Syria to the southern part of the Amanus Mountains to the north and the Persian Gulf to the south. In the studies related to especially ancient glass the term Mesopotamia is used broadly even though northern and southern Mesopotamian sites require a distinction. This dissertation will follow Nissen (1990) and define the lands above Baghdad as northern Mesopotamia and below Baghdad to the Persian Gulf as southern Mesopotamia. Further designations like Upper Mesopotamia and Lower Mesopotamia are not used in order to be consistent and avoid confusion. In this regard, Arpachiya, Assur, Chagar Bazar, Mari, Nineveh Nuzi, Tell Asmar, Tell al-Rimah, Tell Brak, Telloh, and Tepe Gawra are among the settlements listed as northern Mesopotamian, and Eridu, Diqdiqqah, Kish, Larsa, Nippur, and Ur are listed as southern Mesopotamian.

Syria: Syria is bordered by Turkey to the north, Lebanon and Israel to the west, Iraq to the east, and Jordan to the south. It is mountainous in the west and has a desert in the east. The Orontes River, which begins in Lebanon, passes through Syria, and then enters Turkey from the western side of Antioch, is one of the crucial parameters relating Tell Atchana, ancient Alalakh, to the cultures of northern Syria. Ebla, Hama, Hammâm et-Turkmân, Jebel Aruda, Oylum Höyük, and Tell Chuera are among the settlements related to the Orontes River and referred to in this study as northern Syrian. Qadesh and Qatna are likely denoted as inner Syria.

Levant: The Levant occupies modern Jordan, Lebanon, Palestine, and Israel. Settlements located in this region are defined as Levantine and Beth Shean, Byblos, Megiddo, and partially western Syria including Ras Shamra, and ancient Ugarit are among the Levantine sites mentioned within this study.

Egypt: Egypt is situated in northeast Africa and expands into the Nile Valley. The region that ancient Egypt occupied changed according to the period. The Unified Kingdom of Egypt (ca. 3000 B.C.) occupied the entire Nile Valley. At its greatest extent (ca. 1250 B.C.), ancient Egypt expanded its land from the Syrian coast in the north down the Nile Valley to Nubia in the south. It stretched to the Red Sea in the east and into the Libyan Desert in the west (Baines and Malek 1983). During the second millennium B.C., the contacts of Egypt with northern Syria, including Tell Atchana, ancient Alalakh, and Mesopotamia, via military campaigns and trade, are well known and briefly discussed in the next chapter. Within the context of vitreous material studies, Abusir, Abydos, Badari, Beni Hasan, el-Amrah, Deir el-Bahri, Djoser, Elephantine, el-Gezeh, Gurob, Hierakonpolis, Malkata, Medinet Habu, Saqqara, Lisht, Naqada, Tell el-Daba, Tell el-Amarna, Qantir, Qau, and Wadi Qirud are cited among the Egyptian sites.

3) Research on archaeometry, especially on ancient technologies, requires specific terminology that might not be well known to readers outside of the field. In order to familiarize the reader with frequently used terms and to avoid misinterpretations, a subsection with basic definitions — like a glossary on physical and chemical terminologies relevant to the second millennium B.C. vitreous materials — is provided.

For the chemical and physical vitreous terminology, the basic glossary of Karol W. Wight (2011: 126–27) and Andrew Shortland (2012: 223–31) are used and

the terms are listed alphabetically. An extended section on techniques and materials is provided in the third chapter.

Annealing: Annealing is the heating and slowly cooling process of glass. Control of the heating is mandatory in order to avoid cracking and deformations of the final object; thus annealing is a crucial step in vitreous material production where the final products are sensitive to thermal shock (instant change at temperature) and have a tendency to crack.[1]

Amorphous: Materials without a fixed shape or form.

Batch: The mixture of raw materials to make vitreous materials. This term is mainly used for glass. In the second millennium B.C., in a glass batch, the ingredients are heated in a crucible made out of clay. The molten ingredients are called glass melt, but in several publications the term "batch" also was used to denote the glass melt. In this dissertation, the melted ingredients are referred to as "melt" and the ingredients to make glass or frit are referred to as "batch."

Core: A silica-rich body of faience or a clay body prepared in the shape of a vase to dip into glass melt or to roll glass rods around to obtain core-formed glass vessels.

Flux: Flux is an alkaline substance that is used to decrease the melting point of a batch. Ingredients like silica, which requires higher temperatures to melt, fuses at a lower melting point via the use of flux(es), which is/are generally the ashes of alkaline plant(s) in second millennium B.C. vitreous technologies.

[1] Heat and temperature are two different concepts. Heat is energy and has units given as joules or calories. Temperature refers to the reflection of heat and is an objective measure of how hot or cold an object is. Temperature has different but convertible units like Celsius, Fahrenheit, or Kelvin. Readers interested in the basic physical terms are encouraged to refer to C. J. Adkins, *Equilibrium Thermodynamics*, third edition (Cambridge: Cambridge University Press, 1983), or any other thermodynamics book.

Faience: Faience is a vitreous material with a sintered quartz body and glaze (Moorey 1985: 133).

Frit: Objects made out of sintered siliceous bodies without glaze are defined as frit.

Fritting: Fritting is the pre-firing process of vitreous ingredients at a lower temperature. This preliminary step increases the success of subsequent firings of the vitreous batches.

Glass: Glass defines a specific physical state like solid, liquid, and gaseous rather than a chemical composition in modern terminology (Newton and Davison 1989: 4). For second millennium B.C. glass, the reader should briefly think about soda–silica–lime glass colored with metal oxides of copper, cobalt, antimony, etc. Second millennium B.C. glasses could be transparent or opaque. The ingredients and composition of the glass directly affect how it behaves and how it must have been manipulated during the Bronze Age, which are explained in detail in the third chapter.

Glaze: Glaze is a discrete vitreous layer applied to the faience surface. It is also is called the glassy layer.

Glazed stone: Glazed stones are silica-rich stones, mainly steatite, quartz, or rarely flint coated by vitrified surfaces, namely glaze.

Marver: A smooth and flat surface on which glass is pressed, rolled, and shaped. In the second millennium B.C., rolling or pressing the glass melt on a marver was the technique to shape spherical or flat beads.

Opaque: Opaque materials do not allow a complete or partial passing through of light, i.e., opaque defines neither transparent nor translucent artifacts. It is a term generally used for glass.

Opacifier: A material added to glass batches to make it opaque.

Sintering: Sintering is processing a vitreous material at a lower temperature than it requires so that the ingredients of the vitreous material come loosely together with a small amount of glass in its structure.

Slurry: Mixing the raw materials of faience, namely silica and alkali, with water and obtaining a jelly blend.

Stabilizer: A stabilizer is a compound generally chosen among less water-soluble ions, like magnesium or calcium, and added to the chemical composition of glass in order to make it resistant and chemically stable.

Viscosity: A unit for measuring a material's tendency to flow. When the viscosity is high, the material has a low tendency to flow, and if the viscosity is low, the material is very likely to flow. For example, honey has a higher viscosity as compared to water.

1.3 Aims, Objectives, Methodology, and Theoretical Framework

The aims and objectives of this dissertation can be divided into four main categories:

- To bring together the vitreous collections from Tell Atchana, ancient Alalakh, and obtain a comprehensive study looking at the collection as a whole,
- To examine the compositions and characterize the technology and thus the production of the ancient manufacturing techniques of the artifacts,
- To assess and evaluate the vitreous assemblage both archaeologically and archaeometrically to explain the manipulation of raw materials and how ancient artisans were organized,

- To put the site into the broader socio-technological framework of the second millennium B.C. Near East and illuminate possible transfer(s) in ideas, innovations, and technological knowledge.

The first major aim of this thesis is to bring together the whole corpus. This includes a survey of the artifacts and proper documentation of objects distributed among Turkish and British museums. This extensive set of information, including descriptive and visual records of the artifacts, is collected in comprehensive appendices.

The second aim is to use the archaeometric data for the characterization of the compositions, which will provide significant information on the manufacture and technology of the artifacts. Artifacts included in this study are categorized based on chronology and typology, so that the significance of each artifact or artifact group is underlined. Among the artifact groups, the accessible ones were sampled and instrumentally analyzed by using a broad range of techniques including scanning electron microscope electron dispersive X-rays (SEM–EDX), X-ray fluorescence (XRF), X-ray diffraction (XRD), inductively coupled plasma mass spectrometer (ICP–MS), and isotope chemistry. This broad selection of methodologies is valuable as they complement each other while explaining phenomenon-related vitreous material production at Tell Atchana, ancient Alalakh.

The third aim is to synthesize the evidence from the archaeological and archaeometric records. In combination with the archaeological contexts, these compositional analyses help to reconstruct how the raw materials were manipulated in order to obtain the desired items and how the artisans were integrated and practicing around the workshop areas. The distribution of the materials across the site and the accumulation of some sets in workshop areas are especially focused

upon. The differences among the technologies will be demonstrated through archaeometric analysis (such as major and minor compositions, use of colorants) but it is not only the differences, but also to what extent different technologies overlap is one of the keys in this study. Rather than providing archaeological and archaeometric data separately, this study will integrate the two so that an audience of different backgrounds can easily read this thesis.

The final aim of the project combines the second and third objectives of the thesis and creates a close relationship between archaeometry and archaeology; otherwise both sets of data will be inconclusive. Understanding the vitreous technologies of Tell Atchana, ancient Alalakh, helps to situate the technological selections and applications of the site among the technological trends of the second millennium B.C. This will give a broader idea of how interregional and intraregional exchange occurred at the level of technological knowledge and artisanship and how social, economic, and political spheres intersected within a society where the vitreous industries were pursued.

The study of the vitreous materials also requires the understanding of organization behind the production. As stated by Franz Boas to define modes of production, "we have simple industries and complex organization" as well as "diverse industries and simple organization" (Boas 1940: 266, 267). In current archaeological theory, economic systems within their idiosyncratic social and cultural mechanisms are studied through two main components: the organization of production and craft specialization.

The organization of production in a society is organically related to sociopolitical and socioeconomic settings since distribution of products and the consumption or exchange strategies were shaped by political, social, economic and cultural patterns.

Therefore, to evaluate Tell Atchana within the general social network of the second millennium B.C., proposing possible models for production of vitreous material within the limits of this dissertation is essential.

The sociopolitical and socioeconomic structures of ancient communities leave traces in the archeological record either as textual information like archives and glyptic, or non-textual data like architectural features or artifacts (Rice 1981, Costin 1991:2). Archeological data such as physical, chemical and occasionally biological markers of artifacts contain information that can illuminate the organization of the production and craft specialization in ancient societies. Tools and implements, the architectural contexts of production like craft quarters or workshops, organic residues and the products themselves appear in the archaeological record (Costin 1991:1). In this dissertation, architectural contexts as well as chemical and physical prints of the artifacts are available to trace back the production systems of vitreous materials at Alalakh.

The identification and interpretation of craft quarters and craft specialization in the archaeological record has led several scholars to create various theories and the associated terminology. The typology based on household or workshop production has since been regularly cited in the literature (van der Leeuw 1977; Peacock 1982; Rice 1987). Cathy Costin (1991) on the other hand, not only distinguished between household or workshop productions, but also considered the production for general consumption or production for elites. As a result, four general terminologies rose for the discourse of production: household production, workshop production, independent production and attached production.

To interpret the archaeological contexts of a workshop area highlighted this dissertation (chapter V) and terminologically define the area, this reseach will follow

Costin's (1991) theory since she proposed the most descriptive argumentation for the interpretation of archaeological contexts as well as she presented models for production for elites. Considering the fact that glass, faience, and frit were among the luxurious items mostly consumed by the high ranked societies, Costin's theory suggests the best fit for the data from Alalakh.

'Production' is defined as turning raw materials into goods, and 'specialization' as an organized method of this production (Costin 1991:3). Both production and specialization are subsets of the socioeconomic and sociopolitical systems and should be considered key factors in the political economy of complex societies (Brumfiel and Earle 1987). Through examining craft specialization and sociopolitical organization of production, linkages between crafts and hierarchically higher status elites could be better understood. To examine the organization of production in more detail, this dissertation will use Costin's model where the context of production is divided into two groups: 'attached' and 'independent' depending on the degree of organizational and economic control exhibited by society's elites.

'Attached production' describes elite control over the production especially for high-status (usually high-cost, restricted access) goods (Earle 1981; Costin 1991:7, 11). Elites or states try to control production of goods and especially luxury items, which is important to reinforce their social status and to manipulate their power (Helms 1993; Peregrine 1991; Stein 2001). This maintenance of elite institutions on production and practitioners on crafts were also evidence by profession lists of textual records (Archi 1982; Hauptmann 1988; for Alalakh see von Dassow 2008). Such sponsorships by elites emphasized their social and political position in the society and made the attached specialist producers economically and socially dependent on their patrons.

For ‘independent production’, the control over production is in the hands of the producers themselves. Manufacturers produce according to demand and distribute products mainly to a public market of customers (Costin 1991:11). This model, while not without critics, is widely used in archaeological studies today and has proved to be of great use in interpreting archaeological data. The workshop contexts subjected to this dissertation are also analyzed through Costin’s theory in order to assess the nature of ‘attached’ or ‘independent’ characteristics of the craft quarter.

Besides the attached and independent nature of the craft quarter, in order to understand the patronage and distribution of the vitreous artifacts among the elites, this dissertation also benefits from the models proposed for second millennium B.C. Egypt since these examples provide the most suitable comparanda in terms of material and chronology (Shortland et al. 2001, 2007). Similarly the identitiy of the artisans and the value of vitreous materials especially glass are discussed based on the theories proposed first for Egypt (Moorey 1985; Nicholson 1993; Shortland et al. 2001). This theoretical framework helps to build a case for not only for organization of production at Alalakh but also illuminates the context of invention and artisanship in the second millennium B.C. based on vitreous materials.

1.4 Background

Tell Atchana, ancient Alalakh, is a crucially important archaeological site for scholars focusing on chronology, material culture, geography, interregional trade, economics, textual records, and further specialized topics of the second millennium B.C. The Amuq Valley of Hatay, Turkey, where the site is located, is well watered and fertile, and connects the neighboring regions, namely inner Syria, the Levant, Mesopotamia, and Anatolia, as well as the Mediterranean and the Aegean Seas via

the Orontes River and Cyprus. In the course of its history, the site was the capital of a small Bronze Age principality called Alalakh and Mukish as it is variably referred to in the textual records.

The site was first excavated by Sir Charles Leonard Woolley from 1936–39 and after a break during World War II, from 1946–49. Woolley's excavation campaigns yielded many temples, palaces, and other architectural remains along with a rich and variant material culture embracing the unique frit, faience, and glass corpus. His series of publications (1936, 1937, 1938, 1939, 1948, and 1953) and the final account on Alalakh (1955) have been used for subsequent research. Nevertheless, Woolley's excavations and publications left several inconsistencies and gaps in the history of Alalakh, mainly related to the chronology (Smith 1940; Woolley 1955; Landsberger 1954; Kantor 1956; Albright 1957; Goetze 1957; Collon 1975; Na'aman 1976; Dever 1985; Gates 1981, 1987; Heinz 1992; Berghoffen 2005). Several lines of research, including ceramics (Swift 1958; Williams and Hastert 1977-1978; Gates 1981, 1987; McClellan 1989; Heinz 1992; Bergoffen 2005) and textual records (Wiseman 1953; Magness-Gardiner 1994; Lauinger 2007; von Dassow 2008), have tried to solve the problem of chronologies.

New research at and around the site started in 1995 as the Amuq Valley Regional Project (hereafter, AVRP) and a new excavation campaign began in 2000 and is still ongoing (Yener 2005, 2010b; Yener et al. in prep.). The main focus of the new rounds of excavations under the direction of K. Aslıhan Yener (hereafter, Yener excavations) is to understand the chronological gaps in Woolley's excavations and to establish a precise site chronology; thus, a team of specialists is working on various aspects of the settlement.

This dissertation relies on specialists' work in many ways as chronology and archaeological contexts are the most crucial sources of information. The integration of production technologies with the general social, economic, and industrial setting of the settlement depends on information from various media, including ceramic, architectural, and raw material identifications. Hence, the subject of this study trusts the results and interpretations of the Yener excavations, and disregards previous information that has been questioned in light of emerging evidence. The chapter breakdown reflects this differentiation.

1.5 Chapter Breakdown

This dissertation is composed of nine chapters. This chapter gives an introduction to the aims and objectives of the dissertation and provides a glossary relevant to the second millennium B.C. vitreous technologies.

The second chapter covers the ancient history of Tell Atchana, ancient Alalakh, with up-to-date references. This section presents the political and social setting of the site during the time period, which explains the demand for the production of luxury items and, thus, vitreous material crafting at the site.

The third chapter focuses on the details of the material characteristics and production techniques of the vitreous materials and summarizes the history of the glazed stones, frit, faience, and glass in Anatolia, Mesopotamia, Syria, the Levant, and Egypt with references to the corpus of Tell Atchana, ancient Alalakh. This chapter also provides a glimpse into the textual records relevant to the glass production of the second and first millennium B.C.

The fourth chapter covers the related history of vitreous material research at the site. It is composed of two parts. Part one documents all the vitreous materials unearthed during the Woolley excavations, and refers to the terminological problems

created by Woolley while proposing and explaining the new identifications. Part two summarizes all the previous scientific research on the site's vitrified material assemblage. Overall, in the chapter, the material assemblage of the site is compared and contrasted to regional patterns while keeping the corpus central to the discussion.

The fifth chapter introduces the archaeological contexts with vitreous remains (artifacts, installations, etc.) recovered in the Yener excavations between 2004 and 2014. For a beneficial discussion of vitreous material manufacture, architectural features relevant to production are summarized. Besides frit, faience, and glass, traces of other crafting activities like pottery production, stone and metalworking are provided in order to estimate linkages between local industries. This chapter provides charts and graphics to visualize the production potential of the site.

The sixth chapter presents the instrumental methods used for the archaeometric analysis of frit, faience, and glass. It explains the basics of the methods and why and how they were applied to the vitreous materials of Tell Atchana, ancient Alalakh. It covers information on sample selection, sample preparation, and the standards of measurement in each methodology.

The seventh chapter introduces the new scientific results and interpretations of the second millennium B.C. data. By combining the instrumental results with the archaeological context data provided in the fifth chapter, this section gets to the essence of the dissertation. The results are compared to other analytical data published for Mesopotamian, Levantine, and Egyptian vitreous materials and the idiosyncratic characteristics of Tell Atchana, ancient Alalakh, are underlined.

The eighth chapter introduces the relevant craft theories and possible models fitting the production patterns of Tell Atchana, ancient Alalakh. Organization of production, patronage over vitreous material production and distribution, identitiy of

artisans, value of vitreous materils, multi functional and integrated crafts are discussed in this chapter within the theories that suggest the best fit for the data from Alalakh. In this section, archaeological interpretations of the new results presented in the seventh chapter are discussed within a broader theoretical frame.

The final chapter summarizes each section and puts forward the conclusions derived from the study of the vitreous material production in the second millennium B.C. at Tell Atchana, ancient Alalakh. The conclusions are centered on the importance of integrating archaeology and archaeometry for the research of specialized artisanship and ancient technologies.

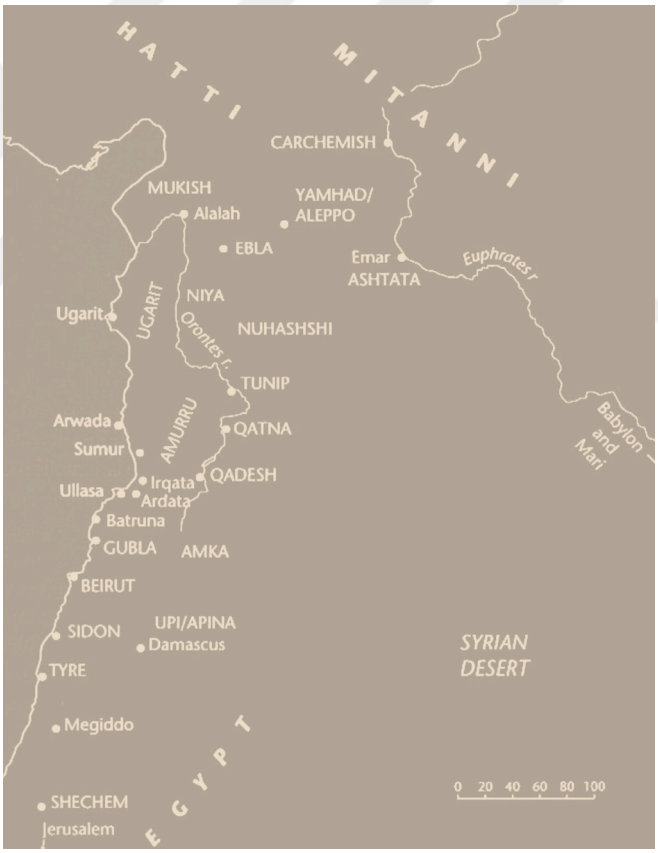

Fig. 1.1: Syria and the location of Alalakh during the Middle and Late Bronze Ages (after Bryce 2014: 12).

Period	Chronology
Middle Bronze Age II	ca. 1700 (?)–1600 B.C.
Middle Bronze Age II – Late Bronze Age I transition period	ca. 1600–1500 B.C.
Late Bronze Age I	ca. 1500–1450 B.C.
Late Bronze Age I – Late Bronze Age II transition period	ca. 1450–1400 B.C.
Late Bronze Age II	ca. 1400–1300 B.C.

Table 1.1: Chronology

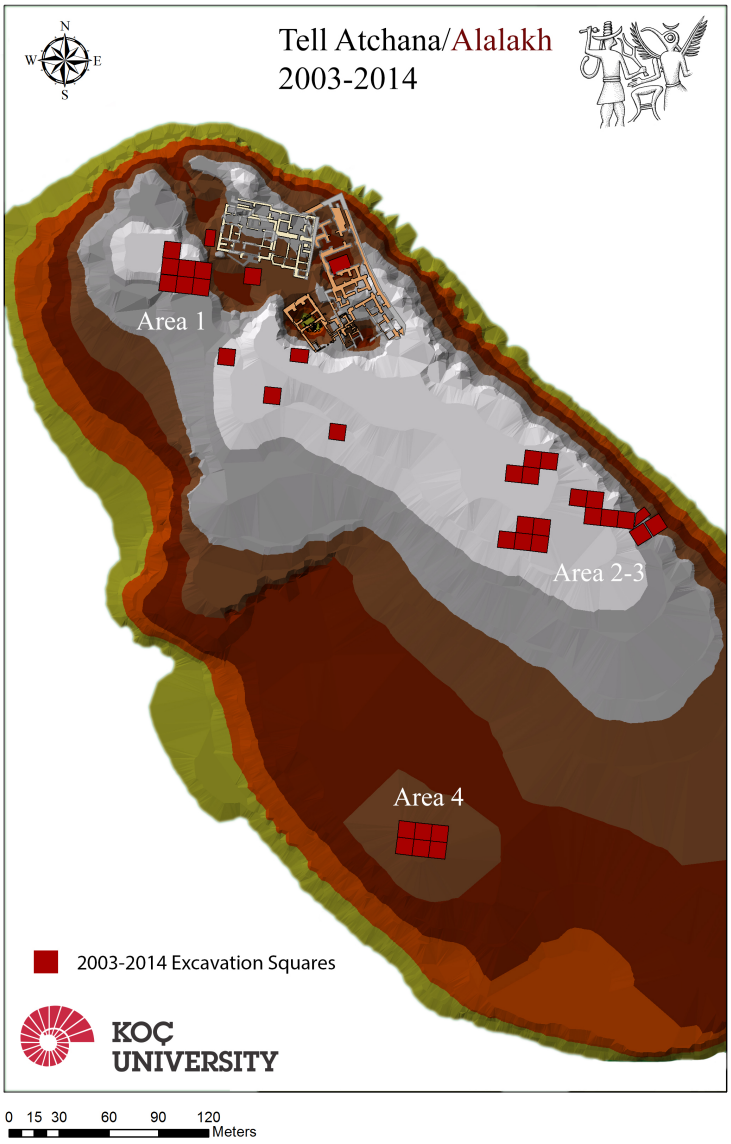

Fig. 1.2: The squares excavated at Tell Atchana, ancient Alalakh during the 2003–2014 excavation campaigns (The Alalakh Excavation archive).

CHAPTER II:

A BRIEF HISTORY OF TIME:

ALALAKH IN THE SOCIOPOLITICAL SETTING OF THE SECOND MILLENNIUM B.C.

Tell Atchana, ancient Alalakh, is located in the Turkish province of Hatay in the southern portion of the Amuq Valley near a major branch of the Orontes River. The mound is an oval measuring 750 × 325 m along the northwest–southeast direction with an approximate elevation of 100 m above sea level. The mound extends over a total of 22 hectares with 19 ha of habitable area and rises 9 m from the level of the surrounding plain (Yener 2005). This chapter refers to the ancient settlement as Alalakh.

This chapter summarizes the ancient history of Alalakh within a wider socio-political setting of the second millennium B.C. It aims to establish a historical background for the demand for vitreous material production and the relevant interlinked production. The sections extend the discussion to trade relations and the consumption of vitreous materials within the second millennium B.C. by centrally presenting evidence from Alalakh.

Woolley, after finishing his excavations at Ur, focused on understanding the early connections between the Near East and the Aegean. He first surveyed the coastal sites and harbors. During the course of his research, the coastal site Al Mina

(OS11) and the inland settlement Tell Atchana (AS136) first attracted attention in 1936 (Woolley 1937).[2] The first soundings done in 1936 provided promising results; thus the British Museum and the Ashmolean Museum arranged excavation campaigns until 1939. During World War II, the work was interrupted until 1946 when the second round of excavations resumed, under the auspices of the Turkish government, for another three years. Woolley's expedition focused on a section of the mound and mainly targeted the royal precinct. He identified 18 successive levels dated to the Middle–Late Bronze Age architectural levels. On the other hand, Woolley's method of excavation and gaps in his final publication fueled debates on chronology (Albright 1957; Mellink 1957).

Alalakh has primarily been a second millennium B.C. settlement and after a gap at the end of the 14th century B.C., it was re-settled in the Early Iron Age (Yener 2013; Yener et al. in prep.). In the Middle Bronze Age, Alalakh was subservient to the kingdom of Yamhad, based at Halab (Aleppo). Its allegiance shifted to Mitanni in the first century of the Late Bronze Age and later to the Hittite Empire in the 14th century B.C. Peripheral to the kingdoms of the Middle Bronze Age and empires of the Late Bronze Age, Alalakh was a marginal actor in the political arena during its life span.

Alalakh gets attention from scholars and gains importance in Near Eastern archaeology due to its stratigraphy for its occupational levels. Moreover, the archives found in the Level VII and Level IV palaces of Alalakh together with its records

[2] Soundings from the 1936 sites excavated by Woolley were identified during Braidwood's AVRP surveys (1937). Between 1932 and 1938, the AVRP surveys, conducted by James Henry Breasted and Robert Braidwood, established a ceramic and cultural sequence for the valley, which is still in use. According to the alphabetical coding system applied to identify the sequences, the Middle and Late Bronze Age of the valley are labeled as K (MBI), L (MBII), and M (LB), and the most important information for these phases comes from Alalakh (Braidwood 1937; see also Yener 2005).

provide information for unclear periods of Near Eastern chronology. Compared to the archives from other Near Eastern sites — those that yielded thousands of tablets like Mari, Nuzi, and Ugarit — the archives of Alalakh are very limited in terms of quantity, but very enlightening in terms of political, social, and cultural information. In addition to the palatial archives, a statue of King Idrimi with its autobiographical inscription is a unique source of information to illuminate the political history and chronology of Alalakh together with its contemporary sites (Smith 1939, 1949; Wiseman 1953; Olivia 1998, 2000; von Dassow 2008).[3]

The Middle and early Late Bronze Age sequences of Alalakh, corresponding to the levels between and VII and IV, have been extensively studied (Heinz 1992; Gates 1981, 1987; Na'aman 1976, 1979; Collon 1975; McClellan 1989; Bergoffen 2005). On the other hand, the final levels of the site (IV–0) have not been studied sufficiently, most probably due to the lack of both archaeological documentation and lack of evidence. With the new expedition under Yener, these levels were excavated and reinvestigated (Yener 2010b; Akar 2012a). There is also new evidence on the sequence of the site thanks to material evidence of the Early Iron Age, Iron II, and III periods (Yener 2013; Yener et al. in prep.). Furthermore, the new excavation campaigns started to unfold the complex relations among the actors of the second millennium B.C. by documenting evidence from different lines of research including architectural, material, technological, and artistic trends, which also includes the production technologies of vitreous materials.

The new corpus of vitreous materials and their secure archaeological contexts were unearthed over the course of a decade (2004–2014) during these excavation

[3] Smith published the inscriptions on the statue in 1949 in his book *The Statue of Idrimi*. A discussion of the inscriptions, their interpretations, and chronological implications are presented in the following sections.

campaigns (chapters V–VI and appendices I–III). Prior to discussing historical events and linking the history of vitreous materials to political and trade relationships, a background of the geography and the second millennium B.C. economy is important in order to explain the sparks leading to the production of luxury items.

2.1 Geography and Economy

In its geographical setting, Alalakh is located in northern Syria. The Beqaa Valley, through which the Orontes River flows, provides fertile land for settling. The river is almost 570 km long. It starts in Lebanon, passes the Lebanese and Anti-Lebanese mountains, and flows past Homms and Hama in Syria before entering Turkey from the western part of Antioch. The river constitutes an invaluable resource for the Amuq Plain as it waters the fertile land and provides transportation wherever suitable.

During the second millennium B.C. — and still today — northern Syria was geographically in an advantageous situation since the surrounding land was arable. Grapes and olives were agricultural products that were among their traded goods. The forestry resources around the Amanus and Taurus Mountains included mainly cedar, cypress, and pine, which were desired products for the Mesopotamian and Egyptian economies. These woodland products were not only important as exports, but they must have also been used by local economies for construction, carpentry, and firewood for domestic and industrial purposes, including the production of vitreous materials. The region also had access to valuable metal resources (such as copper) and other relevant raw materials (such as semi-precious stones), which were readily available in its hinterland in the mountainous zones. Specialized crafts mentioned in the textual records (von Dassow 2008: 256, 262, tables 4.3, 4.4) must

have had easy access to raw materials. The manufacture of wooden items, as well as the production of metals and textiles, were advanced in this region and this was well documented in ancient texts (Peker 2009: 8–9).

The geographical setting of the site not only offered tremendous benefits for industrial production activities, but it also served as a pivotal zone in long-distance trade. For second millennium B.C. interregional trade, access to Anatolia was possible via northern Syria, which made the Amuq Valley a key locale in interregional commerce. Access to crucial raw materials and being part of the long-distance trade networks must have prompted the local production of both luxury and daily items.

The main reason behind the second millennium B.C. political struggles among the super powers for Alalakh was the site's central role in long-distance trade dynamics (Peker 2009: 9). It was also geopolitically important for military activities. That particular time was a period of international trade and opposing super powers like the Hittites, Egypt, and Mitanni; thus it is not hard to imagine that settlements with advantageous positioning were at the heart of the political struggles during this period. Consequently, the history of Alalakh witnessed the shifts of power among the regions as a result of military campaigns. Alalakh became a buffer zone between the empires and survived for more than 800 years with its hybrid and idiosyncratic cultural atmosphere. To set the scene of Alalakh in the general history of the Bronze Age, the following sections present chronological accounts.

2.2 The Middle Bronze Age (MBA)

Throughout the MBA, regional powers dominated northern Syria. Written records from sites such as Ebla, Mari, Alalakh, and Tell Leilan quite extensively discussed political relations and the socio-economic environment among these

regional states. Those archives report the names of the five states controlling this landscape. The kingdoms of Yamhad and Qatna were reigning in the west while Shamshi-Adad was ruling in the east; Mari and its successor state Hana were ascendant in the Jezireh region (Akkermans and Schwartz 2005: 288–326).

In the MBA, Alalakh was subservient to the kingdom of Yamhad based at Halab (Aleppo). The regional kingdom of Yamhad dominated the northern part of Syria through a chain of subservient states expanding from the Euphrates River to the Mediterranean coast. The names Alalah, Ugarit, Ebla (Tell Mardikh), Emar (Tell Meskeneh), Carchemish, Urshu, Hassu, and Tunip are mentioned in the tablets found in the Level VII palatial archive of Alalakh. These cities were referred to as subservient or ally states and connected to Yamhad (Wiseman 1953; Bryce 2005: 70; Archi in prep.).

While Yamhad was the most important political power in Syria, in central Anatolia, the Hittites were rising as the dominant political and military entity. In the Old Kingdom Hittite Period (1650–1500 B.C., calibrated chronology according to Peker 2009),[4] Hattusili I (1650–1620 B.C.) moved his army to the Near East in order to expand towards Syria and capture Babylon. Controlling Syria was possible only by controlling Aleppo first, which led Hattusili I to march his armies from either the Bahçe Pass in the north or the Belen Pass in the south of the Amanus Mountains leading towards Alalakh. He sacked and destroyed the city and mentioned this in his annals (CTH 4.2; Melchert 1978: 5). This was the first — but not the last — time the Hittites appear in the political history of Alalakh. After Hattusili I's military campaigns, the kingdom of Mukish became a center of attraction for the Hittites.

The destruction of Alalakh by Hattusili I was matched archaeologically to

[4] The chronologies given for the Hittite kings were based on calibrated Middle Chronology given in Peker 2009.

Level VII of Alalakh (Naaman 1974: 267; Collon 1975; Gates 1987). It is accepted that Ammitakum and his son Hammurabi were the kings of Alalakh contemporary with Hattusili I (Landsberger 1954: 52; Otten 1964: 118; Klengel 1992: 81; Bryce 2005: 71) (Table 2.1).

The destructions by Hattusili I was followed by his grandson Mursili I, and Aleppo, capital of the Yamhad kingdom, was destroyed. Following that, in the 16th century B.C., Babylon was sacked and destroyed by the Hittite armies led by Mursili I (Bryce 2005: 96).

Aleppo/Yamhad Kingdom	**Alalakh**	**Chronology**
		1800 B.C.
Yarimlim I		
Hammurabi I		
Abbael (son)		1750 B.C.
	Yarimlim (brother of Abbael)	
Yarimlim II (Abbael's son)	Ammitakum	1650 B.C.
Niqmepa (son)		
Irkaptum (son)	Hammurabi (son)	
Yarimlim III (son of Niqmepa, brother of Irkaptum)	Destruction of Alalakh by Hattusili I	
Hammurabi II Destruction of Aleppo by Mursili I		

Table 2.1: Aleppo/Yamhad and Alalakh kings during the 18th–17th centuries B.C. (reproduced after Peker 2009: 30, table 1).

In this time of political instability, MBA Alalakh was enjoying luxury goods,

including the ones made out of frit and faience. However, our information on the vitreous materials in MBA Alalakh is scarce. There is evidence of frit and faience recovered from the palatial rooms of Level VII and in grave contexts (Woolley 1955: 123, 297–98). Periods earlier than this level were represented only with a single frit bead found in a Level VIII mixed context. The Level VII palatial objects are all faience and they are all luxury items, including a human mask and a toilet box lid. The grave goods contain only beads made out of frit and faience. The exact number of artifacts recovered by Woolley is not known due to his ambiguous definitions whereas the Yener excavations unearthed four artifacts dated to the MBII levels of the site. Three of these artifacts are faience and one is a fragmentary glass bead (AT15825) recovered from a mixed context (chapters IV and V).

Relevant to the discussion here is that the existing evidence indicates that the people of Alalakh knew vitreous materials, mostly frit and faience, at least at the court level during this period. Luxury items unearthed in the rooms of the Level VII place supports this argument. The glass bead (AT15825) unearthed from a mixed context might be the earliest evidence for the existence of glass at the site, but its mixed context is problematic at this stage of research. The upcoming excavation campaigns by Yener plan to focus on the MBA levels, which will hopefully uncover further evidence.

The picture changes tremendously during the transition period from the MBA to the LBA, when glass fully became a part of the vitreous material corpus. As discussed in detail in chapters IV and V, the transition periods, which were roughly reflected archaeologically by Levels VI and V of Alalakh according to Woolley's excavations, were critical to the history of vitreous materials. The earliest examples of core-formed glass vases and mold-made glass figurines of the Near East were found at

the temple context of Level VI, signaling new and flourishing industries in the region if not also at Alalakh.

2.3 The Late Bronze Age (LBA) and Level IV of Alalakh

The LBA witnessed the rise of empires. Politically, the Hittite, Mitanni, and in the LBIIb (LB II, ca. 1400–1200 B.C.), the Middle Assyrian Empires together with the New Kingdom of Egypt were active players in trying to control Syrian lands. The Hittites became the dominant power in the vast territory of Anatolia. Early in the LBI, the Mitanni Kingdom became the rising power of northern Syria and supplanted the role of the vanished kingdom of Yamhad. In the south, Egypt expanded its territory to the borders of Mitanni (Klengel 1992; von Dassow 2008). The fall of the Yamhad Kingdom in Syria also affected the political situation of the vassal cities and states including Alalakh. It served in a subservient position first to the Mitanni Empire and later to the Hittites.[5]

The rise of the Mitanni Empire, based in the Jezireh Plain as a powerful authority, influenced the social and political life in the Anatolian and Levantine regions. Its influence in the neighboring regions can be further recognized by understanding the Mitanni Empire's social, political, and cultural systems, one of which is actually the emergence of glass industries, which is closely linked to the Mitannian cultural sphere (Barag 1970, 1985; Peltenburg 1971). Details of the attributions to Mitanni on the rise of vitreous industries are discussed in chapters III and VIII; further research on the emergence and origins of the Mitanni state, culture, and ethnicity are still under debate among scholars.

[5] Alalakh might have been also independent for a time ca. 1600–1500 B.C. (von Dassow 2008). This time interval is still waiting for further illumination.

There are various arguments attributing the origins of Mitanni strongly to the Hurrians (Wilhelm 1989; Kühne 1999: 206), but these suggestions are still not solid enough to point to the foundations of this great power (von Dassow 2008: 20). Currently the oldest textual record mentioning the name "Mitanni" is an inscription on Amenemhat's tomb found in Egypt. Although the identity of Amenemhat is not clear, he may have been in the service of Amenhotep I and probably Thutmose I, whose reigns date to the late 16th through early 15th centuries B.C. The inscription on the tomb refers to "Mitanni" as an enemy of Egypt and mentions Mitanni as an opponent of Egypt (Brunner 1956).[6]

From the dynasty of Thutmose I onward, the kingdom of Egypt tried to dominate the Levantine region. The desire for ruling this territory brought Egypt and Mitanni into conflict. This confrontation can be traced via the textual records of Egypt. The name *Naharina*, "River Land," appears frequently in the texts referring to the Mitanni Empire or to the power behind the Levantine rulers who opposed Egypt (von Dassow 2008: 21). Due to the fact that no textual records from the Mitanni capital have yet been found, Egyptian records are used as the main sources to explain the events, people, and places in the region.

Contemporaneous to Mitanni in the north and New Kingdom Egypt (18th Dynasty) in the south, Alalakh was ruled by the dynasty of King Idrimi (ca. 1450 B.C.). Three hundred tablets uncovered from the Level IV palatial archive of Alalakh pertain to the kings Idrimi, Niqmepa, and Ilimilimma. These administrative records certify the subservient position of Alalakh to the Mitanni Empire during the reigns of these kings.

[6] The relation of the text to Mitanni is presented in detail in Kühne 1999: 212–13.

Alalakh Level IV, its chronology, and the foundations of the Level IV palace have been intensively studied since it was first excavated (Woolley 1955; von Dassow 2008). Woolley stratigraphically attributed the beginning of Level IV, together with the palatial complex, to the reign of Niqmepa. He argued that the Level IV palace was short-lived with an occupation of two generations at most, and assigned Niqmepa as the founder whereas Ilimilimma was responsible for the later additions (Woolley 1955: 110–11).[7] His attributions were mainly based on the contents of the Level IV palatial archives. The palatial archives found in Room 33 of the Level IV palace together with the rest of the tablets found throughout the palatial area pertain mostly to the kings Niqmepa and Ilimilimma. Among the Level IV archives, only two tablets (AIT 3 and AIT 71) and a tablet fragment (AIT 99) pertain to King Idrimi (Wiseman 1953). Tablet AIT 3 is a treaty between Idrimi, the king of Alalakh, and Pilliya, the king of Kizzuwatna, signed under the custody of Mitannian King Parattarna (Wiseman 1953: 31–32). This tablet is a remarkable document; it is evidence to clarify both Alalakh's allegiance to the Mitanni Empire and shed light on its contemporaries during the reign of Idrimi. Based on the rest of the textual records, AIT 71 refers to Idrimi's acquisition of a slave and tablet fragment AIT 99 is part of a contract signed before Idrimi's reign. These tablets in their archaeological and

[7] Architecturally, the Level IV palace was composed of three blocks; the main block of the palace was elongated toward the northeast, near the ruins of the Yarim-Lim palace in Level VII. The southeastern block (Rooms C4, C5, C6, and C7) should have been used as a service wing since those rooms yielded an oven, hearth, and several storage jars (Woolley 1955: 111, 129–30). On the northwestern side lies the "Serai Gate" providing an entrance to the courtyard of the palace from the northwestern city walls. The palace itself was a two-story building with a courtyard at the center surrounded by several chambers (Rooms 2–36, C1–8, and D1–2; Woolley 1955: 116–30). Excavations of these rooms exposed a tremendous amount of artifacts of a wide range of types. Pottery — especially white-slip ware and base-ring ware — was found throughout almost the entire complex together with a remarkable amount of Nuzi ware vases and goblets. Gold, silver, copper, bronze, ivory, and basalt objects and fragments together with seals and seal fragments were found throughout the rooms of the palace. In addition to all of these artifacts, excavations in these areas yielded 300 tablets and tablet fragments, mainly found in Room 33 (Tablets ATT/38/73, 76–92, 244–61, 263–65, 267–71; Woolley 1955: 127).

contextual context could challenge Woolley's attribution of the Level IV palace as the "Niqmepa Palace" if reassessed together with the text on the statue of Idrimi.

Von Dassow attributes the Level IV palace to Idrimi (von Dassow 2008: 36). Based on the inscription on Idrimi's statue that says he built a house like a kingly throne, von Dassow points out also the presence of other archival records (AIT 71) pertaining to Idrimi and argues that Idrimi lived in the Level IV palace. According to her, there is no clear evidence for attributing the foundation of the Level IV palace to Niqmepa, but there is some evidence for the attribution of the palace to Niqmepa's predecessor, Idrimi (von Dassow 2008: 35–37).

The life and political history of King Idrimi is understood from the inscriptions carved on the lower skirt of his statue. According to these carvings, Idrimi was a prince of the old Amorite dynasty of Yamhad and had fled from Aleppo to Emar because a "bad thing" had happened in Aleppo. Although he was the youngest of all his brothers, he decided to get his father's throne back. He departed from Emar and arrived in the city of Amiyya in northern Canaan. In Amiyya, people from Mukish,[8] Niya, and Ama'e had recognized him as the son of their king and joined him. Seven years after Idrimi had left Alalakh, he returned there with newly recruited troops. Once in Alalakh, Idrimi dealt with seven years of conflict with the Hurrian king, Parattarna, before reaching an agreement that made Alalakh subservient. With the support of the Mitanni Kingdom, Idrimi was the successor to the throne of Alalakh. As the king, Idrimi fought for seven years against the Hatti (Hittites) and eradicated seven cities. With his booty and prosperity, he built a palace and shared his wealth with his relatives. He dedicated himself to religious duties. At the end of his life, he put his son, Addu-nirari, in charge of his duties. This fairytale-

[8] Here the name "Mukish" appears as a city rather than a state (von Dassow 2008).

like story ended with an unusual column naming and blessing its writer, Sarruwe the Scribe (Smith 1949).

These inscriptions raise issues about the predecessor-successor sequence of Idrimi's dynasty. The name of Addu-nirari does not appear on any tablet found in the Level IV archive of Alalakh. The Level IV archives indicate the name of Niqmepa as the successor of Idrimi, who was the successor of Ilimilimma. According to these records, the dynasty is arranged as Niqmepa — Ilimilimma — Idrimi — Addu-nirari, which assigns Niqmepa as the grandfather of Idrimi (Woolley 1955). Woolley identifies the "bad thing" as the removal of Ilimilimma from the throne, which he bases on the unusual find-spots of the archaeological findings (Woolley 1955: 385–95). As a result, Niqmepa of Alalakh becomes the contemporary of Saushtatar in Mitanni (Woolley 1955: 385–95). On the contrary, by analyzing the Level IV archives, Wiseman revised the dynastic sequence as Ilimilimma (I)[9] — Idrimi — Niqmepa — Ilimilimma (II) (Wiseman 1953).

Wiseman also suggests two options to explain the absence of Addu-nirari in the archival texts. According to him, either Addu-nirari ruled for a very short time after Idrimi, so no records survived, or he was assigned only for religious duties as recorded on the statue (Wiseman 1953: 5–8). Furthermore, the name Sarruwe[10] as the author of the Idrimi statue inscriptions appears as the writer or witness for several other documents dated to the reigns of Niqmepa and Ilimilimma (Na'aman 1980: 107–10). Thus, the presence of Sarruwe as a scribe in Idrimi's court supports Wiseman's sequencing. Although Wiseman's dynastic chain is accepted generally among scholars, the fate of Addu-nirari still needs to be illuminated.

[9] Ilimilimma I is the Ilimilimma of Aleppo and the father of Idrimi.
[10] Na'aman studied Sarruwe's texts and his scribal characteristics (Na'aman 1980: 107–16).

Aside from the archival records and their interpretations, the archaeological context of the statue also sparks different theories about Idrimi and his dynasty. Woolley found the statue in a pit possibly dug from Level IB, but it was chronologically dated to an earlier period.[11] Due to this contextual uncertainty, Jack M. Sasson argues that the statue was inscribed during Alalakh Level IB as a memorial art piece to remember the re-founder and defender of Alalakh (Sasson 1981: 318–20; Longman 1991: 60–66). On the contrary, Sasson's argument was opposed due to style and inconsistencies in content of the statue to its archaeological context (Oller 1989: 416–17). Since indisputable archaeological and textual evidence of Addu-nirari has not yet been found, none of these theories can be more than a suggestion.

In the LBA, the vitreous material assemblage of Alalakh shows an extensive spread. The variety in colors and shapes reflects a well-established specialized technology (chapters III–V) not only at Alalakh, but also in the Mitannian cultural sphere, which Alalakh was a part of. Furthermore, the earliest glasses of Egypt, dated to the Tuthmosis III period, were associated with Mesopotamia, which actually was under the Mitannian influence during this period. The amount of tributes brought into Egypt from the military campaigns of Tuthmosis III to Mesopotamia and Syria were depicted on the walls of Karnak Temple, which also recorded glass ingots (Oppenheim 1973: 10–11; Shortland 2012: 55). The depiction of glass ingots on the temple walls provoked scholars to establish linkages between Egypt and "somewhere in Mesopotamia," mostly referring to northern Mesopotamia, in terms of glass artifacts. Two questions appear here: first, the definition for Mesopotamia and Mesopotamian glass are vague among the glass scholars; and, second, possible

[11] Level I is dated 1273–1194 B.C. by Woolley (1955: 399). Revised chronology dates Level I to the late 14th century B.C. (Yener et al. in prep.).

candidates (tribute-donors) who sent glass as tribute to Egypt during Tuthmosis III period were almost not questioned.

Even though there are gaps in the textual records, a historically relevant argument to glass might be made here. Michael C. Astour (1963) provided the place-names from Alalakh based on the north Syrian lists of Tuthmosis III. According to these records, it is known that Alalakh gave tribute to Tuthmosis III. Even though the content of the tributes is not clear, they might well have included glass. We cannot be certain unless a textual record confirms such a relation, but Alalakh with its flourishing vitreous corpus, ability to produce glass (see chapter V and VII), and being known as a tribute-giver to Tuthmosis III could be added together to make Alalakh a possible donator of glass to Egypt. Recent chronological synchronisms indicate that the king on the throne of Alalakh sending tribute to Egypt could be either Idrimi (based on Yener's working chronology) or Niqmepa (Peker 2009). This dissertation uses the latest chronological synchronisms chart made by specialists from the Yener excavations (fig. 2). Hopefully, further excavations will shed light on this hypothesis. Archaeologically speaking, whether it was Idrimi or his successor Niqmepa, glass as a material was very well known at Alalakh in Level IV.

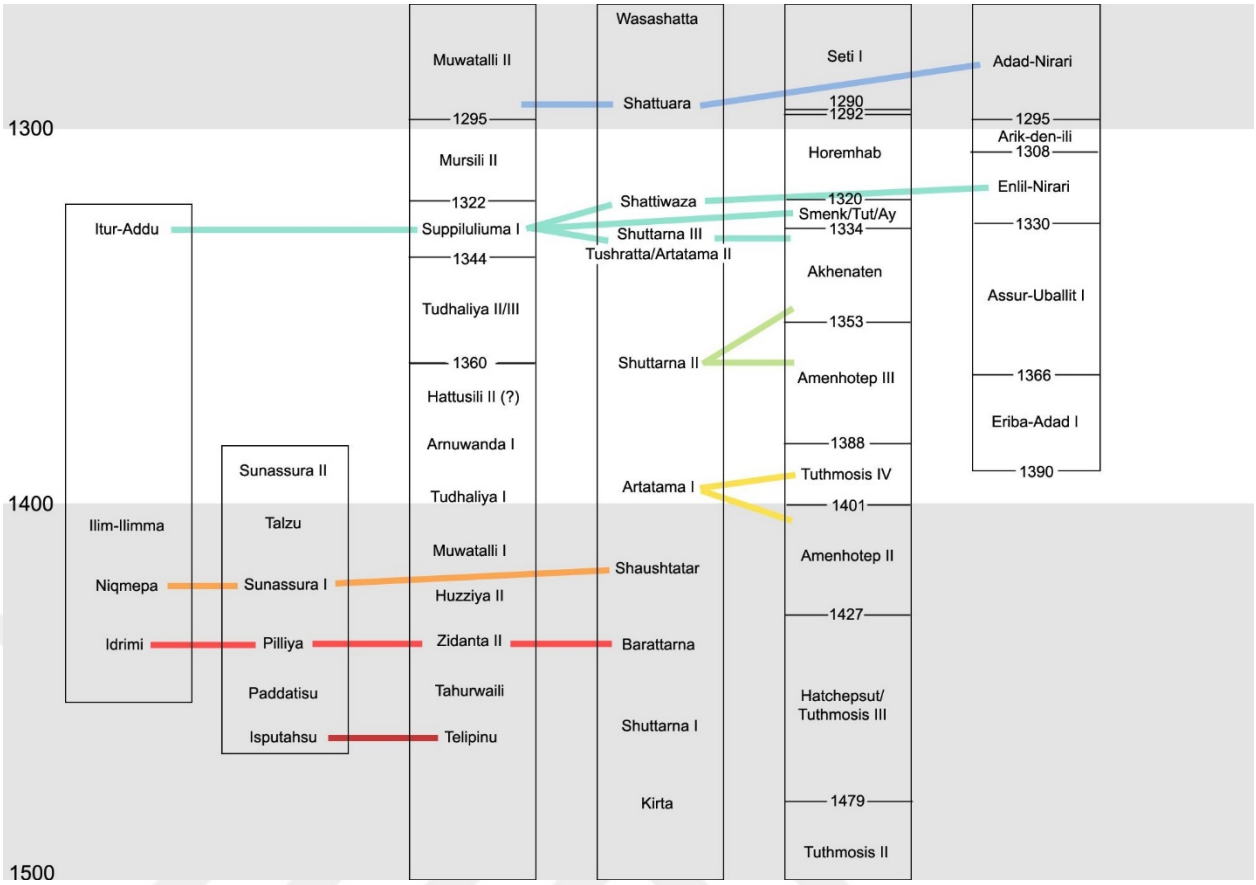

Fig. 2.1: New Alalakh synchronisms (The Alalakh Excavation archive, with kind permission of K. A. Yener).

2.4 The Relationships of Level IV Alalakh to Contemporary Settlements

As discussed above, Alalakh was a vassal to Mitanni during the 15th century B.C. Tablet AIT 3 clearly defines Idrimi of Alalakh as a contemporary of Parattarna (referred to as Barattarna in the chart) of Mitanni (fig. 2.1). This tablet synchronizes the reigns of Idrimi and Parattarna. However, to establish further linkages with other regions, the reign of Parattarna is still unclear. There is only a single record found among the Nuzi administrative tablets that refers to his name (HSS XIII 165; Wilhelm 1976; Stein 1989).

Unlike Idrimi, the reign of his successor Niqmepa is quite well documented in the Level IV archives. Almost half of the tablets were signed during Niqmepa's

reign by alternately using Idrimi's, Abbael's[12]or his own seals (Collon 1975). Prosopographical studies by von Dassow also support Collon's assertions by arguing that these tablets were produced during the reign of Niqmepa (von Dassow 2005: 45–46, 48–50; 2008: 45). The name Niqmepa appears in tablets AIT 13 and AIT 14, which carry a special importance to uncover his synchronic relations to Mitanni. Both of these records are about legal issues[13] that were brought before the Mitannian king, Saushtatar (mid-to-late 15th century B.C.), who sealed these tablets with the seal of his predecessor, Shuttarna (Collon 1975: no. 230; Stein 1989: 40; von Dassow 2008: 46). Saushtatar of Mitanni is suggested as the successor of Parattarna, who is contemporary with Idrimi (von Dassow 2008: 47). Saushtatar, who opposed Thutmose III's campaigns into the Levant, was king of *Naharina*, which is known to be Mitanni. In correlating Hittite chronology to Mitanni, Bryce puts Saushtatar as a contemporary to Thutmose III and Tudhaliya I/II (Bryce 2005: 120, 123, 128). Another tablet, AIT 2, found in the Level IV palace courtyard, is a fragment from a treaty signed between Ir-Teshub, king of Tunip, and Niqmepa, king of Mukish. The seal impressed on the treaty tablet for the king of Mukish writes "king of Alalakh," creating a problem for the attribution of Mukish and Alalakh as a state or a city.[14] This tablet contains issues about territories and fugitives' problems, which points out a military conflict between Alalakh and Tunip, and concludes with an emphasis on the allegiance to the Mitannian king (von Dassow 2008: 53).

[12] Abbael is the son of Sarrael. For the dynastic use of Abbael's seal by Niqmepa, see Dassow 2008: 281; Collon 1975, no. 11.
[13] Tablet AIT 14 is about a territorial problem, probably with Kizzuwatna, and tablet AIT 13 is about a tribunal of people (von Dassow 2008: 48–49).
[14] Mukish in the inscription on the statue of Idrimi has the determinative identifying it as a city (von Dassow 2008). However, Mukish was referred to as a state rather than a city on tablet AIT 2.

The name of Niqmepa was also referred to in a text outside of Alalakh. Ugarit Tablet RS 4449 is the record of a letter sent to Niqmepa, the king of Alalakh, from the king of Ugarit, Ibiranu, mentioning the loss of a fugitive belonging to Niqmepa (Bunnens 1987; Arnaud 1996: 47–54). Since there is not much known about Ibiranu of Ugarit and the name is quite common in the Ugaritic dynasty, the relation of Alalakh and Ugarit in terms of contemporary kings is still unclear.

2.5 The Reign of Ilimilimma and the End of the Level IV Palace

The successor of Niqmepa was his son Ilimilimma. Even though a textual record dedicated to Ilimilimma or clarification of his reign as king has not yet been found, two tablets (AIT 15 and AIT 330) mention Ilimilimma as the son of Niqmepa (Collon 1975: nos. 193, 220). Additionally, nine tablets coming from the non-palatial archives were sealed with his seal (tablets AIT 48–49, 70, 85, 87–88, 94, 103–04 in von Dassow 2005: 45–48).

According to Woolley (1955: 130), the Level IV palace was looted and burned during a civilian's rebellion — not by an outside enemy — against the king of Alalakh; he dated this event to ca. 1415 B.C. He proposed this theory due to the unusual fact that the properties of the Level IV palace would have been carried off had it been destroyed by enemies. Furthermore, the quality and quantity of the findings are not enough to reflect court life even compared to findings from the ruins since they were most probably looted. The condition of the tablets and objects lead to the conclusion that there was a hurry to remove or loot goods (Woolley 1955: 130). According to the traditional understandings of establishing a chronology, imported pottery was used to date these levels. The existence of a Cypriot Base-Ring II shard and a Mycenaean LH IIIA shard among the palatial findings fixes the destruction of the Level IV palace to post-date 1425 B.C. (Stein 1997: 56). The new round of

excavations brought a broader perspective to the new chronology of Alalakh by providing a set of data composed of fine-grained and relational stratigraphy, deposit-defined seriation, ceramic seriation, and textual records as well as radiocarbon dating and dendrochronology. Studies are ongoing to precisely date these levels (Yener et al. in prep.).

The end of Level IV and the beginning of a new period in Alalakh was interconnected with the political and military environment of the second half of the second millennium B.C. The destruction of Level IV is attributed to Hittite King Suppiluliuma I and was dated to ca. 1370 B.C. by Woolley (1955: 130). However, this date is changed to 1340 B.C. according to the low chronology (Gates 1987). Mukish became a vassal of the Hittites in the mid-14th century B.C. (Bryce 2005; Klengel 1992). This change in Alalakh's political situation and the control of the city by the Hittites were mentioned in the textual records (Astour 1972). The preliminary results of the Yener excavations suggest a new picture for the chronology at Alalakh. According to new dating, the site was abandoned around 1300–1290 B.C. and reoccupied as a minor settlement in the mid-12th century, around 1140 B.C. (Akar 2012b; Yener 2013).

Archaeological deposits prove the Hittite presence at Alalakh (Woolley 1955). Woolley defines Level III/II as the "Hittite fortress of Alalakh," extrapolating the archaeological remains of a Hittite-style administrative complex and a Hittite-based material assemblage found in subsequent levels (Level I; Woolley 1953, 1955). On the other hand, the results of Yener's archaeological expedition at the site disprove Woolley's definitions for Levels IV and III (Akar 2012a; Yener et al. in prep.). Instead of a sudden collapse at Level IV followed by a re-emergence at Level

III/II, new excavations reveal archaeological deposits verifying the reuse and reconstruction of the post-Level IV sequences.

Ongoing excavations at the settlement are still searching for answers to the chronological problems. Furthermore, better explanations are now being developed to understand the cause of the destruction or abandonment of the site. According to the latest excavation results, rather than annihilation, Alalakh was abandoned during the late 14th–early 13th centuries B.C. and the occupation ended at the beginning of the 13th century B.C. (Yener 2013; Yener et al. in prep.). Further debates related to the chronology of Alalakh are beyond the scope of this dissertation.

Relevant to this study is the continuity of the existence of vitreous materials in the settlement. The 2004–2014 excavation seasons unearthed a significant corpus of frit, faience, and glass artifacts indicating cohesion in the production or at least the demand for vitreous materials (appendix I). Furthermore, a craft quarter area excavated in the LBII contexts of the mound yielded pottery kilns and installations producing vitreous materials. The analysis of the kiln fragments and slags were the subject of the author's MA thesis (Dardeniz 2012). Even though the exact type of vitreous material as frit, faience, or glass could not be absolutely determined, it is clear that production activities were going on at the settlement almost until the abandonment of the site.

2.5 Reflections of History in the Material Culture of Alalakh

Strategically located at the juncture of multiple trade networks, Alalakh's pivotal role in both land and sea networks was certainly one of the major reasons for the LBA empires to seek to control the territory of Mukish. Continuous changes in political control together with the dynamic trade network connections that Alalakh was involved with created a complex and hybrid material culture in the settlement.

The exchanges between Alalakh and contemporary international cultures built a highly cosmopolitan environment. Intensive and broad trade contacts were widely dispersed according to archaeological and historical data. Archaeological findings together with textual records bring the complex relations into sharp relief (von Dassow 2008; Yener 2010b).

The exceptionally rich and unique artifact assemblages provide solid evidence to show the influence of different cultures on the hybridization of the material culture of Alalakh. Various cultural trends, such as pottery styles or architectural features, left their traces on every element of artistic goods produced in this capital city. Archaeological evidence reflects a complex mixture of cultures in all aspects of daily life, including production technologies (Erb-Satullo 2010; Dardeniz 2013, 2014).

The divergence in socio-economic life also triggered new progress and ideas in related technological areas. An increase in demand due to commercial activities or changes in daily life may have activated an advanced expansion in production techniques and technologies including glass, faience, frit, pottery, and metal. All these are archaeological evidence of a variegated socio-economic life at Alalakh. As noted above, the cultural influences of the Mitannians were dominant for a long time both in material culture and in the production technologies of Alalakh. With the dominance of the Hittites immediately after the Mitanni Empire, the city was also marked with its characteristic Hittite trends in the material culture.

Besides archaeological evidence, textual records provide critically important information to illuminate various aspects of production like its hybrid material culture, socio-economic relations, as well as the social status of the production-related labor, i.e., the craftsperson in LBA Alalakh. Tablets unearthed in the Level

IV palace, Level III, and Level II were examined by various scholars and it was revealed that various crafts like the potter (*paḫāru*), smith (*nappāḫu*), carpenter (*naggāru*), stone-cutter (*zadimmu*), leather-worker (*aškāpu*), reedworker (*atkuppu*), weaver (*išparu*), seal-cutter (*parkullu* [*ḫuli*]), bow-maker (*sasinnu* [?]), or scribe (*ṭupšarru*) were done by diverse groups of people having different social statuses (von Dassow 2008: 256, 262, tables 4.3, 4.4). Whether these four classes[15] were in royal service or not, as von Dassow acknowledges, everything was recorded from the palatial perspective. This information did not include local–social relationships. Tablets documented issues about the favored subjects of the royal court. Nevertheless, these tablets are indications of palace and elite interest and their control over crafts. The elite desire to oversee crafts was due to either emphasizing their power or manipulating their social status through the superintendence of production.

Obtaining raw materials necessitates organization and in terms of vitreous materials, achieving colors requires special technological knowledge and the availability of specific minerals and metals. As the household and personnel lists demonstrated, various kinds of artisans like smiths and potters were categorized in these documents, thereby proving palatial governance of them. Although hitherto available textual records did not document the details of a control mechanism, this complex administrative system also covered control and organization of raw

[15] According to these tablets, four different social groups were identified: *ḫupše*, *ḫaniaḫḫe*, *eḫelle*, and *maryanni*. *ḫupše* (*ḫupšena* or in some Alalakh IV texts, *purre*) were a relatively poor or low-ranking people holding their own lands (Dietrich and Loretz 1970). Dietrich and Loretz (1970) and von Dassow (2008) argue that *unuššuḫuli* refers to "one who owes royal service." Also, *ḫaniaḫḫe* was referring to an impoverished class of the population occupied as craftspeople, daily-workers, or soldiers (Schloen 2001: 303). However, *eḫelle* and *maryanni* classes refer to a more high ranking status. *eḫelle* (*eḫelena*) describes "released- or freed-men" (Dietrich and Loretz 1969: 92). Most probably this symbolizes an independence from the royal service. On the other hand, *maryanni*, who were chariot warriors, constituted a distinct elite class (von Dassow 2008).

materials — even the distribution and consumption of goods. Eventually, all these craft–palace and craft–elite relationships constitute an example of the socio-economic structure in the LBA capital of Alalakh, which needs further examination and is touched upon in chapter VIII.

Alalakh seems to have created its idiosyncratic culture by harmonizing different elements from various cultures. Furthermore, the integration of production activities and the use of technological knowledge among the integrated crafts indicate experimentation, trial and error, and the perfection of the manufacture of luxury goods including vitreous materials. Different technological advancements were reached in order to provide high-quality goods to palatial and domestic markets. These technological achievements and the socio-economic environment of the period can be further researched by investigating archaeological contexts related to production technology. In this regard, any production debris excavated at the site is a source of primary knowledge. The contextual information summarized in chapters IV, V, VII, the scientific examinations collected in chapter VII, and the integration of crafts discussed in chapter VIII demonstrate how technological processes were developed in relation to the nature of the socio-economic and socio-political settings and how different production activities were integrated with each other.

CHAPTER III:

DEFINITIONS AND HISTORY OF VITREOUS MATERIALS

Archaeological objects with their forms, colors, and materials are representatives of their cultures, and thus understanding their material characteristics is essential. This chapter presents an overview of both the material characteristics and the history of vitrified materials from Anatolia, Syria, the Levant, Mesopotamia, and Egypt without introducing any stylistic or typological trends concerning Tell Atchana, ancient Alalakh. The artifactual corpus of the case site with their parallels and comparisons are demonstrated separately in chapter IV section 3.

This chapter focuses also on the technological aspects of all vitrified materials in chronological order by mainly concentrating on the second millennium B.C. in order to understand and to interpret the archaeological materials within the process of emergence and development. Discussions on archaeometric research done on the vitreous artifacts of the period are specifically avoided except in some crucial cases where the analyses are necessary for a definitive explanation. A comprehensive narrative of scientific examination is provided in chapter VII as comparative information.

Vitreous materials are generally tiny and fragile and mostly decayed, and thus lacking accurate identification by the excavators. Furthermore, the identification of vitreous artifacts is not consistent even at the same excavation site, and therefore the

credibility of inventories and related documentation is low. As J. F. S. Stone and L. C. Thomas (1958: 38) already noted, “far too frequently excavation reports, especially those dealing with the Middle East, lack precision, and accurate descriptions of the substance found are mainly wanting or may be wholly misleading.” These deficiencies and inconsistencies in the definitions as well as the misleading popular terminologies among archaeologists need correction, which in turn requires time and proper scientific studies. These terminological conflicts are also the case with the Tell Atchana, ancient Alalakh, vitrified corpus, especially for the material excavated by Woolley; therefore, a descriptive chapter on the material characteristics is inevitable.

Chapter I presented a small glossary on the fundamental terms and definitions. However, to establish a precise and consistent terminology, basic material science knowledge of the vitrified materials of the second millennium B.C. is necessary. Therefore, each subsection in this chapter provides some scientific information and presents the elementary characteristics for each vitreous material. Even though the major raw materials — soda, silica, and lime — are similar for the vitreous assemblages, the final products, namely, glazed steatite, frit, faience, and glass have different material properties that provide each of these materials with different chemical and physical characteristics.

Besides terminological problems concerning materials, a brief explanation is necessary on the production stages of vitreous artifacts, where in the modern terminology of “making” and “working” indicate different stages of manufacture. For the second millennium B.C., the crafting of frit, faience, and glass “making” defines the production of the materials from their raw materials whereas “working” identifies later manipulations of the materials. In other words, manufacturing

vitreous materials in certain conditions from silica, soda, lime, and colorant is referred to as "making." A second stage of manipulation of the material to give it a final shape is called "working." The difference between glassworking and glassmaking is crucially important for second millennium B.C. glass industries, which is discussed deliberately in section 3.4.5 of this chapter.

In cases where a separation between making or working is not possible, then this study uses the words "production and/or manufacture." For example, for the faience of the second millennium B.C., the stages of making and working cannot be separated. The core and glaze of faience could not be worked/manipulated later as separate materials. It is not likely that faience cores and glaze were treated as two different materials during production. Thus the following chapters use "faience production" rather than faience making and/or faience working. [16]

Finally, this chapter presents summaries of the history of frit, faience, and glass in the second millennium B.C. contexts of Anatolia, northern Syria, the Levant (mainly the north), Mesopotamia, and Egypt. The historical background for the assemblages is important to understand the emergence, development, and use of vitreous materials within and among the regions. To establish a framework for research, only relevant, well-known, and *sine qua non* examples are discussed. However, transcribing every single detail is specifically avoided, but a general bibliography is provided.

3.1 Glazed Stones

3.1.1 What Is Glaze?

[16] Artisans related in faience production are defined as faience makers or faience workers (Shortland 2012; Nicholson 2012). The same terminology is followed in chapter VIII to refer faience artisans.

Glazes are vitrified surface coatings providing impermeability to the objects or applied for decorative purposes on the faience or baked clay bodies (Moorey 1994: 167; Hodges 1989: 42). The major component of glaze is silica. Silica melts at 1710^{o} C, which is not an accessible temperature with the firing technology of the second millennium B.C. Therefore, silica must be modified with the addition of fluxing materials, which are agents to decrease the melting temperature. Glazes are therefore classified based on the fluxing materials. Alkaline glazes contain soda or potash as opposed to glaze, which contains lead. The second millennium B.C. glazes used in the Near East are alkaline glazes.

Far more important for second millennium B.C. archaeology is the beginning of glazing technology. Glazing is an important technological stage among other vitreous technologies since it leads the way to glazing various stones, then faience production, and later glazing on pottery. The earliest examples of glazing in archaeology start with glazing silica-rich stones like steatite (a serpentine), which are magnesium silicates, quartz, or flint (Moorey 1985: 135). Among these, the most common is the heat resistant steatite: a soft, easily cut, and fine-grained stone suitable for the production of small objects like beads and amulets.

Steatite was glazed by methods like direct glazing, burning, or etching (Moorey 1985: 138–39). The fundamental research of Horace C. Beck (1934) on glazed stones classified glazed steatite into three groups:

Glazed: This method defines the application of the glaze directly on the surface of the stone or the use of the cementation process (see section 3.3.1 on faience production methods below). This method is observed in the Near East and Egypt.

Burnt: This technique defines the application of an alkali or a glaze to the surface of steatite, which is then fired. Objects produced with this method are found at Near Eastern and Egyptian sites.

Etched: In this technique, first the surface of the steatite is coated most probably by an alkali, and then heated. This is a method generally observed in the Indus Valley rather than the Near East or Egypt.

3.1.2 History of Glazed Steatite and Quartz

Glazed stones, mainly of steatite, are commonly found in Egypt and are respectively rare in Mesopotamia, Anatolia, and the Levant as early as the late fifth millennium B.C. and the history of glazed stones is still unclear. Glazed beads made of glazed steatite in green or greenish blue color appear first in the Badarian period, dated approximately the last quarter of the fifth millennium B.C. in Egypt. Such beads were recovered from tombs at Naqada, Badari, el-Amrah, and el-Gerzeh, which are dated to the Predynastic periods (before ca. 3050 B.C.) (Nicholson 1993: 18).

During the second millennium B.C., glazing on stones was common especially for small objects like beads and amulets. There was a limited color palette, mainly utilizing blue and green colors. For glazing tiles, ceramics, and similar clay objects, a flourishing industry was not established until the first millennium B.C., a topic that will not be covered in detail as a part of this dissertation.

Rather than stones, glazing on terracotta was a later invention and such artifacts were not found until the 16th century B.C. Terracotta glazes were generally blue and green colored. The vitreous glazes on terracotta are sometimes confused with painting on terracotta. Simply, in glazing terracotta, a mixture of silica, soda,

and lime may be painted on the surface of the ceramic prior to firing; it then forms a glaze, and this is different than paint (Moorey 1994: 167).

3.2 Frit

Frit is one of the most confusing materials among the vitrified materials since the term is used both to define faience and a specific type, "Egyptian blue," which is a type of frit. Frit has a sintered siliceous body without glaze, but it does not crystalize completely so it has the properties of a liquid (Kuschke 1970; Moorey 1985: 134; Moorey 1994: 167).

Frit is used commonly in the second millennium B.C. to produce beads, amulets, inlays, and a limited corpus of vessels. Various colors like blue, brick red, white, black, and yellow have been observed among the frit artifacts. Among those, the most popular colors were blue and green; brick red was noted as very rare.

Frit is mostly confused with faience. When the glaze of faience has been washed off, it might look like frit. More than being a material to produce jewelry or small artifacts, frit has an important relationship to glass. It is an intermediate product while producing glass. When glass is produced in two steps, silica and fluxes are melted to produce frit in the first stage. In the second step, frit is ground into powder form and melted to produce glass.[17]

Cakes of frit and crucibles for producing them were first discovered at Tell el-Amarna (hereafter Amarna) where a glass factory was unearthed (Petrie 1894: 25ff.; Lucas and Harris 1962: 19.). After producing frit, the frit cakes were ground

[17] For details of glass production, see section 3.4.2.

into powder, which was either used to produce glass later or to be used as pigment.[18] Unworked pieces of blue-colored frit or Egyptian blue were also recovered at Yorghan Tepe, ancient Nuzi (Starr 1939; Kirk 2009), and at the recent excavations at Tell Atchana, ancient Alalakh (see chapters IV and V).

3.2.1 Egyptian blue

Egyptian blue is a special version of frit. It is made by sintering quartz and coloring it with a special mineral named Egyptian blue. So, Egyptian blue is actually the natural mineral cuprorivarite ($CuO.CaO.4SiO_2$), a silicate of copper and calcium. Firing temperatures of 900^o–1000^o C are enough to produce Egyptian blue depending on its alkali (flux) content, which lowers the melting point. Egyptian blue frit produced at 1000^o C tends to be a darker blue depending on the alkali content. Firing around 850^o –950^o C with low alkali causes light blue-colored softer material whereas high alkali causes a pale blue coloring and a harder material (Tite and Bimson 1987).

In archaeology, the raw mineral constituent is generally used to define the final product itself, which creates terminological problems. Blue frits that either include or lack the mineral cuprorivarite are defined as Egyptian blue based on their color. Technically, the identification of Egyptian blue frit is only possible with XRD analysis. Moorey (1994: 168, 186) argued for an independent classification of Egyptian blue separate from other blue frits since Egyptian blue, blue frits, and even blue faience, glass, and sometimes azurite (Peltenburg 1987: 12) are confused terminologically.

[18] See section 3.4.2 for details of the glassmaking process and the use of frit as an intermediate for glass production.

To further confuse the issue, the term glass paste (*pâte de verre*) was frequently used to define frit, Egyptian blue, and sometimes glass. This was a common terminological confusion and Woolley, whom this dissertation partially relies on, repeatedly made this mistake while defining the Alalakh vitreous assemblage. Additionally, the Ur assemblage has the same problems in material identification.

Egyptian blue was not only used as a material to produce artifacts like beads, amulets, vases, and cylinder seals, but it also was utilized as a pigment for wall paintings, portraits, and panels. The use of the material as a pigment was observed in second millennium B.C. frescoes in the Aegean[19] and Egypt and were known to have continued until the Greco-Roman periods (Vlachopoulos and S. Sotiropoulou 2012; Dardeniz 2015; Ganio et al. 2015).

3.2.2 History of Frit and Egyptian Blue

The origin of Egyptian blue in Egypt dates back to the sixth dynasty of the Old Kingdom period (ca. 2550–2400 B.C.). In Mesopotamia, the Royal Cemetery of Ur provided numerous examples, but Woolley's terminology is still problematic and confusing since he used glass paste, frit, and faience as substitutes for each other (Woolley 1934).[20]

In Anatolia, frit and/or Egyptian blue have been recovered as grave goods since the Early Bronze Age (hereafter; EBA). The cemetery of Resuloğlu yielded numerous necklaces made out of dark and light blue frit or Egyptian blue, faience,

[19] The wall paintings of Hattusha and Tell el-Daba are under study to investigate the vitrified material character of the samples where blue color was possibly obtained by using Egyptian blue pigment (personal communication, Constance von Rüden, November 2014).

[20] For Woolley's terminological problems in terms of definitions, please see chapter IV.

carnelian, seashells, and copper beads dated circa the second part of the third millennium B.C. (Yıldırım 2006; Yıldırım and İpek 2010). From the MBA, the Sarıkaya palatial room of Acemhöyük yielded similar light and dark blue frit and faience beads woven as a decoration on a textile (Özgüç 1968: 19). Nimet Özgüç in her last publication dated the Sarıkaya palace between ca. 20th–17th centuries B.C. (Özgüç 2015: 13).[21] Furthermore, Professor Aliye Öztan recovered similar blue beads from the ruins of the palace during cleaning.[22] On the other hand, this material from Anatolia has not been fully analyzed yet, so it is not possible to securely identify the material as frit or Egyptian blue.[23]

In the LBA, the ancient site Nuzi, with its modern name Yorghan Tepe, located in modern Iraq, yielded evidence for 15th century B.C. frit.[24] In Nuzi stratum II, from Temples C–A and mainly Temple A, frit beads, especially in the shape of frogs and flies, were recovered along with a frit cup and a frit vessel fragment (Starr 1939: 91, 94, cf. 446). Blue frit objects were the most common whereas red was very rare in the frit collection (Starr 1939: 447). Pamela Vandiver studied the vitreous collection of Nuzi and she noted that blue, brick red, white, black, and yellow were the colors for the Nuzi frits, all of which had different chemical compositions (Vandiver 1982: 82). The colorant for red and yellow were found to be iron (ferric

[21] This palace was dated dendrochronologically to 1777–1774 B.C. (Kuniholm et al. 2005) though his dendrochronological results were lately challenged by Manning et al. 2016 by providing radiocarbon results dating the Sarıkaya palace between ca. 1794–1785 B.C. (Manning et al. 2016: 18, fig.9).

[22] Personal communication with Professor Aliye Öztan. She kindly allowed me to see this material in Aksaray Museum depots in 2016.

[23] The excavation director of Resuloğlu, Professor Tayfun Yıldırım, kindly provided me with some samples from the EBA Resuloğlu beads for further analysis in order to exactly identify the material as frit or Egyptian blue. The first analytical results points towards to a new local technology, which is beyond the subject of this dissertation. This study will be conducted in collaboration with Professor Yıldırım as a part of a post-doctoral project.

[24] The settlement is referred to as Nuzi throughout the rest of the chapter.

oxide) and for blue, copper was used. The same levels at Nuzi also yielded Egyptian blue artifacts.

Egyptian blue was recovered from the late MBA and LBA levels (ca. 1650–1200 B.C.) of Ras Shamra (Ugarit[25]). Almost 250 manufactured objects including beads, pendants, scaraboid and cylinder seals, disc fragments, decorative inlays, vessels, gaming pieces, and 20 small ingots of raw material were found mostly in burial contexts in the lower city, royal palace, and residential quarters, as well as the sister site of Minet el-Beida, which was the harbor town and necropolis area of Ugarit (Yon 2006: 157–58). Ten percent of the Egyptian blue artifacts and two of the raw materials were analyzed by XRD, SEM, and particle induced X-Ray emissions (PIXE); metallic oxides of copper, arsenic, and tin were investigated (Bouquillon and Matoïan 1998; Matoïan and Bouquillon 2000, 2003), indicating the presence of Egyptian blue from the Nile valley (Caubet and Kaczmarczyk 1987: 52). Matoïan and Bouquillon (2003: 338) noted that Egyptian blue had been used both as a raw material and as a colorant for faience. Moorey reported that both copper and bronze scrap were used as colorants for the LBA Egyptian blue of Ugarit (Moorey 1994: 189; Matoïan 2003; Matoïan and Bouquillon 2003). Since production debris was not recovered at the site, two possible origins for Egyptian blue were suggested: first, Egypt, due to the characteristic and chemical composition of the artifacts; and second, local production, due to the use of Egyptian blue as raw material for the production of faience with local recipes (Caubet and Kaczmarczyk 1987: 49; Matoïan and Bouquillon 2003: 343).

[25] The kingdom of Ugarit and its principal port Minet el-Beida were located on the coast of northern Syria at a strategically important crossroads between Mesopotamia, Egypt, and the Aegean (Matoïan and Bouquillon 2003: 333). The settlement is referred to as Ugarit throughout the rest of the chapter.

3.3 Faience

The word faience derives from the faience of Faenza in Italy. However, the faience of the second millennium B.C. is different from this material. Ancient faience is composed of a sintered quartz body and glaze (Moorey 1985: 133).

Various terminologies including paste, white paste, Egyptian blue paste, Egyptian faience, and glazed frit were used to refer to faience in the literature. As noted above, similar terminological confusion is also seen for the Alalakh corpus (Woolley 1955).[26] To avoid any misidentification of the material, this dissertation relies on Stone and Thomas' (1958: 38) definition of faience as "finely powdered quartz grains cemented together by fusion with small amount of alkali or lime or both."

In faience, the ingredients need to be sintered to a certain degree in order to produce a liquid that binds the rest of the material while cooling and the surface is glazed (Brill 1970: 115). That may be the reason for the use of the word "glassy" for the surface of faience although it is different from glass in terms of chemical characteristics (Moorey 1985: 133–34).

3.3.1 Production of Faience

Faience as a raw material can be modeled by hand or it can be shaped with a mold. The hardness of faience may vary depending on whether it is dry or fired. The glazed layer generally does not survive post deposition, which may be the reason archaeologists or non-specialists define it as frit or paste. The glaze is applied with one of three different methods (fig. 3.1):

Direct application of glaze: In this method, the glaze is prepared by mixing the raw material with water so that a slurry is produced. This mixture is applied on

[26] For the inconsistent use of faience terminology by Woolley, see Chapter IV.

the surface of the body by dipping the object directly in the glaze or brushing it on the surface. The water is absorbed by the porous body of the object, which is followed by firing so that the glazing mixture left on the surface melts during firing and forms the glaze (Lucas and Harris 1962: 172–80; Vandiver 1983; Tite et al. 1983).

Faience objects produced by direct application have the remnants of uneven surface glazing or even drops of glaze. In this method, the thickness of the glaze depends on the porosity of the body and water percentage of the glazing mixture (Moorey 1994: 184).

Efflorescence: In this method, the glazing slurry is mixed with the core. While drying, the water-soluble alkaline salts migrate towards the surface of the artifact (i.e., effloresce) and create a white layer, which after firing in an oxidizing atmosphere at around 850^{o} C turns the slurry to glaze (Noble 1969). In this method, the most important parameter is the drying rate of the artifact. Some spots that dry faster have a thicker glaze on the surface (Moorey 1994: 184).

Cementation: In this method, the artifact is prepared as a mold and mixed with a possibly organic and animal by-product adhesive that is imbedded in the glazing slurry, which has soda, silica, lime, and colorant for the desired color. Then it is fired to 1000^{o} C (Tite et al. 1983). Recent research has proposed the use of cattle dung as a source of alkali at least for the cementation method (Matin and Matin 2014), which is one of the most available resources in ancient societies.

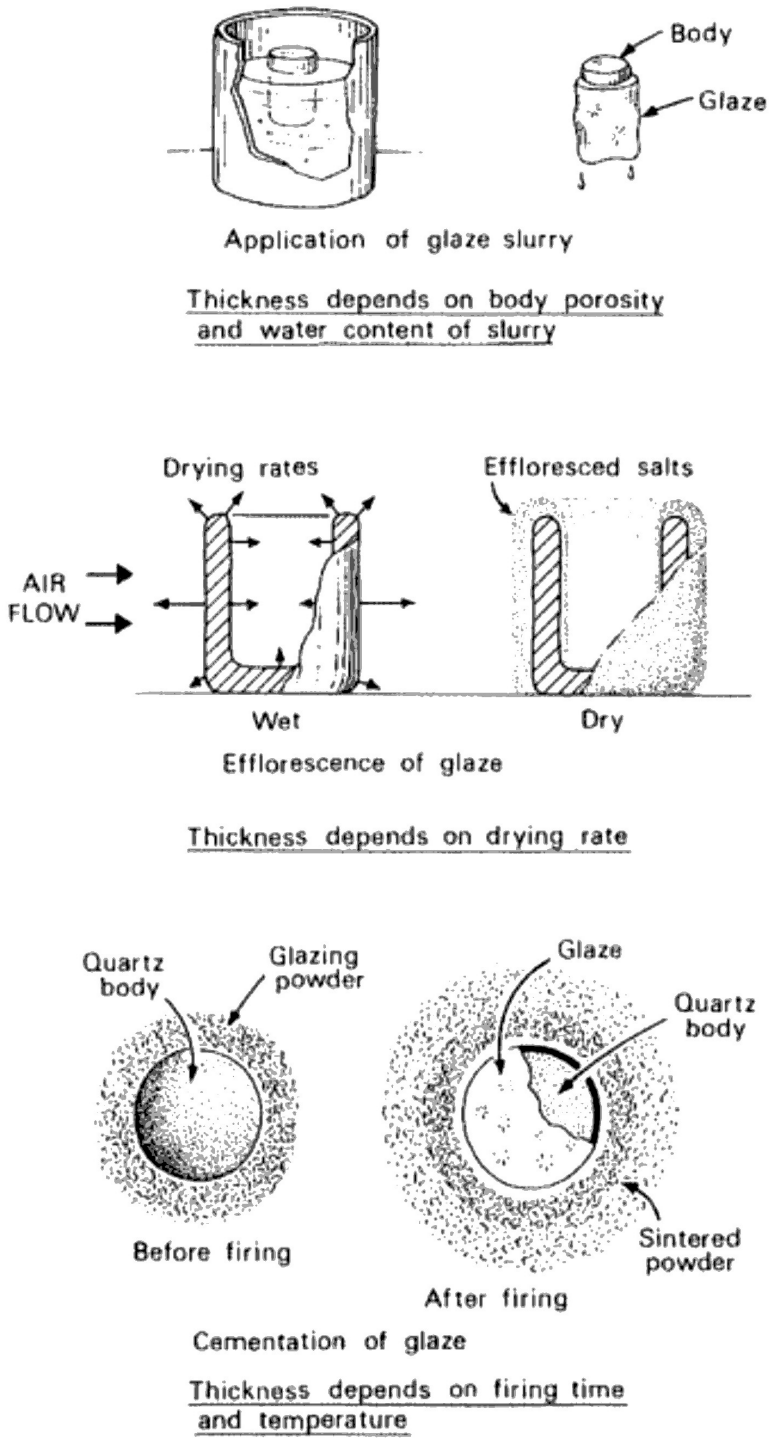

Fig. 3.1: Faience production techniques (after Kacmarczky and Hedges 1983; Moorey 1994: 185, fig. 12).

3.3.2 Colorants in Faience

For producing colors in faience, the chemical nature of pigments need to be understood since the same metal oxides can produce different colors under varying

firing conditions. For example, iron oxide can produce pink colors under oxidizing conditions whereas mild reducing conditions create blue or green. Strong reducing conditions produce grey or black (Kaczmarczyk and Hedges 1983: 140–50; Moorey 1994: 185).

At northern Mesopotamian and Syrian sites, like Tell al-Rimah and Tell Chuera, respectively, and at southern Mesopotamian settlements, such as Nippur, Ur, or Kish, blue, green, and black faience appeared at the beginning of the third millennium B.C. and around the end of the millennium, brownish red and yellow became apparent. Details of the archaeological contexts are given in section 3.3.3 for Tell al-Rimah, but the yellow glaze of the faience was found to contain lead and antimony; lead antimonite together with copper was found as the green colorant. Black colors were obtained by using manganese with a high iron content (Pollard and Moorey 1982; Kaczmarczyk and Hedges 1983; Caubet and Kaczmarczyk 1989). The same trend for black colors was investigated also at Kish.

Polychrome faience was a later achievement. In Mesopotamia (Nuzi and Tell al-Rimah), the Levant (Ugarit), and Egypt (Amarna), polychrome faience appeared around the middle of the second millennium B.C. when glass artisans practiced polychromy (Peltenburg 1971: 9). Polychrome faience production produced its most vivid colors in the Minoan center of Knossos (1700–1480 B.C.). A range of colors — including yellow, turquoise blue, blue, violet, and green — are visible on plaques, inlays, and town mosaics known from the Palace of Knossos (Tite et al. 2009; Sinclair 2012).

3.3.3 History of Faience

Faience beads first appear in green ca. 4000–3500 B.C. in the Amratan period (Naqata I/Middle Predynastic) in Egypt, but their earliest existence in Mesopotamia

is uncertain (Moorey 1985: 137, 142). The earliest existence of faience beads were reported by Max Mallowan as coming from the Halaf period levels (ca. 6100–5100 B.C.) at Arpachiya, though there is uncertainty regarding the archaeological contexts (Mallowan 1935: 91, 98). The isolated finding of this faience seal(?) or discoid pendant(?) together with two frit(?) vessels from the same levels is problematic due to the very early appearance of the material and the lack of scientific evidence to characterize the material. To clarify, the problem of the existence of faience in the Halaf period necessitates revisiting the material from Arpachiya. Furthermore, faience ring beads were reported as grave goods in the northern part of Arpachiya (Mallowan 1935: 38, 92, 97), "white paste" was reported in the later Ubaid periods (ca. 4500–4000 B.C.) of Tepe Gawra (strata XIX–XVI), and the Uruk period (ca. 4000–3100 B.C.) of the site (strata after XIII) yielded faience ring pendants and stamp seals (Tobler 1950: 192). "Small paste ring beads" were recorded in the Ubaid cemetery (Woolley 1956: 88). On the other hand, the definitions of the material given in the quotation marks are always speculative due to the lack of scientific evidence and a standardized terminology.

In the fourth millennium B.C., the evidence for the production of faience becomes more solid. Faience objects were recovered from the "bead stratum" at Nineveh (Stone and Thomas 1958: 42; Foster 1979: 23), at the burials of Gawra (Tobler 1950: 87–88), at Ur (Woolley 1956: 66), at Uruk (Heinrich 1936: 26, 41, pl. 13h), and at the "Eye-Temple" of Tell Brak (Mallowan 1947: 33, 102, pl. X: 9, 108–09, pl. XIV: 9–13, 254–56, pl. LXXXIV). According to Moorey (1985: 143), the frequent use of faience, especially at Nineveh, as amulets and seals of various shapes indicates possibly a local origin rather than a southern origin as Perkins (1949: 188) suggested. At the end of the fourth millennium B.C., the use of faience became wider

and faience bowls and vases started to appear. A blue glazed jar with an impressed chevron on the shoulder was found in Ur stratum H of Pit F (Woolley 1956: 30, 63, 177: U.14422, fig. 9d). Lower in the same pit, a turquoise glazed open bowl was also recovered (Woolley 1956: 30, 63, 177: U.14908). Similar vases were recorded at Telloh (de Genouillac 1934: 36–37, 61) and Jebel Aruda (van Driel and van Driel-Murray 1983: 7) without an exact attestation to their northern or southern origin.

The use of faience continued in the early Dynastic to Ur III periods (ca. 3000–2000 B.C.). Beads and cylinders seals were recovered in cemetery A at Kish (Mackay 1925, 1929). In the private and royal graves of Ur, beads were found (Woolley 1934: 524). At Tell Chuera, a green glazed mace head was found at level 4 of the Anten-Tempel (Moortgat 1967: 32–35, fig. 23). Beads, pendants, bowls, and fragments were found through levels VIII–IX at Tell Taya (Reade 1968: 244–45, 249; Reade 1971: 98, pl. XXVd; Bimson 1973) and Mari (Parrot 1956: 121, pl. LII.1047). Small molded animal figures exist in the artifact corpus of Assur (Andrae 1922: pls. 49a–60), Kish (Watelin 1934: pl. XXXI.4–5), and Nippur House K, which were all dated to the Akkadian period (Vandiver and Yener 2009: 150–51).

Recent research at Başur Höyür, located in Siirt in southeastern Turkey, yielded thousands of frit and faience beads. Dated tentatively to 3100–2800 B.C., the beads found at Başur Höyük are mainly blue and greenish blue.[27] The chronology of the artifacts is not clarified yet and the tentative dating mainly depends on the associated ceramic assemblage. Similarly, the western Anatolian site Seyitömer Höyük located at Kütahya region also yielded faience and frit beads, bird shaped amulets as well as faience cylinder seals dated to the EBAIII period (Bilgen et al. 2015: 146–47, fig. 160–61). Seyitömer Höyük at the western Anatolia and Başur

[27] This information is based on personal communication with Dr. Emma Baysal, the bead specialist of the Başur Höyük excavation.

Höyük at the southeastern region have great potentials to add to our knowledge on the occurrence of faience throughout the EBA.

The third millennium B.C. graves of Assur, dated to the Ur III period, yielded faience animal figurines (Andrae 1925: 61; Haller 1954: 8–9). At Ur, faience beads (U. 17891) and inlays (U.16928) were recovered from Shulgi's Mausoleum, with reservations in terms of chronological attestations (Woolley 1974: 102). Similar pieces were also found in the later levels of Ur (Woolley 1974: 47, 50). Furthermore, for the first time a textual record appeared at Ur (Legrain 1937: no. 1498) in a period where the artificial manufacture of *dušû* stone, which is most probably an imitation of agate, was mentioned (Moorey 1985: 146–47). The text also provides clues about the involvement of stonecutters in the production of artificial stones; however, what the record really defines is still ambiguous due to the lack of sufficient textual evidence.

Ur continued to yield artifacts from the early second millennium B.C., but faience became rare then. Woolley, the excavator of Ur, believed that the site Diqdiqqah, in the northeastern part of Ur, was a place where faience animal-shaped amulets (mostly frogs, monkeys, fish, and tortoises), flower-shaped amulets, and Humbaba masks were manufactured (Woolley 1974: 86), though his idea never was confirmed. In the same period, inlays of faience were found at Mari in room 49 and court 70 (Parrot 1958) and animal figurines, beads, and pendants were recovered at Chagar Bazar (Mallowan 1947: 174).

For the history of the scientific research of faience, the research done at Dinkha Tepe, located in the northwestern part of Iran, is also worth mentioning. Beads of white and dark frit cores and slightly visible glazes were found in grave contexts dated ca. 1800–1600 B.C. The core in the white frit beads are almost pure

silica whereas the dark ones have copper and manganese oxides (McGovern et al. 1991). The site is important in terms of these early finds; however these assemblages will not be investigated further within the regional and chronological limits of this dissertation.

Until the late second millennium B.C., the evidence of faience in Mesopotamia is scarce and the types of artifacts are restricted mainly to beads whereas amulets, inlays, and vessels are not abundant except for a couple of examples. In the second half of the second millennium B.C., the picture changes radically, which is seen as a result of the introduction of Egyptian faience vessel production in Mesopotamia (Moorey 1985: 148). Antonio Sagona (1980) argued that Mesopotamian faience vessel production has some idiosyncratic aspects, though compared to Egypt the patterns and types are very simple, indicating an industry in its early stage. Similarly Maurice Dunand (1958: 741–80) defined the faience industry of Byblos and Syria as being less developed than Egypt. On the other hand, both of these arguments are based on the type and amount of recovered artifacts, which do not serve a solid basis to argue further on the technological development of the faience industry. With emerging evidence from sites like Başur Höyük, Oylum Höyük, or Tell Atchana, ancient Alalakh, the picture is now changing (see chapters V, VII, and VIII).

In western Anatolia, a unique find, a faience mace head, was uncovered from Troy III (calibrated C-14 results 2290±2140 B.C.) in a megaron-type building; the mace head was lying near the gate. The faience mace head (G6.1049, 98/212-2A) was defined as originally blue-green and attributed to Egypt with reservations (Sazcı in Korfman 1999: 11–13, Abb.11). It was found together with one faience bead, a piece of rock crystal, and a decorated antler ring. The artifact is unique in shape and

material; however the artifacts have the features of glazed stone rather than faience. The published image demonstrates a stone core and a layer of glaze that was partially destroyed due to weathering. Further examinations on this artifact will reveal its exact nature, and thus attributions to Egypt could be substantiated and clarified too.

At the MBA (dated first quarter of second millennium B.C., ca. 18th century B.C.) cemetery of Çavlum[28] located at the Alpu Valley of Eskişehir one blue glass bead, several frit beads were recorded (Bilgen 2005: 19, 45). Nejat Bilgen did not clearly differentiate between the terminology of frit and glass paste thus he reported that he preferred the word glass to introduce the vitreous assemblage of the cemetery. These beads are spherical or ring beads (Bilgen 2005: Levha XLV: 1, 6; Levha XLVI: 1a–j, 2a–m, 3a–p). Examples of spacer beads with three or four grooves were documented (Bilgen 2005: Levha XLV, 4a–d, 5a–b). These spacer beads have parallels at Troya IV and Yanarlar (Emre 1978: 37–41), as well as later examples are recorded at Tell Atchana, Megiddo, Nippur as well as the Mycenenan world (McKinley 1994: 122–26). Besides the glass bead and frit beads, a faience scarab-shaped seal was also documented which Bilgen claimed might be used as an amulet as well (Bilgen 2005: 19; Levha XLVIII: 2a–d). This faience artifact actually has an omega sign on the surface thus have close parallels in Acemhöyük and Kültepe. Furthermore, Çavlum vitreous beads have counterparts at Acemhöyük, Alişar, Boğazköy, Demircihöyük, Gordion, and Yanarlar (Bilgen 2005: 19), whose assamblages are discussed below.

Solid evidence for the existence of faience production in the early second millennium B.C. in Anatolia has not yet been discovered, but sites like Acemhöyük, Kültepe, Alişar, and Konya Karahöyük have yielded faience examples at least as part

[28] Any settlement which might be related to the Çavlum cemetary area could not be identified within the 5 km region surveyed (Bilgen 2005: 44)

of luxury commodities. In Alişar (Yozgat) Stratum II, a faience cup was found (Schmidt 1932: 111, color pl. III, pl. X: b 1868) that has similarities with Acemhöyük (Aksaray, Turkey) Level I (Özgüç 1986b: 207–08, fig. 1). Nude female figures of faience were also recorded in Stratum II of Alişar (von der Osten 1937: 193, fig. 230: d.2966, 2971).

At Kültepe, located in Kayseri, faience objects were found in Levels 1a (beginning of the 17th century B.C.) and 1b (1833/32–1719 B.C.), mainly as grave goods from pot burials (Özgüç 1986a; Veenhof 2000; Günbattı 2008; Kulakoğlu 2010). Tahsin Özgüç evaluated the faience objects of Kültepe in four groups: female figurines, double figurines, zoomorphic amulets, and stamp seals.[29] The female figurines include nine figurines and fragments colored dark or light blue and partially painted with black. One example was gilded with gold (Özgüç 1986b: 201, pl. 41, 1a–b). A seated faience figurine defined as "joined double-figures" were unearthed at Kültepe Level Ib, which has a parallel that was uncovered at Acemhöyük Level I depicting a seated figure of a male (Özgüç 1986b: 204, pl. 43, 10a–b). The zoomorphic amulets in the shapes of rabbits, lions, sheep, and bulls were found as grave goods and Özgüç pointed out their forms as depicting the sacred animals of Anatolian deities (Özgüç 1986b: 205). At Konya Karahöyük, two similar faience figurines, also defined as "Ishtar figurines," were recorded (Alp 1954: 403).

Foster (1979: 46) argued that many of the MBA faiences of Anatolia were imported from Syria due to the stylistic similarities with northern Syria rather than Anatolia. T. Özgüç disagreed with the idea by showing that the styles of the figurines were dissimilar to local Anatolian examples and did not have parallels in northern Syria or northern Mesopotamia. However, he defined the seated faience figurines as

[29] Tahsin Özgüç confuses faience with glazed faience, a generally accepted definition of faience amongst 20th century excavators.

reflecting "south-central or southeast Anatolian characteristics" (Özgüç 1986b: 203). He further argued that faience was a substitute for stone and metal and since Anatolia was rich in stone and metal, there was no need to establish a faience industry in central Anatolia. T. Özgüç (1986b: 204) proposed the possibility of a faience workshop "somewhere in the region south of the eastern Taurus range, that is, in the vast area between the Antakya plain and the Habur region." His proposed location was based on a similar object found at Hammâm et-Turkmân; a workshop had not been located in the region until the current excavations at Tell Atchana, ancient Alalakh. Another example is possibly an atelier unearthed at Oylum Höyük, near Kilis, dated circa the MBII period (Engin 2014). The archaeological material from Oylum Höyük was not completely and fully published. It is not clear whether and how any vitreous material production was practiced at Oylum Höyük[30] though the faience artifacts together with quartz pieces and a workshop area point towards a possibility of production. For a solid suggestion, further archaeological and analytical work on Oylum Höyük is necessary.

A group of faience stamp seals were known from Alişar (von der Osten 1937), Kültepe (Özgüç 1986a–b), Acemhöyük (Tezcan 1958), Konya Karahöyük (Alp 1968), and the Hittite levels of Gordion in the Polatlı province of Ankara (Mellink 1956). Based on the similarities of the stamp seals, Machteld J. Mellink (1956: 42) argued for a single workshop for the production of faience seals found in Anatolia and wrote that "the production of frit or faience is likely to have been concentrated in some of the early Hittite towns with direct oriental contacts." James Mellaart (1962: 32) supported Mellink by further proposing that the third and second

[30] At Oylum Höyük, glassmaking was proposed though this suggestion is not completely published with solid archaeometric evidence. The suggestion found interest in newspaper articles: http://www.radikal.com.tr/hayat/camda-4-bin-yillik-iz-1014648/

millennium B.C. faience objects of Anatolia were local products. Özgüç pointed out that faience stamp seals were not utilized in northern Syria at the end of the Assyrian Trading period when trade declined. He linked the production of faience objects in central Anatolian locations like Gordion and Yanarlar with indigenous and itinerant artisans (Özgüç 1986b: 207; Canby 1965: 42–50).

Faience must have been a luxury material in MBII Anatolia and Syria. Faience objects were generally found in palatial areas (see chapter IV for Alalakh) and there had been no clear evidence of any local manufacturing until the recent excavations of Tell Atchana, ancient Alalakh. Moorey (1985: 149) argued that Syria, if not Anatolia as well, had an industry for producing faience vessels, beads, and amulets during the MBII, which was also hypothesized for the case of Mesopotamia, and which now turns out to be true.[31]

The transition between the MBA and the LBA was not clear for faience production in Anatolia, Syria, and Mesopotamia; however, in the LBA, faience appeared as a flourishing industry. According to many scholars (Moorey 1994: 178), such an industry in Mesopotamia and Syria was linked to Mitannian influence (ca. 1550–1350 B.C.), which was assumed to be the driving force of luxury and elite production. This is exemplified by sites like Nuzi or Tell al-Rimah, located in the Mitannian cultural sphere, which yielded examples of this prestigious technology.

Nuzi yielded evidence for 15th century B.C. faience. In Nuzi stratum II, several faience beads, along with frit and glass beads, were recovered. Only two fragmentary faience vessels were unearthed in the temple context (Starr 1937: pl. 119, I, J; 1939: 461). These faience bowl fragments were examined and red, yellow,

[31] Moorey defined Alalakh as a part of Syria and accepted the site as an important milestone for the faience industry based on four faience vessels found in Level VII (1994: 176). On the other hand, in the Level VII palace, only one faience cup was found. For details of the Level VII findings, see chapter IV.

and white colors obtained by ferric oxide were detected on Nuzi faience bowls (Beck and Jackson in Starr 1939: 461). Typologically, tubular and melon-shaped beads were quite common in the Nuzi collections. Pamela Vandiver suggested that the glazes on the melon-shaped beads were high in magnesium, possibly indicating local production, whereas the cylinder beads could be imports (Vandiver 1982).

Tell al-Rimah, located in modern Iraq, yielded a similar faience corpus to Nuzi stratum II (Oates 1982: 97). Room 5 in the temple of phase II, dated approximately 1450 B.C., included mainly faience and frit artifacts, especially cylinder seals known as the Mitannian type (Oates 1982: 97). Cosmetic cups with lids, bird-shaped vessels, beads, and amulets were among the corpus (Carter 1965), which also had contemporaries found at Tell Chuera (Moortgat and Moortgat-Correns 1976: 38ff., figs. 14–15) and Chagar Bazar (Mallowan 1937: 122, 137, pl. 14A) in the same region.

Ugarit and its sea port of Minet el-Beida yielded several thousand pieces of faience (ca. 18,000), glass (ca. 1,000), Egyptian blue (ca. 266), and glazed pottery (ca. 27 vessels) dated from the 14th to the beginning of the 12th centuries B.C. (Matoïan and Bouquillon 2000). Matoïan (2003: 151, fn. 4) pointed out that less than 1% of the vitreous corpus was composed mainly of faience and dated to the MBII. Recent research shows possible indications of local production, whereas imports from Mycenae were also uncovered (Matoïan 2003: 151–53).[32] Additionally, faience stirrup jars colored in white, blue-green, black-brown, and yellow, faience goblets,

[32] Matoïan (2003: 153, figs. 4, 5) associates some typologies of faience beads (like "grain of a wheat shape" and lozenge form) with the Aegean, and provides comparatives from Rhodes, Passia, Prosymna, Dendra, Mycenae, Hala Sultan Tekke, and Kition. At Ugarit, only four of those types of beads were recovered (Matoïan 2003: 153). On the other hand, those types of faience beads — especially the ones defined as "grain of a wheat shape" — are quite common at Alalakh and were recovered at both Woolley's and Yener's excavations. See Catalogs A and B for similar examples.

and face-goblets were also recovered which have with similar examples found at Enkomi in Cyprus. Decorative plaques were among the so-called "Mycenaeazing" indicating they have Mycenean influence. But, at the same time, the corpus has a local idiosyncratic character that does not share similarities with the Mycenaean or Cypriot corpuses (Matoïan 2000, 2003).

The use and production of faience obviously continued after the 13th century B.C. Unique examples were recovered from archaeological strata dated to after the 13th century B.C. at Assur (Andrae 1935), Tell al-Rimah (phase 1) (Carter 1965; Oates 1982), Nimrud (Mallowan 1950), Tell Fakhariyah (Washukanni) (Kantor 1957), Tell Brak (Oates 1987), Ur (Kassite levels) (Woolley 1965), Mari (Parrot 1975), and Cyprus (Foster 1979).

A relevant subject is the location of faience production centers from about the 14th to 12th centuries B.C. Sites like Tell el-Rimah, Nuzi, and Assur (Andrae 1935: 99–100) had workshop areas, which were probably supplying the local temples and palaces. These products were also part of the trade of luxury faience items like the vessels from Cyprus, Mesopotamia, and the Levant (Peltenburg 1974: 108; Moorey 1985: 154). On the other hand, how many of the luxury faience items were in circulation due to merchant-based trade or how many of them traveled due to gift exchange is still unexplored. It is hard to link such objects with production centers though Peltenburg (1974: 108) favored workshops at Ugarit in the Levant or Meskene (Emar) in Syria since some existing local faience production debris was found there. Distinctive groups locally produced at Nuzi and Alalakh were also proposed based on Mitannian-style cylinder seals (Dabney 1980). The evidence for a faience manufacturing workshop was found in the LBA levels of Tyre (Bikai 1978: 7–8; Brill 1978) and molds directly associated with faience production were

recovered at Amarna (Petrie 1894; Vanthuyne 2013). New evidence regarding faience production appears now at Oylum Hüyük and Tell Atchana, ancient Alalakh. Even though Oylum Höyük is not fully published and has not been archeometrically proven as a site of production, the evidence from Tell Atchana, ancient Alalakh, is provided and discussed from chapter IV to chapter IX.

Faience in Egypt has been known since the Predynastic period, but was represented only by a few beads from graves. Since the early dynastic times (ca. 2900–2545 B.C.), besides beads, zoomorphic and anthropomorphic votive figurines were found at Hierakonpolis, Elephantine, and Abydos; blue-green glazed tiles were recovered at Djoser. At the time of the Old Kingdom (ca. 2543–2120 B.C.), Saqqara and Abusir yielded numerous faience inlays, beads, and blue-colored tablets (Nicholson 1993: 19–22).

The expansion of faience occured during the Middle Kingdom (ca. 1980–1760 B.C.) and the Second Intermediate period (1782–1570 B.C.) when animal figurines (e.g., hedgehog- or hippopotamus-shaped figurines and vessels from sites like Beni Hasan), amulets and beads in the shapes of lions, baboons, hedgehogs, crocodiles, birds, frogs, and cats, core-formed vessels, bowls, human-shaped and female figurines, and scarabs were found in abundance. The graves were found decorated with miniature faience vessels and female figurines were used as grave goods along with ceramic and stone artifacts (Nicholson 1993: 23–25; Vanthuyne 2013). It is most likely that faience workers were also of high status during this period. This hypothesis is supported by the rich grave of a faience overseer named Debeni unearthed at Lisht, which is tentatively dated to the 13th Dynasty (Nicholson 1993: 23).

The designs and decorations of the objects were mostly inspired by the Nile, like the use of the lotus flower, papyrus plant, and depictions of marsh life on the bowls, jars, and vessels. The use of such decorative trends continued during the New Kingdom (1570–1070 B.C.), when the use of faience increased tremendously. The bulk of the information came from W. M. Flinders Petrie's excavations at Amarna where he found not only artifacts (beads, amulets, vessels, etc.), but also debris related to faience production (Petrie 1894). On the other hand, his account of Amarna did not clearly identify archaeological contexts; thus most of the information should be interpreted carefully (Nicholson 1993: 28; Shortland 2012). Petrie found small, one-piece, open-face molds made out of red-brown Nile clay for faience at Amarna; these molds were actually indicators of mass produced faience artifacts (Vanthuyne 2013: 396).[33] Similar molds were unearthed at Malkata, Qantir, and Gurob. Among the faience corpus, beads, vessels, bowls, chalices, scarabs, tiles, and inlays were recovered at sites like Malkata, Amarna, Qantir, Naqada, Medinet Habu, and Abydos (Lucas and Harris 1962; Nicholson 1993).

In Amarna, four types of kilns were thought to have been in use for faience production. Several possible large kilns (especially an oval structure known as kiln 4) could have been used for faience firing (Nicholson 2007; Vanthuyne 2013: 396) as well as some bread ovens (Eccleston 2008: 33–35). In some parts of Amarna (Q48.4 and P46.33), pottery jars were probably reused for faience manufacture as the jars were in use for heating food (Kemp 1995: 165). Several faience molds were found around these installations. Furthermore, recent excavations uncovered an "oven court" where it was suggested that faience was produced in open pits (Kemp and Stevens 2010a: 481–85; 2010b: 256).

[33] Vanthuyne (2013: 398, table 1) mentioned a total of 1,017 molds found at Amarna.

A group of objects from the collections of the Metropolitan Museum of Art, excavated at the glazing factory of Lisht and dated to the Middle Kingdom (late 12th–13th Dynasties, ca. 1800–1650 B.C.), were microscopically examined and confirmed as faience. A vessel found in Wadi Qirud, relatively dated to Nuzi level II, was found to originate from the Near East and not from Egypt (Lilyquist et al. 1993: 5–9).[34]

The research on Egyptian faience is too tremendous to touch upon all the details within this dissertation's limits. Recently, Paul Nicholson and Ian Shaw (2000) reviewed the faience of Egypt as detailed chapters in books dedicated to Egyptian materials and industries. Furthermore, the *Gifts of the Nile: Ancient Egyptian Faience* (Dunn Friedman 1999) exhibition catalog provides 483 illustrations and 224 images of Egyptian faience spanning artifacts dated from the Old Kingdom to the Greco-Roman periods; it serves as a comprehensive guide on the subject. These books and the catalog (with its five articles) cover all of the highlights of Egyptian faience by evaluating various aspects such as symbolic meaning, design, material, and technology. For a complete history of Egyptian faience, the reader is encouraged to reference these publications.

3.4 Glass

The early history of glassmaking and its origin is obscure. A mythological and legendary explanation on the origins of glass belongs to Pliny the Elder or Gaius Plinius Secundus (23–79 A.D.), who was a Roman officer and encyclopedist. In his amazing work *Naturalis Historia* (77 A.D.), he provided a valuable story of a

[34] Lilyquist et al. (1993) examined a selected group of faience, Egyptian blue, and glass artifacts from the collection of the Metropolitan Museum of Art. The details of the collections and the results of their examination are published as a book and they are beyond the scope of this dissertation. Some results are touched upon in relevant chapters only.

merchant ship loaded with natron anchored on the Phoenician seashore. The story is as follows:

> "In Syria there is a region known as Phœnice, adjoining to Judæa, and enclosing, between the lower ridges of Mount Carmelus, a marshy district known by the name of Cendebia. In this district, it is supposed, rises the river Belus, which, after a course of five miles, empties itself into the sea near the colony of Ptolemaïs. The tide of this river is sluggish, and the water unwholesome to drink, but held sacred for the observance of certain religious ceremonials. Full of slimy deposits, and very deep, it is only at the reflux of the tide that the river discloses its sands; which, agitated by the waves, separate themselves from their impurities, and so become cleansed. It is generally thought that it is the acridity of the seawater that has this purgative effect upon the sand, and that without this action no use could be made of it. The shore upon which this sand is gathered is not more than half a mile in extent; and yet, for many ages, this was the only spot that afforded the material for making glass.The story is, that a ship, laden with nitre, being moored upon this spot, the merchants, while preparing their repast upon the sea-shore, finding no stones at hand for supporting their cauldrons, employed for the purpose some lumps of nitre which they had taken from the vessel. Upon its being subjected to the action of the fire, in combination with the sand of the seashore, they beheld transparent streams flowing forth of a liquid hitherto unknown: this, it is said, was the origin of glass." (Pliny the Elder, XXXVI, Chapter 65).

According to this story, Phoenicians used natron chunks to support their cauldrons on the sand, which after firing resulted in the reaction of natron and sand, causing the production of glass. This story links the discovery of glass to the river Belus. There is another record dated almost 1,500 years later mentioning a similar event. The book entitled *The Art of Glass* (*L'Arte Vetraria*) written by the 17th century glassmaker Antonio Neri provides a similar but slightly different version for the emergence of glass, again with a reference to the river Belus and Pliny the Elder:

> "Pliny saith, that Glass was found by chance in Syria, at the mouth of the river Bellus, by certain Merchants driven thither by the fortune of the Sea, and constrained to abide there and to dress their provisions, by making fire upon the ground, where was great store of this sort of herb which many call Kali, the ashes whereof make Barilla, and Rochetta; This herb burned with fire, and therewith the ashes and salt being united with sand or stones frit to be vitrified is made Glass." (Neri 1612, this reference after Rasmussen 2012).

This time, instead of natron, a plant named *Kali* was named; today *Kali* is a well-known source of soda for glass production (Barkoudah and Henderson 2006). Even though these two stories refer to special materials such as natron and *Kali*, both of these legends/stories link the beginning of glassmaking to the Phoenicians and trace its origins back to the river Belus. This river is today called the Na'aman and is located in the northwestern part of Israel. Information gathered via textual records like the aforementioned sources is seen as debatable among scholars since it is generally subjective to the writers' social and political perspectives. They may or may not be true, so they have to be verified. Providing archaeological evidence is an ideal technique to confirm what is documented in ancient textual records and for the second millennium B.C., the existence of glass is a known fact.

Despite centuries-long research, very little is known about the invention of glassmaking, production locations, and technologies (Rehren and Freestone 2015: 233). Quite a number of scholars pointed to Mesopotamia and adjacent areas as the origin of glass (Dillon 1907: 39; Lucas and Harris 1962: 465).[35] According to archaeological records, glass as a material made its earliest appearance in history — most probably — at the end of the third millennium B.C. somewhere in Mesopotamia. Its widespread use started in the second part of the second millennium B.C. (Oppenheim 1970; Barag 1985). Archaeological excavations conducted in the Levant, Syria, and Egypt yielded incredible glass assemblages dated to the second millennium B.C. The revolutionary change came with the invention of core-forming, which is the earliest method of producing glass vessels. The exact invention zone is unclear, but Dan Barag (1985: 36) suggested that this discovery might have been

[35] Barag (1985: 36) and the referenced scholars sometimes call this zone Western Asia.

inspired by glazing objects. The earliest example of a core-formed glass vase was found in Level VI of Alalakh, thus amplifying the importance of Alalakh for the history of vitreous industries.

3.4.1 Definition of Glass

In elementary chemistry, the three main material states are defined as solid, liquid, and gaseous. Glass, on the other hand, shows an amorphous[36] nature making it hard to classify either as solid or liquid. It cannot be classified as solid since it does not have a regular molecular structure; in other words, it is a non-crystalline solid (Henderson 2013). Not being a proper solid does not make glass definable as a liquid either. Glass generally becomes liquid over 1000^{o} C depending on its exact ingredients, but at room temperature (25^{o} C) it is too viscous[37] to flow. While glass cannot be defined either as solid or liquid, this unique material shows the characteristic features of both states. Even though glass is rigid like crystals, it has a random and disordered structure like liquids. To overcome this problem of definition, a fourth state of matter called "glassy state," "vitreous state," or "supercooled liquid" is now extensively in use to define the physical phase of glass better (Brill 1962, 1963).

It is a hard procedure to define types of glass based on either production method or chemical composition since there is great variety for both parameters. The formation of glass cannot be explained by a single perspective, but the aim here is to focus on the formation of second millennium B.C. glass. For second millennium

[36] The term "amorphous" originates from the Greek word *morphé* meaning shape and form.
[37] Viscosity defines the resistance of a fluid to flow or gradual deformation. In other words, if the viscosity of a liquid is higher, it becomes less fluid.

B.C. glass, the standard definition of American Standard Testing Materials (ASTM) could be used, which defines glass as "an inorganic product of fusion that has cooled to a rigid condition without crystallization."[38]

The uniqueness of glass is due to its physical rather than its chemical properties. One of the pioneers of glass research, Robert H. Brill, who extensively analyzed ancient glass from all around the world, ended up with 75,000 different chemical compositions for ancient glass just from the Corning Museum of Glass depots back in 1962 (Brill 1962). This information is self-explanatory enough to appreciate the wide range of compositional variations in glass. What makes glass a glass is not the elements involved in the chemical composition, but the way they bond to each other during the formation of reactions.

The main component of glass is silica (SiO_2). The most common natural type of silica is quartz. Quartz is a crystalline solid and has a regular repeating crystalline lattice unlike glass, which has no regularities in its molecular structure. In our three-dimensional world, glassy structures contain SiO_4 tetrahedral structures. As the two-dimensional figure shows very efficiently, in SiO_4, the oxygen atom of two tetrahedral structures is shared (fig. 3.2).

Fig. 3.2: SiO_4 and two-dimensional sketch of crystal structure (after Rasmussen 2012: 3, fig. 1.2).

The source of silica for glassmaking is either beach sand or quartz pebbles

[38] ASTM 1997. Standard terminology of glass products. ASTM C. West Conshohocken, USA. 162–97.

(Brill 1962, 1963; Jacoby 1993; Moorey 1998 [1994];[39] Henderson 2000, 2013). Melting silica from such pure sources is not easy since the melting point of silica is around 1700° C, which is very hard to achieve and requires special furnaces and a lot of fuel. It is important to note here that this temperature was not achievable by ancient craftsmen due to various reasons, one of which may be the absence of proper pyrotechnological installations. In order to decrease the melting point of silica, a flux[40] is added. Flux is a material used to decrease the melting temperature of silica to around 1000° C and as a flux generally sodium carbonate (Na_2CO_3), simply called soda, is used (Turner 1956b; Gouillart et al. 2012; Henderson 2013).

Source(s) of soda in glass varied over time from plant ash to natron depending on the period and region, actually subject to the availability of raw material (Henderson 1985; Barkoudah and Henderson 2006). Even though the use of soda is advantageous for decreasing the melting point of silica, its addition makes glass less resistant to water and more open to chemical attacks. To overcome this problem and to give glass its resistance, a third component is needed that should work as a stabilizer and increase the chemical stability of glass. Lime is extensively used in ancient glass as a stabilizer. However, its deliberate addition to early glass (i.e., LBA glass) is questionable since calcium may have been naturally mixed into glass as an impurity in the silica (sand) or soda source (Turner 1956a–b). The addition of both flux and stabilizer reduces the melting point of the mixture to around 750°–725° C. The earliest glass composed of these constituents is referred to as soda–silica–lime glass (Turner 1956b; Moorey 1998 [1994]; Henderson 2013).

Plant ash was used as a source of soda as early as the LBA, and now all LBA

[39] For this and some additional references cited as Moorey 1998 [1994] indicate that the 1998 edition of the book is used.
[40] The word "flux" originates from the Greek word *fluxus* meaning flow.

glasses are known to have used plant ash as the source of soda. Youssef Barkoudah and Julian Henderson (2006) extensively studied the plants of Syria as part of the Raqqa (Syria) ancient industry project to establish raw material sources for 800–1200 A.D. This project and the results of their research serve as a model for earlier plant ash usage in glassmaking around the region. The authors compiled a huge amount of ethnographic and textual data on sodium-bearing plants and conducted an analysis with the aid of Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP–AES) and XRD on plant ashes. The scientific results show that the species *Arthrocnemum strobilaceum*, *Salsola vermiculata*, *Halopeplis* sp., *Salsola kali*, *Salsola jordanicola*, and *Anabasis syriadca* could be possible sources of soda for ancient glassmakers. Some ash samples of *Anabasis strobilaceum*, *Salsola vermiculata*, and *Salsola jordanicola* contained calcium levels insufficient for glassmaking, and a separate source of calcium would have been required if they were used in the production of glass. In addition, samples of a related species called *Salsola vermiculata* from Aleppo contain potassium oxide levels that are too high for the manufacture of soda–lime glass.[41]

As a very well-connected geological and geographical part of Syria, the *Salsola kali, Salsola jordanicola*, and *Anabasis syriadca* also grow on the Amuq Plain. Broader botanical research supported by elemental and isotope chemistry is necessary to identify the exact species and their soda potential for vitreous technologies. However, it could be logical to argue at this point that if not all then some of these soda-bearing plants must have also been used for vitrous material production in the Amuq. The isotopic ratios presented in chapter VII support this

[41] A. E. Marschall (1933) refers to the species as "Barilla" or "Rochetta" by referencing the Assyrian textual records. He also defined the Assyrian word *uhulu* and its counterpart *ahla* in the Syriac as both meaning lye from plant ash.

argument.

A second type of glass is known as natron glass. In natron glass, natron (sodium carbonate 10-hydrate) or trona (sodium carbonate bicarbonate 2-hydrate) are used as a source of alkali flux. Natron glass first appeared after the LBA in Egypt and the Levant and was widely used during the Iron Ages and the Hellenistic–Roman periods. The use of natron in glass continued until the eighth–ninth centuries A.D., but after that the Islamic influence caused a revival in the use of plant ash (Henderson 2013). There has not been a lot of research on ancient natron sources. The most extensively documented source known today is Wadi Natrun in Egypt (Lucas and Harris 1962; Shortland et al. 2006). Based on textual records and fieldwork, Shortland et al. argue for Wadi Natrun and al-Barnuj, both in Egypt, as the primary sources of natron in antiquity. As a potential alternative to non-Egyptian natron sources, they argue that Lake Van[42] is too remote for Egypt, Lake Pikrolimni in Macedonia is too small, and the al-Jabbul lakes in Syria are too uncertain as sources of natron (Shortland et al. 2006). On the other hand, recent research has pointed to central Anatolian and Lake Van deposits as potential natron and trona supplies from the Iron Age onwards (Dardeniz 2015).

3.4.2 Glassmaking Process

Glass mainly consists of silica, soda for decreasing melting temperatures, and lime for stabilization or giving durability to glass composition. But how is the reaction mechanism working? Which material is reacting with which first?

In glassmaking, the preparation of raw materials prior to the melting process forms the first stage. In order to increase the surface area, which increases the speed

[42] They refer to Lake Van as being situated in Armenia. Lake Van is located on the periphery of the city of Van in modern Turkey.

and melting of the chemical reaction, the raw materials of glass production should be ground to a small size. Since the silica determines the minimum melting temperature of the glass batch, grinding to a small size is very important in order to increase the efficiency of the reaction (Brill 1962) and save fuel, which is the most expensive part of glassmaking. When all of these materials are well ground and mixed in proper proportions,[43] thorough mixing is necessary. This will help to produce homogeneous glass and, if colorants are present, it will help to disperse them and prevent streaking.

When the heating starts, soda is the first component, which begins to fuse. Fused soda then starts to react with silica (sand) in order to generate sodium silicates. This mixture is a liquid material and the reaction equation can be shown as:

$$Na_2CO_3 + n\ SiO_2 \text{ -----}> Na_2O + n\ SiO_2 + CO_2$$

Figure 3.3 shows a three-dimensional image of the reaction between sodium carbonate and silica. In their extremely valuable research project, scientists from the European Synchrotron Facility (ESRF) show for the first time the interaction between grain geometry and the reaction rate below 1000^{o} C by examining the stages of the above reaction from the mix of powders to molten glass.[44]

[43] Robert H. Brill from the Corning Museum of Glass (CMOG) documents an ethnographic account of glassmaking. Dr. Brill is a pioneering glass scholar who worked for decades as a researcher in CMOG and analyzed thousands of pieces of ancient glass. In the documentary "The Glassmakers of Herat," a glassmaking family from Afghanistan was filmed in 1968. This family was still using traditional methods in 1968, so this video is still very valuable due to the information it can reveal. In this half-hour documentary, the steps are easily traceable: the collection of raw materials (quartz pebbles and plant ash), the grinding, mixing, and heating.

[44] For this experiment, the researchers used an industrial scale rather than ethnographic values. They used mixtures of raw materials for making industrial window glass, which is two-thirds silica sand and one-third sodium and calcium carbonates. This examination targets the production of high quality glass in lower temperatures and is designed for industrial facilities (Gouillart et al. 2012). As usual, archaeology and archaeological science once more benefited from developments in industrial technologies.

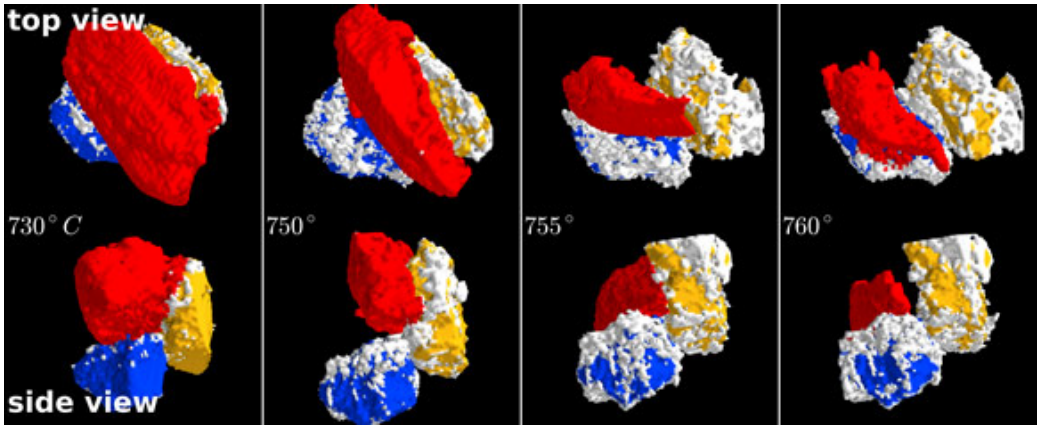

Fig. 3.3: Reaction between a grain of sodium carbonate (red) and two grains of silica (blue and yellow) observed at various temperatures and from different angles. These reactions produced sodium silicates, the precursors of glass. The grain of sand measures about 100 micrometers across. (Credit The American Ceramic Society and Gouillart et al. 2012).

This first step shown in the reaction equation and figure 3.3 is followed by the addition of lime and other possible alkalis to the liquid mixture in order to combine it with silica (Philips 1941). Following that, the temperature of the melt starts to increase and the viscosity starts to decrease. This is the time interval when excess silica in the medium starts to fuse in the reaction mechanism.

As it is indicated with red in the equation, the reaction of silica and soda causes the formation of carbon dioxide on the products side, which is not the only gas released throughout the process of glassmaking. Various carbonate, nitrate, and sulfate components are converted to the relevant oxides, and result in the liberation of gas bubbles in the final melt (Philips 1941; Rasmussen 2012). Of course, glass with gas bubbles is not a desired final product. In order to get rid of these, glassmaking is practiced in two steps. In the first stage, glassmakers are heating the mixture and allowing a reaction of soda and lime with silica form an intermediate product called frit. During the generation of frit, a complete fusion of the reactants does not occur, but most of the gaseous byproducts are eliminated. This intermediate product is then prepared by crushing and grinding for a second stage of heating in

order to obtain a glass without bubbles (Oppenheim et al. 1970). It is important to note here that the addition of some agents, such as antimony oxide, will reduce the possibility of producing bubbled glass (Brill 1962). In the case that the glass batch includes scrap glass (cullet), this will reduce the overall melting temperature (Henderson 1985).[45] It is also important to generate a clear color, which is possible with minimum contamination. Unlike metal smelting, in glassmaking as well as in glassworking, indirect heating must have been applied (Crossley 1998). This technology and airflow system necessarily makes the vitreous material kilns related to pottery kilns rather than metal furnaces (Rehren and Freestone 2015: 235).

Since the end product is colored and most of the nitrate and sulfate components converted to oxides are actually joining the glass compositions as colorants, the next section shortly discusses colorants in glass.

3.4.3 Colorants

The additions of colorant(s) play an important role in glass production. The deliberate addition or unintentional mix of various metal oxides results in the formation of different colored glasses. The table in figure 3.4 shows metals and their oxides, which are responsible for creating a wide range of colors in glass.

Colorless glass was very rare in antiquity since metal oxides, especially iron oxide as a common impurity in sand, color glass to a dark amber or blue-green color according to the oxidizing or reducing condition during the glassmaking process. For example, the addition of copper may result in blue, blue-green, or red depending on the oxidation state of copper while glassmaking (Moorey 1998 [1994]).

[45] The use of scrap glass is commonly known for Roman, Byzantine, and Islamic glass. The Serçe Limani shipwreck is a great example of the scrap glass trade (Bass 1984; Lledó 1997). On the other hand, there is not yet evidence for the LBA recycling of glass.

COLOR	METALS RESPONSIBLE FOR COLOR	RESULTING OXIDES RESONSIBLE FOR COLOR
WHITE	Calcium plus antimony, or tin	$Ca_2Sb_2O_7$; SnO_2
YELLOW	Lead plus antimony, or iron	$Pb_2Sb_2O_3$; Fe_2O_3
ORANGE	Chromium	CrO_3
RED	Copper or lead	Cu; Pb_3O_4
PURPLE	Manganese	Mn_2O_3
BROWN-VIOLET	Nickel	NiO
BLUE	Cobalt or copper	CoO, Cu
BLUE-GREEN	Iron or copper	FeO, CuO
GREEN	Chromium	Cr_2O_3

Fig. 3.4: The various metal oxides responsible for the coloring of glass (table created by the author with reference to Brill 1963, Lambert 1997, and Rasmussen 2012).

Thousands of variations in glass compositions create not only different chemical formulas and colors, but also different physical properties, making each piece of glass unique and more complex than we thought. Figure 3.5 sketches a two-dimensional view of typical Roman glass indicating how complicated the structure is. Workability, molding and annealing properties, and blowing conditions are shaped according to these compositions of glass. For example, glasses containing higher amounts of lead are more suitable for molding practices since they are less viscous and easily flow into a mold (Henderson 2013).

For LBA glass, it is difficult to distinguish the glass by eye, but several analytical methods depending on trace elements are effective to make distinctions based on the region. For example, LBA Egyptian glass can be distinguished from

Mesopotamian glass by trace elements like titanium (Ti), chromium (Cr), lanthanide (La), and zirconium (Zr) (Shortland et al. 2007).

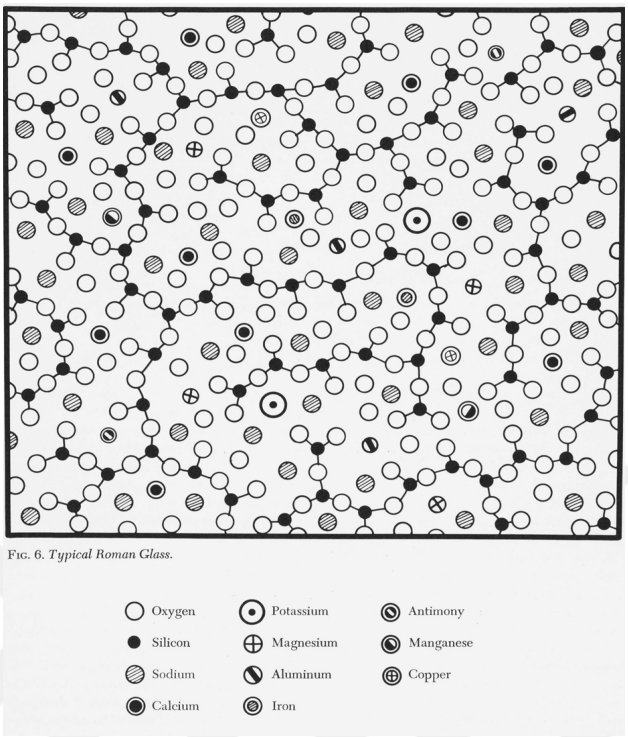

Fig. 3.5: Two-dimensional structure of typical Roman glass (Brill 1962: 135, fig. 6).

3.4.4 Does Glass Have a Melting Point?

The bonding and breakage of chemical bonds in glass provide this material with a great property: viscosity. Glasses, instead of having a melting point, soften as the temperature increases since in glass — unlike solids — different bonds break at different times. The viscosity property allows glass to be described in terms of their viscosities, which has a unit called poise (Brill 1962).

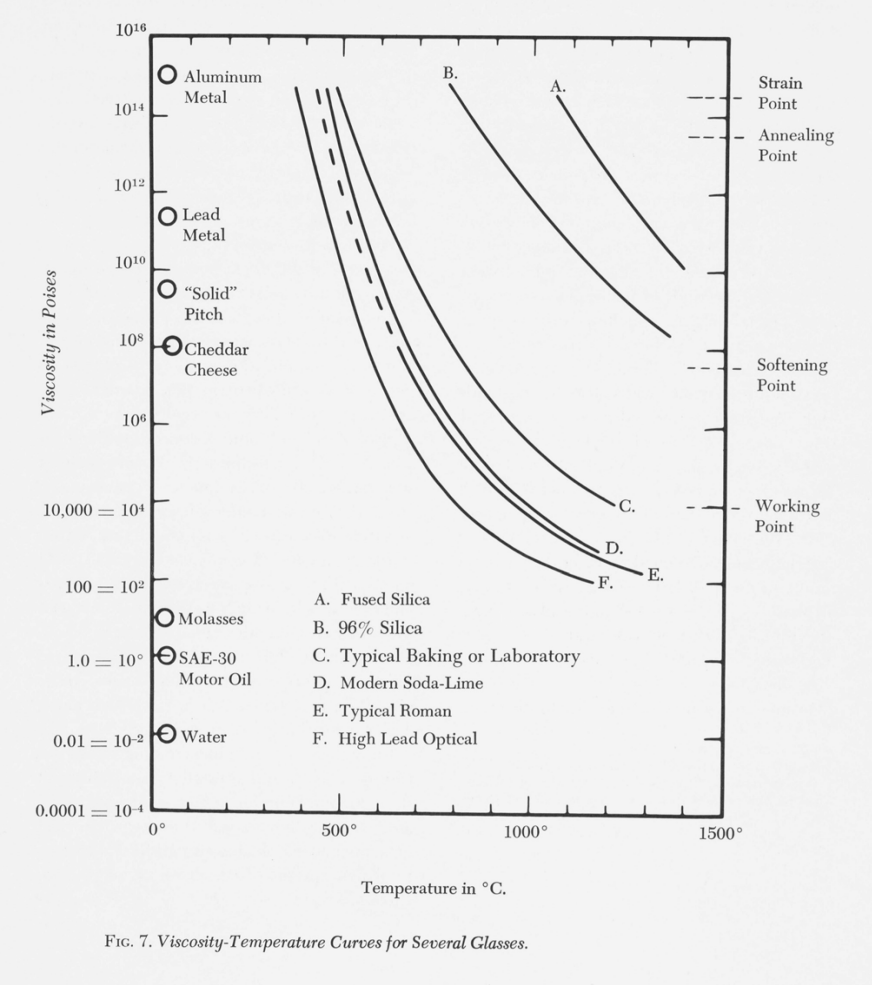

FIG. 7. *Viscosity-Temperature Curves for Several Glasses.*

Fig. 3.6: This graph shows relationship of temperature and viscosity (after Brill 1962: fig. 7).

Viscosities have a direct effect on the workability of glass. In most examples, viscosities are 10^{19}–10^{22} poises and begin to soften when viscosity is $10^{7.65}$ poises (Brill 1962).

If viscosity becomes 10^{7} or lower, glass becomes deformed under its own weight. With $10^{3\text{-}4}$ poises, the glass will flow quite easily in a mold or it can be blown. Figure 3.6 shows how different temperatures in different glass compositions affect viscosities, and therefore annealing, softening, and working points.

The soda–silica–lime glass of the second millennium B.C. has a hardness of 5.5 in Mohs scale of hardness, which can slightly vary according to the components. This hardness value of glass is approximately the same as lapis lazuli. In order to

compare, the Mohs values of other stones used are: serpentine 3–4, obsidian 5.5, turquoise 5–7, and rock crystal 7 (Bates and Jackson 1984).

3.4.5 Glassmaking versus Glassworking

Glass production terminologically covers two different concepts called glassmaking and glassworking. Glassmaking defines the production of glass from raw materials whereas glassworking defines the manufacture of artifacts from raw glass, in other words, semi-finished glass ingots (Freestone et al. 2009). It is theoretically possible that both glassmaking and glassworking can be practiced at the same workshop and the case site of this study demonstrates a multi-media workshop where glass, faience, and frit as well as stones and metals were all being worked (see chapters VII, VIII, and IX).

Shortland (2012: 85) argued that glassmaking and glassworking might be taking place in different workshops or ateliers based on his research discussing the independent nature of glassmaking and glassworking in the Roman period (Freestone et al. 2002). This hypothesis cannot be rejected completely for the LBA sites where there might have been different sections for glassmaking and glassworking at the same site. Considering these two options — either linked or separated glassmaking and glassworking ateliers — it becomes crucial to make a distinction between the steps of production in order to evaluate the archaeological records since all contexts, including glass debris, do not necessarily specify glassmaking.

It is extremely difficult to differentiate between glassmaking and glassworking in the archaeological record. For glassmaking, raw materials together with high temperature kiln(s), crucibles, ceramic vessels, as well as metal tools to move and manipulate glass objects, products, and unsuccessful glass batches are expected to be found in an archaeological context. On the other hand, glassworking

debris should have also yielded finished products as well as raw cullets and/or ingots together with low temperature furnace(s), discarded glass-like vessels, or rods together with metal tools (Shortland 2012: 86–87). According to Shortland (2012: 87), when comparing these two sets of the archaeological remains of production, only unsuccessful glass batches seem like a distinguishing parameter between glassmaking and glassworking contexts since failed batches will only present in glassmaking areas. The absence of failed batches at the glass production site Amarna divided the researchers over the interpretation. Excavation director Paul Nicholson argued for glassmaking at the site as opposed to Edgar Pusch and Thilo Rehren (2007: 144), who objected to Nicholson's argument by pointing out the lack of glass batches. However, Nicholson's excavations of the industrial debris associated with glassmaking and the recovery of a semi-finished glass fragment (TA22) from a secure context (Nicholson 2007: 109) represented direct evidence that glassmaking occurred at Amarna (Smirniou and Rehren 2011, 2016: 53).

The production of glass requires technological knowledge of materials, access to raw materials and fuel, and a final destination for the finished products (Rehren and Freestone 2015: 236). For Bronze Age glass production, Pusch and Rehren (2007: 162) proposed a model for the circulation of glass. They suggested that several elite-attached workshops were producing colored glass ingots, which were then shared among workshops to produce a wider range of colored objects. This model explains glass trade and/or circulation between Mesopotamia, Egypt, the Levant, and Greece even though there is still a lacuna on how these regions were exactly connected to each other in terms short-range and long-range trade (Rehren and Freestone 2015: 236). This model only proposes a mechanism for tangible products (i.e., artifacts) in circulation, but it does not explain the exchange of

intangible goods like techniques, sequence of production, or technological knowledge that must have been also shared among the regions as a result of either trade, military campaigns, or court level interactions.

It is worth mentioning the production of glass vessels here, which counts as a revolution in glass technology. Glass vessels first appear around the 16th–15th century B.C. and the earliest example thus far was found at Alalakh.[46] These vessels were produced on a core made of sand or clay, which was a new skill then (Peltenburg 1987). The core was dipped into the molten raw glass or glass rods were coiled around the core, which was used most probably to make the surface decoration. The core and glass on it were smoothed by rolling it on a flat stone called a marver and cooled down under control so that it did not crack. After cooling, the core was removed carefully. This process shows that glass artisans have the know-how to manipulate glass when it is hot and they know how to control the cooling down of the final object and the plastic properties of the material. Therefore Henderson (2013: 21, 156, 357) defined glass as the "first synthesized material."

The hot working of glass was an important stage in glass technology, but all of the glass vessels were not produced by the core-forming method. Some appear to have been cold worked and some artifacts, like female figurines, were mold made. Bearing cold working technologies in mind, shaping glass could have benefitted from stoneworking technologies (Shortland 2012: 46), which is discussed in detail in chapter VIII.

[46] Now new evidence emerges from Büklükale though the chronology of Büklükale glass vase necessitates further clarification.

3.4.6 History of Glass

The earliest glass beads were reported from level 4 of Nineveh Great Pit MM[47] (Beck, in Campbell, Thomson, and Mallowan 1933: 180–81, pl. LXXIX, 25–26) and from Tell Judaidah phase G, attributed to the early third millennium B.C. of the Amuq Plain[48] (Braidwood and Braidwood 1960: 341, fig. 258; Vandiver and Yener 2009: 149).

Besides its collections of glass in Stratum II, Nuzi also yielded earlier examples of glass beads. In Stratum IV, grave 5A of pit L4, a copper pin with a spherical glass head was recovered together with a late Akkadian (ca. 2350–2150 B.C.) cylinder seal (Starr 1937: pl. 55F). The northern palatial levels of Tell Asmar yielded fragments of a glass rod dated to the Akkadian period (Gibson 1982). Similarly, Nippur yielded glass beads dated to the Akkadian period (Gibson 1990: 5).[49] Glass fragments and a piece of raw glass were found also at the Akkadian levels of Tell Brak (Oates and Oates 1991: 138).

The most famous raw glass dated to the dynasty of Akkad or early Ur III period is a lump of blue glass, which was recovered at Abu Shahrein, Eridu, in modern Iraq (Hall 1930: 213; Barag 1985: no. 179).[50] The analysis of the artifact shows the existence of 0.15% cobalt and 0.40% copper though the colorant was reported as cobalt due to cobalt's prior coloring properties compared to copper's

[47] Beck reported two glass beads: one is pale blue and the other one is green. However, the exact dating of the archaeological context is not clear (Moorey 1994: 190). On the other hand, Shortland (2012: 44) recorded the bead from Tell Judeideh as "the most reliably dated early glass bead."
[48] This bead is pale yellow-green (Braidwood and Braidwood 1960: 341).
[49] The Nippur beads were found with tablets of the Akkadian period and therefore were dated to this period (Gibson 1990: 5).
[50] This object is now in the British Museum (BM 115474).

coloring properties (Garner 1956: 147).[51] Among the graves of Ur, Woolley (1934) reported glass beads in one Late Akkadian (PG 1213) grave and one Neo-Sumerian (PG 973) grave. In one early second millennium B.C. grave, Woolley noted also some glass beads (Woolley 1976: 205).[52]

Two glass beads recovered at Nippur (Area WF) and dated to the Akkadian period carry special importance for the discussion here because they have significant properties, have secure contexts, and are very early examples of glass technology. One of the beads is an olive green and white spherical bead and the other one is a cylindrical bead colored bluish-green and yellow (Vandiver and Yener 2009: 153; pl. 167, 2). These two beads were chemically analyzed, as they were well preserved. They were chemically characterized with the aid of XRD, SEM, microprobe, and lead isotope analysis (LIA). The green bead has high soda, high calcium, and magnesium and is colored with 3% iron oxide and the white parts have 5% iron oxide and 1.3% lead oxide. The bluish-green bead has 3% copper oxide as a colorant and the yellow parts have lead stannate, which is the earliest documented existence of lead stannate. The LIA analysis shows matches with Trabzon (Sayre et al. 2001: 84) and the Black Sea Pontic mountains. However, this conclusion is tentative since the other ore sources are not yet well characterized (Vandiver and Yener 2009: 154).

At Assur, the corners of the Ziggurat were found to contain glass beads as votive objects dated ca. 1813–1781 B.C., but the chronology is not secure as these glass beads might also belong to the 14th century B.C. (Beck 1934; Haller and Andrae 1955: 2–3; Edzard 1964). The old Assyrian graves of Assur also yielded glass beads (Haller 1954: 39).

[51] The source for cobalt is proposed as Iranian since it does not contain manganese, nickel, or zinc (Garner 1956), although sources of cobalt exist in Turkey as well.
[52] The identification of glass beads could have been a general misidentification by Woolley.

The Eridu and Tell Asmar fragments are important for the emergence of glass manufacture since these artifacts evidence the imitation of precious colored stones (Oppenheim 1970: 85). On the other hand, any existing evidence from before the 16th century B.C. could not be identified as true glass; rather they are frit or sintered quartz. The finds summarized above are generally found as isolated and they might not be products of intentional production; rather, they may indicate by-products of over firing in glaze manufacture (Moorey 1994: 192).

In western Anatolia, three small glass spheres and a glass bead were found in Troy IIg (ca. 24th–23th century B.C.) though their contexts were not secure (Schliemann 1884: 478–80). In the MBA, central Anatolian sites Büyükkale IVd (Boehmer 1972: 175, no. 1809) and Alişar Stratum II (Osten 1937: 284–85, fig. 309) yielded glass beads. At Alalakh Level VII, polychrome glass beads were reported though the stratigraphy is questionable (Woolley 1955: 269; see chapter IV).

Geoy Tepe and Dinkha Tepe in Iran also yielded glass beads colored with cobalt and copper, respectively, in the MBA (Crawford 1975: 12; McGovern et al. 1991: 399–400).

The earliest evidence for glass vessels, which were accepted as an aspect of developed glass production, first appeared towards the end of the MBA. The earliest polychrome glass vessel fragment was recovered at Level VI of Alalakh (Woolley 1955: 300). Alalakh Level VI and its subsequent phases (Level V–0) continued yielding polychrome glass vessels, amulets, beads, and figurines. A detailed examination of the Alalakh corpus will be made in chapters IV and V and therefore it will not be repeated here.

Megiddo Stratum IX (ca. 1550–1479 B.C.) yielded a female glass figurine, disc pendants, and spacer beads (Loud 1948: 182, pl.210: 45; Barag 1970). The

existence of glass finds also continued to Megiddo X (ca. 1570/1550). At Ajjul, gold jewelry with glass was found (Maxwell-Hyslop 1971: 118–20). Nimrud yielded glass spacer beads that dated before 1500 B.C., and similar spacer type beads were also reported in Greece and Iran and therefore indicate a wide distribution (Barag 1985: no. 17). A casting mold for spacer beads were found in Boğazköy (Boehmer 1972: 217–18, no. 2229, pl. LXXXVII), though this mold might well serve for faience or frit beads or even metal (gold) too. Boğazköy as the capital of the Hittite Empire was not rich in terms of glass, but an upper part of a glass female figurine dated to the 14th century B.C. was recovered at the site (Boehmer 1972: Tafel LXV, no. 1861). Furthermore, a tablet mentioning the manufacture of red glass was also found.[53]

A significant artefact relevant to these discussions was recovered in Boğazköy in 2003. It is a sandstone mould (4,1 cm x 3,4 cm x 1,8 cm) with miniature images of Hittite gods on both sides along with Luwian hieroglyphic inscriptions including the term ^{NA_4}KÁ.DINGIR.RA "Babylonian stone" (Baykal-Seeher and Seeher 2003: 101, 103, abb. 1, 2). Since such figurines of Hittite gods made of lapis lazuli are known from textual sources, it was assumed that the mould was used for casting similar statues of gods in blue coloured glass, to imitate the lapis lazuli versions. Why glass was referred as "Babylonian stone" in this manner is not yet clearly understood.

A similar mold to Boğazköy's was found at the Hittite settlement Ortaköy-Sappinuwa. There are more than 200 molds recovered at the settlement some of which might be possibly linked to the production of vitreous materials (Süel 2015: 172). Even though the molds are recorded as clay, some of those might be also stone.

[53] See section 3.5 for a detailed discussion of the tablet.

Unfortunately, a complete study and publication of these molds are not available during the time of writing this dissertation.

A promising research project on Anatolian glass is now ongoing at Büklükale, a site located at Kırıkkale almost 100 km from the southeastern part of Ankara. In Level 3, dated to the LBA period, the Büklükale team found a Nuzi-type glass vase without a base in the 2011 season. This glass vase fragment was core-formed and defined as Mesopotamian style. It was found together with glass pendant fragments (Matsumura 2012: 426–27). At the time of the writing of this dissertation, the archaeometric research on the artifacts are ongoing by Henderson but the complete set of results have not become available yet. Based on these analyses, further elaborations could be done on the possible production centers.

Barag (1985: 35) argued that there were active glass workshops at the end of the MBA in Syria-Palestine. Moorey (1994: 194) pointed out Nimrud glass spacer beads as an isolated indicator for the Syria-Palestinian glass industry since a fully developed glass industry appears first in Nuzi stratum II. The glass concentrated in Nuzi was found mostly in a destruction layer that ended in stratum II, dated circa the end of the 15th century B.C., though a revised dating has shifted the chronology as late as 1350 B.C. for stratum II (Stein 1989).[54] All objects were recovered in contexts of houses and royal buildings and none were found in grave contexts since no cemeteries were excavated at Nuzi, except for a few graves.[55] Most of the glass

[54] The dating of the Nuzi stratum II is based on the seal of Saushshatar, king of Mitanni, found in the house of Shilwi-teshup, who was a high-status individual related to royal court at Nuzi. Stein (1989) reported that the seal is not a personal but a dynastic seal and thus might be the seal of one of his successors. Such an argument causes a redating of stratum II to as late as 1350 B.C. Such dating makes Nuzi stratum II almost contemporary to Amarna, which questions early Mesopotamian glass production in Nuzi rather than Egypt (Shortland 2012: 65).

[55] The information available from Nuzi is still the original excavation report from Starr 1939. The excavation material is split between the Baghdad Museum and the

was found in Temple A (i.e., Ishtar Temple), the Palace, the house of Shilwi-Teshup, and Room C22 (Starr 1939). The objects include thousands of beads, vessels (goblets, shallow bowls, and piriform bottles), and fragments. Glass beads were widely distributed and amulets shaped like birds, frogs, and flowers were characteristic. By far, the most common glass objects were blue beads. Almost 8,000 of them were found within the temple complex. The shallow bowls are monochrome whereas goblets and piriform bottles are polychrome with a blue base and white-, yellow- and amber-colored meander, feather-like, and twist decorations. Molded star pendants and nude-female figurines associated with Ishtar were also found at Nuzi (Starr 1939: pls. 120, 128, 130–31). Vandiver (1982) showed that a variety of techniques were used in Nuzi to produce soda–silica–lime glass. Beads were made by rod forming, amulets by molding or free styling, and vessels by core-forming and some rare examples by the grinding of cold glass. She argued that Nuzi glass does not show the emerging stages of technology: it was already sophisticated by the 15th century B.C.[56]

At Ugarit and Minet el-Beida, almost a thousand glass objects including beads of various types, pendants, inlay fragments, gaming pieces, monochrome and polychrome scarabs, and 20 blue ingots colored with different tones of blue were recovered. The analysis of one blue ingot with SEM–EDS indicated heterogeneous or fritted material, whereas another examination showed a more homogeneous glass colored with cobalt and opacified by calcium antimonate (Matoïan and Bouquillon 2003). From the LBA levels, about ten glass vessels were found that were associated

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Semitic Museum at Harvard. Research done on the glass of Nuzi is mainly based on the collections of the Semitic Museum at Harvard.

[56] With the new chronological attributions, this dating should be the 14th century B.C. See footnote 54.

stylistically with Egypt, Mesopotamia, and Cyprus (Matoïan 2003: 153).[57] Valérie Matoïan and Anne Bouquillon (2003: 340) suggested that these glass vessels might have been imported from Egypt based on the increasing trading activities between Ugarit and Egypt in the LBA. Additionally, the chemical composition of the ingots recovered at Ugarit have similarities with Egyptian cobalt-colored glass ingots (Nicholson et al. 1997). Matoïan and Bouquillon (2003: 340) also pointed to Anatolia as another source for glass vessels based the similar chemical characteristics of Ugaritic glass vessels to the ingots from the cargo of the Uluburun shipwreck (dated ca. 1300 B.C.) (Bass et al. 1989). On the other hand, they did not clearly explain their reference to Anatolia; in other words, they do not specify which sites in Anatolia they connect with Ugarit. Another problem concerning this argument is that neither the origin of the Uluburun glass ingots nor the characteristics of Anatolian glass are fully identified.

It is also worth mentioning Assur despite its slightly later chronology. Glass finds dated to the 13th century B.C. at Assur show diverse technical skills. Oppenheim (1970: 9–68) suggested that the textual records mentioning glass found at the library of Assurbanipal (7th century B.C.) probably were later copies of the 13th century B.C. tablets of Assur (see section 3.5). Core-formed glass vessels and fragments were recovered from graves (mainly in tombs 37 and 133), which were contemporary to Nuzi II, and in the Ishtar Temple founded by Tukulti-Ninurta I (ca. 1243–1207 B.C.). There were mosaic glass fragments with human, animal, and floral patterns and inlay wall plaques colored in red, white, yellow, and blue (Haevernick

[57] Matoïan (2003: 154, fig. 6) proposed a Cypriot origin for the polychrome core-formed glass vases of Ugarit due to their connotations with the typologically similar examples from Enkomi, Kition, Kourion, and Lapithos. On the other hand, more than ten vase fragments found at Alalakh show similar typology and decorations. See chapter IV and catalogs A and B.

1968). The existence of an ingot fragment was cited as evidence for local production (Moorey 1994: 197), though a workshop was not identified.

The Middle Assyrian levels (ca. 1250 B.C.) of Tell el-Rimah yielded core-formed vases, beads, molded glass pendants, nude-female figurines, and goblets made of opaque mosaic glass (Harden 1969; Saldern 1970: 206). Despite the extensive assemblage, no industrial debris related to glassmaking was unearthed.

Polychrome glass was also reported at Chagar Bazar and Tell Brak dating to the 14th and 13th centuries B.C. At Tell Brak, glass ingots were also recorded, letting scholars elaborate on local production (Oates 1997: 85, fig. 124) though industrial debris was not recovered. Several excavations like Nippur (Neumann 1927), the Kassite levels of Ur (Woolley 1965) and Tchoga Zanbil (Porada 1970), Susa (Barag 1970), and Larsa (Huot et al. 1976) continued to yield glass artifacts later than the 13th century B.C., but these artifacts are beyond the subject of this dissertation.

Most of the Egyptian glass and the problems related to the context and dating of the earliest glass has been known since 1960s (Lucas and Harris 1962: 189–91; Peltenburg 1987).[58] Since then, several additions were made both from excavations and the art market; they are too many to mention within the frame of this dissertation, but some highlights are summarized below.

In Egypt,[59] beads and scarabs were found made of glass during the Middle Kingdom. The most important among those were the ones from Qau, which was an

[58] Some glass said to be dated to the fourth millennium B.C. is strongly challenged. The beads from Gebelein dated to the mid-third millennium B.C. and now in the Cairo Museum are thought to be glass with reservations since no further analysis has been done on the artifacts (Shortland 2012: 44).

[59] Some 25–30 glass artifacts dated ca. 2500 B.C. by Peltenburg (1987) are problematic. These glass objects — mainly beads — were recovered during the late 19th/early 20th century excavations; thus, their stratigraphy and dating are not clear.

important town around 2080–1640 B.C. (Lilyquist and Brill 1993; Shortland 2012: 49). The importance of Egypt in the history of glass production increased in the 16th century B.C. According to Christine Lilyquist et al. (1993: 5), the existence of glass in Egypt can be surely situated at the end of the second intermediate period during the 15th to 17th dynasties or the beginning of the 18th dynasty, dated approximately 1550 B.C. A small glass plaque with unknown provenance and inscribed with the names of Ahmose (ca. 1550–1525 B.C.) and Amenhophis I (ca. 1525–1504 B.C.) was found among the collections of The Boston Museum of Fine Arts. The XRF analysis of the artifact yielded calcium, copper as colorant, antimony as opacifier, and iron (Gordon 1982: 294). Further, dark blue, light blue, green, and colorless beads inscribed with the name "Senenmut," who was one of the officials of Hatshepsut (1479–1457 B.C.), were also recorded in the early glass corpus of Egypt (Lilyquist and Brill 1993: 24). These beads were found in Deir el-Bahri and were found to be made out of soda-silica-lime glass showing similarities with Amarna glasses, and thus argued as reflecting almost a century-long tradition in the chemical composition of glass (Bimson and Freestone 1988: 11).

The earliest securely dated glass vessel was recovered from tomb KV34, which belongs to Tuthmosis III (ca. 1479–1425 B.C.) (Nolte 1968: 50–52; Lilyquist and Brill 1993: 25–26). The vessels and the fragmentary pieces do not have standardized types and designs, so the attribution of the artifacts to Mesopotamia or identifying them as Egyptian is not easy (Barag 1970: 83). Contemporary to Tuthmosis III's own tomb, another tomb was recovered in 1916 at Wadi D, located over the Plateau of the Valley of the Kings. This tomb was identified as belonging to the three foreign wives of Tuthmosis III, whose names were Mnuwai, Manhata, and

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Some of them were examined and found to be glazed and not glass (Shortland 2012: 43–44).

Maruta, and dated circa 1450 B.C. (Lilyquist 2004). However, the tomb was robbed and some of its objects were found on the local antiquity market, all of which are exhibited today at the Metropolitan Museum of Art in New York. Both the names of the wives as well as the other grave goods connected them to the area outside Egypt, possibly to northern Syria or the Levant. The tomb was very rich in luxury items: cold-worked glass vessels, armlets, necklaces, and faience jars (Lilyquist 2004).

It is important to consider that the earliest glass objects of Egypt with a secure archaeological context were recovered from two tombs and the assemblages of the graves goods show typological similarities to Syrian, Levantine, and Mesopotamian styles (Shortland 2012: 54). It was suggested that these early artifacts were brought into Egypt as tribute in the mid-15th century B.C. campaigns of Tuthmosis III to the Levant (Oppenheim 1973: 10–11). Evidence for this argument was found in the "Hall of the Annals" of the temple at Karnak, where Tuthmosis III had dedicated the booty from his Syrian campaigns to the temple. Among the booty at least two baskets of "precious stone" were recorded, along with lapis lazuli and turquoise that were defined as glass or an imitation of precious stones (Sherratt and Sherratt 1991; Shortland 2001; 2012: 55). Another piece of evidence of glass as tribute was found on the sloping entrance hall relief in the tomb of Rekhmire (TT100), who was the vizier of Tuthmosis III (Davies 1935, 1943; Shortland 2012). On this relief, Rekhmire, on behalf of Tuthmosis III, was shown as accepting tribute coming from the Aegean, Nubia, and Syria. The tribute included metallic and ceramic vessels, wood, and two smaller vessels, which were most probably marbleized faience similar to the ones found in the tomb of the foreign wives (Davies 1935, 1943; Shortland 2012).

By depicting faience and/or glass vessels as a part of the tribute, this scene from Rekhmire's relief provides clues as to the technological transfer happening at the court level (Shortland 2012: 54). According to Shortland, the initiation of the Egyptian glass industry was also associated with foreign craftsmen whom were thought to have been brought to Egypt during the same campaigns. It is known that artisans from various fields were among the gift exchange between courts. Furthermore, a father and a son with Syrian names were recorded as the chief boat-builders of the Egyptian pharaoh, thus indicating mobile crafts (Moorey 2001). It would therefore not be surprising to have foreign artisans related to glass production in Egypt, although solid evidence for such a hypothesis has not been found yet. Of course, the reality of the emergence of the glass industry in Egypt might be more complex than just relating it to mobile, imported, or captured artisans (Shortland 2001: 218).[60]

Glass objects were also found in the tomb of Tuthmosis III's successor, Amenhotep II. Almost 76 vases were recovered from his tomb among many other precious items with various styles and variations in decorations (Nolte 1968: 54; Lilyquist and Brill 1993: 28). However, it was not until the son and the successor of Amenhotep II, Tuthmosis IV (ca. 1401/1398–1391/1388 B.C.), that the first established standardization in glass assemblages (mainly glass vases) appeared in Egypt. The best provenanced and dated glass from this period was recovered from his tomb, KV43, which yielded almost 35 glass vessels (Nolte 1968; Reeves and Wilkinson 1996). The decoration and colors of these vessels resemble the later vessels found in Amarna and Malkata (Shortland 2012: 62). There certainly was a demand for glass in Egypt during and after this period. The glassmaking

[60] For a detailed discussion on mobile crafts, see Chapter VIII.

ateliers/factories recovered at Amarna (mid- 14th century B.C.) show evidence for enough glass production to satisfy the demand (Petrie 1894; Nicholson 1995; Shortland 2000a, 2012).

Amarna was closely linked to the history of ancient glass. The site was founded by Amenophis IV, who later changed his name to Akhenaten, servant of Aten (Kemp 1989). During the excavations, Petrie (1894) recovered 38 complete glass vessels at the Great Palace of Amarna and, at the palace dumps, he found 750 glass vessel fragments, which he later reconstructed to 150 complete vessels. He could not recover any glass from areas other than the palatial area, whereas later expeditions at Amarna found only 19 more fragments indicating a tight relationship of glass objects to the palatial court (Lilyquist 1993; Shortland 2000a, 2012: 70). The importance of Amarna for the history of glass is not restricted to the rich corpus of glass vessels and fragments, but includes the workshops recovered at the site that are confirmed as related to glass production as discussed below.

For the earliest incarnations of glass production, glass workshops in the archaeological record are rare. Shortland proposed two possibilities for the rarity of the workshops: first, glass production in this period was not on an industrial scale, i.e., glass itself is rare; and, second, glass workshops may have been located in small production areas within temples, palaces, or other pyrotechnology related zones, which might be overlooked archaeologically due to the selective archaeological research questions of the period (Shortland 2012: 85).

There have been only two glass workshop sites identified by the time of this dissertation. Both are located in Egypt; Amarna and Qantir were examined extensively archaeologically and analytically. Amarna was excavated by Petrie and he stated that “the site of three or four glass factories, and two large glazing works

were discovered; and though the actual work-rooms had almost vanished, the waste heaps were full of fragments which shewed the methods employed" (Petrie 1894: 25). Still, Petrie neither defined the exact archaeological context of these finds, nor gave an exact location for the zone that he identified as the "glass factories." In the main site plan, Petrie (1894: pl. XXXV) reconstructed glass "moulds," which could have well served for other vitreous materials like faience objects (Shortland 2012: 87). All the archaeological debris was collected together, eliminating the chance of re-examinating the contexts. Furthermore, the finds from Amarna were distributed among the museums and thus the complete corpus is unknown.[61]

House N50.23 at Amarna, excavated by the German team in 1912, also yielded "a large workshop for the production of glass and faience," where faience molds, glass rod fragments, finished goods of faience and glass, and kilns were recovered (Borchardt and Ricke 1980: 311–12). The area surrounding N50.23, coded as M50.14, was excavated by the Egypt Exploration Society in 1921, where a glazing kiln, molds, rod glass fragments, and unfinished glass beads were recovered (Peet and Woolley 1923: 15–19). Recently the Egypt Exploration Society has conducted a number of campaigns at O45.1 where two large kilns, a smaller pottery kiln, glass rod fragments, and cylindrical vessel (probably glass crucibles) fragments and a number of frit fragments were recovered; thus the area was linked to vitreous material production (Nicholson 1995, 2007; Nicholson and Jackson 1998; Nicholson and Henderson 2000).

Most of the research related to the Amarna glass workshops was based on the remaining materials since the new excavations, which provide clean archaeological

[61] The material is mainly distributed among the museums in the U.K. The biggest part of glass material is now stored in the Petrie Museum of the University College London.

contexts, yielded relatively small amounts of material (Nicholson 2007). Thus, Amarna as a glassmaking site is questioned frequently (Pusch and Rehren 2007: 144), but it still is important in the history of the LBA as a glassmaking and/or glassworking site.

Qantir, with its ancient name Piramesse, is another important glass workshop dated to a later period (ca. 1300–1270 B.C.).[62] Three main zones related with pyrotechnological activities were recovered: QI, QIV, and QV. QI was found as related mainly with bronze working with some crucibles, QIV with glass and Egyptian blue, and QV with glass (Pusch and Rehren 2007). The findings of Qantir are proposed color-specialized glass production, especially of red ingots, and bronze production on an "industrial scale" (Pusch and Rehren 2007: 131). On the other hand, Egyptian color specialization based on the evidence of one site (Qantir) needs to be further investigated. Since, if there is color specialization, there must be to be more specialized workshops existing within the region for other colors though archaeological evidence is not uncovered yet.

Other glass workshops in Egypt include Malkata, Ghurab, and Lisht. Yet, none of those sites are sufficiently published or analytically examined to confirm glass production (Rehren and Pusch 2007; Shortland 2012). Besides artifactual evidence, textual records — especially the Amarna letters — also mention a demand for glass in the second millennium B.C. (Moran 1992).

Finally, it is crucial to make an overview of the shipwreck, Uluburun, which sank with its full cargo and provided an almost complete picture of the traded goods of the LBA in the eastern Mediterranean. Discovered in 1984 on the Mediterranean

[62] Qantir (ancient Piramesse) was founded by Seti (1294–1279 B.C.). The glass workshops were dated to ca. 1300–1270 B.C. due to a piece of cartonage found in situ on the floor of workshop QIV inscribed for Ramesses II (Pusch and Rehren 2007: 131).

coast of Kaş, Turkey, the Uluburun sank with its entire cargo. Archaeological and analytical examinations of the artifacts are ongoing, but some relevant hypotheses on trading systems, including glass, have been made. Underwater excavations continued for more than a decade and artifacts brought to light by over 20,000 dives show that the Uluburun wreck dated to the 14th century B.C. (1316 B.C. based on dendrochronology). It was carrying cargo either from Egypt to Mycenae or vice versa (Bass 1986; Pulak 1988, 1997, 2005, 2008). The Levant, especially the famous harbors of Ugarit and Cyprus, seemed like stepping stones in the route (Pulak 2005, 2008).

Relevant to our discussion, the Uluburun ship was carrying 175 glass ingots colored blue, turquoise, violet, and one amber as well as a Canaanite jar full of glass, faience, and frit beads (Bass 1986; Pulak 1988, 1997, 2005, 2008). Most of these finished product beads are either globular or trapezoidal in shape and could be considered as common for all of the regions in the LBA. This suggests that the Uluburun was carrying a cargo of finished glass beads as well as raw material glass that could be shaped according to the desired design at the final destination. The high numbers of Egyptian and Levantine artifacts in the Uluburun cargo let scholars argue that the route of Uluburun was from Egypt to Mycenae (Pulak 2005). There is also scientific evidence to support this hypothesis, thus Cemal Pulak's interpretation for the route of the ship is the most likely for now.

According to the chemical analyses of Egyptian, Mesopotamian (Tell Brak, Nuzi), and Uluburun glass ingots, the cobalt blue glass originated from Egypt. The elemental results of the Amarna glass and the Uluburun cobalt blue glass are superimposed with Egyptian compositions (Jackson and Nicholson 2010). Lanthanide (La)–Chromium (Cr) trace elements also show the origins of the

Uluburun glass as Egypt, but it is important to note that only three glass ingots out of 175 were analyzed from Uluburun as comparative in the study of Caroline Jackson and Nicholson (2010).

The results of the compositional and trace element analyses above and several others (Brill and Stapleton 2012) show the differences and superimpositions in glass artifacts found in Egypt and Mesopotamia. On the other hand, compositional and trace elemental analysis alone are not enough for provenancing glass. Further isotopic evidence and complete chemical characterization of all glass ingots are necessary in order to clarify the trade of glass among the regions. The overlapping of analytical values with known centers from Mesopotamia and Egypt were used as support for textual records where glass was listed among the traded items between Mesopotamia and Egypt. However, our archaeological information relies on selected sites, and the textual records were not clear as to which settlements were involved in the trade of glass. This handicap creates one of the main lacunae in glass studies in order to determine the link between glassmaking sites and trade routes for glass. The next section dives into the details of the textual records documenting vitreous materials and especially glass.

3.5 Textual Records Mentioning Vitreous Materials

Textual records on vitreous materials and production techniques are vague, though some written records regarding glazing technologies, glass production, and colored materials — especially faience and glass — are presented below with a special focus on glass since glass was the only vitreous material with a special textual corpus regarding its technology.

Our knowledge of colored glass comes from three types of textual records: economic records/letters and word lists dated to the middle and late second

millennium B.C., and glassmaking receipes dated to the first millennium B.C. The textual evidence from the middle and late second millennium B.C. referred to imitations of precious stones, which are linked to glass by philologists. The first millennium B.C. tablets on the other hand provides receipes for making colored glass.

From the second millennium B.C. one tablet acquired from a dealer[63] and one found in Boğazköy (BM 108561) were related to colored glass manufacture.[64] One tablet (VAT 16453) linked to glassmaking is available in the Staatlische Museen in Berlin and was recorded as found in Babylon. According to Oppenheim, these texts do not simply provide instructions on technical methods, but they are a literary creation (Oppenheim 1970: 4, 22). The glass texts are actually the work of scribes and therefore were more literary than technical with regards to glassmaking (Oppenheim 1970: 40).

From the library of Assurbanipal (668–627 B.C.), where almost 20,000 clay tablets were recovered, a few dozen broken pieces were unearthed that were related to glass production. Leo Oppenheim (1970) simply defined them as the "glass texts."[65]

The texts from the library of Asssurbanipal are extremely noteworthy for understanding several technical and ritual perspectives of glassmaking. Even though they were dated to the seventh century B.C., they were thought to be later copies of the second millennium B.C. texts. Among the glass texts corpus, texts A, B, and C mention ritual preparations (offerings and sacrification of a sheep), "religio-magic"

[63] This tablet, with the museum number BM 120960, could not be certainly dated, but Oppenheim suggested the last third of the second millennium B.C. as the possible date of the text (Oppenheim 1970: 22).
[64] These tablets are now in the British Museum.
[65] These tablets are now in the British Museum.

practices, and a selection of favorable times, places, and wood for the establishment of the kiln for making glass (Oppenheim 1970: 9–68).

A set of tablets and fragments provide a detailed recipe for making *zagindurû*-colored glass, which defines a greenish type of lapis lazuli or turquoise. The production of the intermediary product *zukû*-glass, which necessitates repeated heating, was explained in the texts. A combination of *zukû*-glass with a copper compound yields blue glass defined as *tersītu,* which means preparation. In two heatings, *tersītu* was converted into *zagindurû*-glass. It is important to note here that green glass was obtained through several heating and mixing practices of blue glass. On the other hand, some glassy substances like *būşu* and *anzaḫḫu*, which were used as pre-processed glass, were just named without providing any production recipe. *Anzaḫḫu* is known as containing antimony and it was used to produce *būşu*-glass (Oppenheim 1970: 34–36). *Tersītu*-glass was suggested to be translucent blue glass, which also serves a basis for opaque green (*zagindurû*-glass) and red-colored[66] (referred to as red lapis lazuli) glass (Oppenheim 1970: 42–50). Similarly *dušû*-colored[67] glass, which was accepted to be yellow, was made from green glass (Tablet B: 16–20 + fragment e) (Oppenheim 1970: 48).

Besides the tablets from the library of Assurbanipal, text BM 120960, with uncertain dating and provenance, is the most detailed when discussing how to make

[66] "..., One mina of light dušû-colored glass, fifteen shekels of tuzkû-glass (are) the ingredients for red glass from Aššur…" (Tablet D, line J; Oppenheim 1970: 50).

[67] Another text now in the Staatlische Museen in Berlin (Bab. K. 713) was datable to Nebuchadnezzar (ca. 1124–1103 B.C.) in the Middle Babylonian period due to the colophon saying, "*An old original from Babylon. Property of Nebuchadnezzar, king of Babylon.*" This tablet was first published by R. Campbell Thompson (1925) in a limited edition book, *The Chemistry of the Ancient Assyrians* (London), and revisited by Oppenheim (1966) to examine the meaning of *dušû* stone. Oppenheim (1966: 34) suggests that *dušû* is brownish or orange with a purple variety. It seems like Oppenheim changed his suggestion from brownish-orange to yellow in 1970. He further suggested that the text (Bab. K. 713) is a recipe for glazing stones or crystals.

Assyrian and Akkadian red-colored glass.[68] Another tablet, VAT 16453, found in ancient Babylon in a private house at the Merkes excavation, dates to the 12th century B.C. or later and records all the names of the ingredients, like white glass, black glass, shell, sea shell, ashes, white plant, copper and lead; it also specifies the quantities (Oppenheim 1970: 64–67).

The glass text from Boğazköy (BM 108561) also provides a recipe for red glass (Rosenkratz 1965). It is interesting that the paleography of the tablet does not reflect the characteristics of a Hittite scribe, but rather shows Syrian influences (Oppenheim 1970: 67).

The Hittite term *zapzagai-zapzagaia* is also related to glass. A tablet recovered from the Hittite site Ortaköy-Sappinuwa refers to a glass-like material as *zapzagaia* (Coşkun 1997).[69] In a Hittite tablet regarding to eight days funeral ritual (KUB 30.24a+KUB 34.65, obv. I, 15) *zapzagai* weighed in the pan of a scale (in the other pan bread and cheese) was mentioned and translated as glass (Kassian et al. 2002; Otten 1958: 58). Though there is no solid evidence that *zapzagaia* is glass in Hittites. It might be also referring to a type of glazed material. Further evaluation could be possible when the Ortaköy-Sappinuwa tablets are fully published.

Two Akkadian words, *eḫlipakku* and *mekku*, were proposed as being related to glass. The word *eḫlipakku* is Hurrian in origin and is linked to the middle-third of the second millennium texts of Alalakh,[70] Boğazköy,[71] Ugarit, Qatna,[72] Nuzi,

[68] This tablet was first published by C. J. Gadd and R. C. Thompson, "A Middle-Babylonian Chemical Text," *Iraq* 3 (1939): 87ff.

[69] *zapzagai-, zapzaki-, zapzigi-* is translated as referring to glass and vessels made from it (Weeks 1985: 82). Ahmet Ünal (2016: 605) translated ^{NA4} *zapzagai-, zapzaki-, zapziki- and* ^{NA4}zapzagaya as glass, frit, glass paste, transparent stone, obsidian (?), however as explained in chapter III of this dissertation, a clear terminology for glass seems necessary for philological attributions.

[70] Oppenheim (1973) gives a tablet from Alalakh (Wiseman 1953: no. 440: 6–8) that mentions *eḫlipakku.* Oppenheim proposes a reading for Alalakh tablet 440:6–8 as: l-

Ascalon, and the inventory lists of objects sent from Mitanni to Egypt (Oppenheim 1973: 259). Seven Amarna letters sent from the ruler of Ascalon to the Egyptian pharoah and three letters sent from Jurşa[73] to Egypt also mention the word *eḫlipakku*.

The most interesting tablets mentioning *eḫlipakku* are from Ugarit (MRS 12 as No. 6). The royal palace of Ugarit sent six letters to the city governor for trade, one of which (No. 6) mentions a payment in *eḫlipakku*. It is interesting that the scribe recorded the desired payment as *mekku*, but the scribe added an "explanatory gloss" (the word *eḫlipakku*), indicating that these two words were actually in use for the same thing (Oppenheim 1973: 260).

Mekku is Semitic in origin and is translated as "a kind of precious stone." The word was used in ten letters sent from Abimilki, the king of Tyre, to the Egyptian pharoah. The word is known also in Ugarit, and beads and amulets made of *mekku* in Assyria were documented. The Hurrian term *eḫlipakku* is used for the non-Akkadian term *mekku* to point out raw glass (Oppenheim 1973: 263).

In the Amarna Letters, Egyptian pharaoh(s) asked the rulers of Mesopotamia (Palestine and Lebanon including Ascalon and Tyre) to send him/them *eḫlipakku* and *mekku*. Oppenheim translated *mekku* as raw material for glassmaking (Oppenheim 1970: 55–56). In Egypt, *irw ḫsbd* denotes the maker of (artificial) lapis lazuli; however, a corresponding craft is not known yet for Mesopotamia. Furthermore,

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en a-ar-za-ar-ni e*ḫ(!)-li(copy še)-ba-ag-gi* and l-*en ma-áš-ḫé KÙ.GI ḫİ-a-ru-uḫ-ḫé ši-na-am-ni ma-ni-in-ni eḫ-li (copy tu)-ba-ag-gi.* On the other hand, Wiseman did not read the texts as such. I consulted Prof. Belkis Dinçol and Hasan Peker for a reading of the tablet. They noted that reading *eḫlipakku* in the text is rarely possible and an unsupported reading since such a reading was not observed. Furthermore, to read the word as *eḫlipakku*, the scribe must have made mistakes several times, which is not common in the literature either.

[71] Here it is used to describe the color of a garment (Oppenheim 1973: 259).

[72] It is mentioned as temple jewelry from Qatna (Oppenheim 1973).

[73] Jurşa is proposed as Tell Jemmeh (in B. Mazar, "Yurzah=Tell Jemmeh," *Bulletin of Israel Exploration Society* 16 [1951]: 38–41).

glassmakers have not appeared in textual records even though many professions like coppersmiths, jewelers, goldsmiths, or carpenters were recorded separately. Oppenheim suggested that since glassmakers did not need valuable raw materials and only a limited number of helpers were required, there had been no need to record them in administrative texts. He further mentioned that glassmakers might be itinerant artisans working under special circumstances. They might have been producing elite goods such as glass vessels for temple or palace use and if they were not working on elite goods, glassmakers could be manufacturing regular beads for non-elites (Oppenheim 1970: 6–7).

It is important to remember that neither glassmakers nor faience workers were likely to be a scribe (Oppenheim 1970: 5). So the recorded recipes might not be echoing the original practice and there are doubts regarding the texts, mainly for the ones from the library of Assurbanipal; either the tablets reflect real glassmaking practices or they do not. For a complete body of evidence, a glass specialist working on the chemistry of ancient glass recalculated the theoretical values for glass composition based on the recipes given by the tablets (Brill 1972). Brill noted two main difficulties while interpreting the glass texts: first, the texts are fragmentary due to the missing sections of the tablets; and, second, some of the ingredients are not yet identified (Brill 1972: 330). The results of the theoretical glassmaking (especially green and red glass as the compositions were assumed for the ash known as *ahussu* and base glass known as *zukû*-) calculations agreed with the analyzed compositions of Mesopotamian glasses, thereby supporting the links between the texts and real glassmaking recipes, even though some components were still unidentified (Brill 1972: 333, table 1). Furthermore, experimental reproduction of the glass based on

these recipes was successful though Brill always stated his reservations about the results due to incomplete translations (Brill 1970: 107; 1972: 334, figs. 3–5).[74]

3.6. Summary and a Brief Note on the Genealogy of Glass and Possible Roots Linked with Different Vitrified Materials

The history of vitrified materials started with glazing silica-rich stones, mainly quartz and steatite. The chronology of glazed quartz is unclear; however, glazed steatite appeared sometime around the fifth millennium B.C., first in Egypt and then in Mesopotamia (Moorey 1985: 136). Towards the end of the fifth millennium B.C., faience started to be produced. Archaeological evidence points to the first production zone as Mesopotamia and then Egypt (Barag 1985: 35). Related to the production of faience, frit appears to have been produced sometime during the third millennium B.C. in Egypt, the Levant, and Mesopotamia. Frit, Egyptian blue, and Egyptian green frit were similarly produced from mixtures of silica, alkali, lime, and colorants (Moorey 1994 with references cited). Following developments in technology, the production of glass starts around 1500 B.C. (Beck 1934; Lucas and Harris 1962: 464–65; Barag 1970, 1985). The total number of glass objects earlier than the mid-second millennium B.C. is very limited and includes no vessels; therefore real glassmaking is considered to have begun in the second part of the second millennium B.C. Mesopotamia, the Levant, and probably southern Anatolia seem to initiate the first attempts towards the production of this colorful material, which appears not only in blue and green, but also in turquoise, yellow, white, red, and lavender (Dillon 1907: 39; Lucas and Harris 1962: 465).

The origins of glass and the emergence of glass technology are still not clear, but there are various theories linking this technology with other pyrotechnological

[74] Brill identified the *immanakku* stone in the texts as quartzite pebbles. The basis on his arguments could be found in Brill 1970: 109–10.

practices. Among those technologies, metallurgy and glazing have the highest probability to perform similar techniques in order to trigger glass production. The relation of crafts to glassmaking is discussed in detail in chapter VIII, though a small introductory review is provided below.

By-products of metallurgical activities,[75] in other words, metallurgical slag, are vitreous materials. During the refining of metal ores, silica liquefies and separates from the metal resulting in the formation of a glassy product. Theodore A. Wertime argues that refining this glassy slag could have led to the production of glass. To support his argument, he points out slaggy glass lumps from Eshnunna (23th century B.C.) and Eridu (21th century B.C.) in Mesopotamia (Wertime 1973: 678). Furthermore, the use of flux to obtain slag is metallurgical in origin. Bronze by-products and corrosion products used as colorant for blue-opaque glasses and the potential use of silver refining litharge in yellow and green glasses supports Peltenburg's hypothesis (Mass et al. 2002).

Edgar Peltenburg argued for a relationship between metal and glassworkers since both of them were using similar skills while dealing with molten material; meanwhile, faience makers were dealing with cold-state materials (Peltenburg 1987 contra Vandiver 1983). Since the firing temperature for Egyptian glassworking is accepted as 900°–1000° C (Vandiver 1991; Stern and Schlick-Nolte 1994), metalsmiths and glassworkers possibly shared related working conditions (Peltenburg 1987). Henderson argues that annealing may have been a practice that served as a link between metal and glass artisans (Henderson 2013).[76]

[75] In this chapter, the details of ancient metallurgy, the use of flux in metallurgy, etc., are not discussed on purpose since it is an enormous topic on its own and not within the purview of this dissertation.

[76] Glassworking also necessitates annealing (see chapter VIII). Discussing the difference between glassmaking and glassworking is discussed in section 3.4.5.

Peltenburg also suggested a two-staged (Stage 1 and Stage 2) production process for glass. Stage 1 was defined as "a preadaptive stage characterized by the very irregular use of glass," where he noted that glass was a by-product of another technology and therefore not a demanded good during Stage 1. In Stage 2, "individual properties (of glass) have first been realized," which actually triggered a demanding market for glass (Peltenburg 1987: 18).

Another alternative relates the origin of glass to glazing. From the fourth millennium B.C., glazing was used in Mesopotamia and Egypt for the production of glazed tiles. The chemical compositions of glaze and glass are similar. Alkali components of glazes serve as flux to decrease the melting point of silica. At this point, adhering the glaze to a clay-base core had not been developed; therefore powdered quartz core bodies were in use (Lambert 1997). Glaze-coated silica-rich bodies are called faience or sometimes Egyptian faience.[77] Vandiver relates faience production to glass manufacture based on these correspondences (Vandiver 1983).[78] From the fifth and fourth millenia B.C., the artisans of the ancient Near East knew glazing, which was also linked to glass production in the 15th century B.C. due to their similar chemical composition to glass (Oppenheim 1973: 262).

Textual records show that glass, either raw or finished, was a prestigious material. Oppenheim suggested that the introduction of glass and its technology first appeared at the royal court level as gift exchange (finished objects rather than raw materials and artisans), delivery or tribute, booties, or trade, rather than due to

[77] There is terminological confusion/debate for the use of faience, Egyptian faience, and majolica. Joseph B. Lambert argues that faience is the name for tin-glazed earthenware pottery that was produced in Europe a couple of thousand years later. Therefore, he prefers to use the term "glazed quartz" to define this early material (Lambert 1997).

[78] Contrary to Vandiver (1983), Peltenburg (1987) suggests faience production only as a background — but not a real trigger — for glass production due to the rapid emergence of glass technology around 1500 B.C.

political or military situations (Oppenheim 1973: 264). He wrote (1973: 264): "political and military power do not necessarily promote intellectual and artistic influences across boundaries."

This chapter summarizes the material properties of vitreous materials by touching upon chemical and physical characteristics and provides insight into material terminology so that the short history of glazing, frit, Egyptian blue, faience, and glass can be understood without any misconceptions. Throughout the chapter, the most relevant artifacts and publications are underlined rather than providing every single detail of the vitreous corpus of the second millennium B.C. recovered from the Near East.

The following chapter presents the details of the Alalakh vitreous assemblage. It discusses the findings mainly of Woolley's excavations and reevaluates the vitreous nature of the assemblage based on the information provided throughout this section.

CHAPTER IV:

PREVIOUS RESEARCH ON THE ALALAKH VITRIFIED MATERIAL ASSEMBLAGE

The publication of Woolley's reports (1936, 1939, 1947, 1950, 1953) and the final account (1955) on Alalakh presented mainly the unique and complete objects of the site's vitreous assemblage.[79] Such a selective perspective on the corpus was far from being a complete interpretation of the whole vitreous material capacity of the settlement.

One of the aims of this dissertation is to reconcile this minimal coverage by presenting the complete vitreous assemblage of Alalakh so that a comprehensive representation of the vitrified material crafting at the site and its relationship with the neighboring regions becomes possible. This chapter brings together all the earlier research done on the vitrified material assemblage of Alalakh starting with Woolley's excavation accounts. This chapter is divided into two parts. The first part compiles artifacts recovered in Woolley's excavation campaigns and research done on those artifacts. The second part documents the history of scientific research done

[79] The Woolley 1947 publication is the only excavation report where he mentioned several vitrified artifacts. In the other reports, he either broadly documented or did not mention any vitreous objects aside from vitreous cylinder seals. The most complete picture of the vitreous corpus was provided in the 1955 publication.

on the Woolley excavated material. This part also covers scientific research done on the Yener excavation assemblage since the 2000s.

In the excavation reports, the vitrified material assemblage of Alalakh got the attention of scholars right after the publication of selected artifacts. In terms of research trends, it was a time when scholars were debating the origins of vitreous technologies, especially the emergence of glass in Egypt and/or in Mesopotamia. On the other hand less attention has been given to northern Syria or the Levantine region, for which the Alalakh vitreous corpus provides a milestone.

After Woolley's final publication in 1955, Barag published in 1970 the first typological and comparative study of only the glass artifacts from the site. Barag's (1985) work continued and he published an extended section on the glass bottles, goblets, and figurines of Alalakh in the *Catalogue of Western Asiatic Glass in the British Museum*. Barag's studies were based on less than twenty artifacts from the British Museum collection. These studies and several others by Peltenburg (1969, 1971), Hartmut Kühne (1969), and Lilyquist (1993) were based on the typological characteristics of a few complete artifacts and/or decorated fragments, although they have limited or no information on the material characteristics and/or technological stage of the complete vitrified corpus. Even though production techniques for glass (Barag 1970, 1985) and glazed pottery (Peltenburg 1969, 1971) were proposed, these suggestions were based on typological characteristics of the artifacts and the comparison of objects with the better-identified parallels, mainly from the Egyptian corpus from Amarna. Furthermore, the publications on Alalakh mainly focused on glass artifacts, thereby leaving aside the frit and faience assemblage, which then created a significant gap for the information of vitrified materials.

This chapter documents all published glass, faience, and frit artifacts from Alalakh unearthed in the 1936–39 and 1946–49 excavation seasons to establish a complete picture of the vitreous collections of the site. Reevaluation of earlier typological and scientific research provides a broader glimpse into the breadth of the assemblage. It also shows the increasing demand for vitrified objects over time.

4. 1 Part I: Sir Leonard C. Woolley and the 1936–39 and 1946–49 Vitreous Corpus of Alalakh

Woolley first documented the vitrified materials of Alalakh in his excavation reports mentioned above. The vitreous artifacts that he cites in these reports did not number more than twenty. He focused mainly on selected pieces, which he saw as chronological markers (e.g., scaraboid seals), signs of regional relationships (e.g., faience mask resembling the Snake Goddess of Knossos), or archaeologically interesting (e.g., Egyptian blue vase with lion-shaped handle). Thus, these reports were far from being reflective of the complete corpus he unearthed.

An extended version of the vitreous corpus was published in the 1955 account where Woolley wrote a general chapter on the glazed ware and glass of Alalakh (Woolley 1955: 297–302). Yet, this chapter did not provide a complete set of information on the whole vitrified assemblage of Alalakh. A significant amount of glass, faience, and frit objects were recorded in the section on "Moulded Human Figurines" (Woolley 1955: 246–49). Beads and amulets were also discussed in a separate section (Woolley 1955: 268–71). Woolley recorded a noteworthy amount of artifacts in the room accounts of the Level VII and Level IV palaces.[80] Alalakh has a noteworthy collection of seals made out of vitrified materials, mainly frit and

[80] One cylinder seal defined as "white paste" was recovered in House 37 in private houses zone (Woolley 1955: 178). However, I could not recover any other record in private houses related to vitreous materials.

faience. Woolley mentioned most of the frit and faience seals in "The Cylinder Seals and Seal-impressions" chapter (Woolley 1955: 258–68). The most controversial part, including the abundant frit, faience, and glass artifacts, was Chapter VI, "The Graves" (Woolley 1955: 201–23). In this chapter, Woolley recorded many objects without proper AT[81] numbers or appropriate definitions, which has created significant problems in clarifying the exact characteristic of the artifacts. There were also many inconsistencies for the attribution of artifacts to archaeological levels. The same artifact was documented sometimes more than once with different archaeological information and diverse chronological attributions. The terminology Woolley used and chronological inconsistencies in his documentation are reevaluated in detail throughout the chapter and annotated carefully in the footnotes.

From the perspective of material characteristics, the situation is complicated by the fact that the descriptions of frit, faience, and glass were ambiguous, thus lacking the terminological definitions. Woolley started the section of glazed ware and glass with the sentence "vessels of glazed frit were numerous at Atchana," where "glazed frit" was commonly used for defining faience. Such terminological confusion was quite frequent and was also commented on by Peltenburg in a footnote where he underlined the fact that what Woolley called in most cases as frit was actually faience and his terminology was vague (Peltenburg 1969: 73, fn. 3). Among the terms Woolley used were frit, Egyptian blue, glass paste, white paste, paste, faience, and glass where the use of most of them, like glass paste, lapis lazuli paste, and paste or frit, were synonymous.

To clarify Woolley's ambiguous definitions, the author reexamined the corpus within the limitations of museum accessibility. The British Museum and the

[81] AT refers to Atchana and it is the main inventory system used by Woolley while documenting artifacts from Alalakh.

Hatay Archaeology Museum collections were all visually restudied, whereas the collections of the Ashmolean Museum and the University College London were not accessible for a visual examination or a depot study due to ongoing research on the artifacts by other scholars and museum specialists. The collections of those museums were only investigated either through the showcases or online catalogs.[82]

The vitrified material corpus unearthed by Woolley includes mainly beads with various typological features. The catalog of objects observed in the British Museum and the Hatay Archaeological Museum shows the reevaluated objects where the abundance of the bead types and materials can be seen.[83] Pendants and amulets are the second group of vitrified objects evaluated in this chapter. Faience and glass examples were revisited in both of the museum collections. A noteworthy group is the glass vase fragments. Unfortunately, a complete glass vase was not recovered at Alalakh, though vase fragments were numerous. Additionally, a significant amount of rim fragments belonging to glass vases were also documented in both museums and several unpublished examples were registered mainly at the Hatay Archaeology Museum.

Frit and faience are materials popularly used for cylinder seals at Alalakh, whereas glass seals are not very common.[84] The styles and symbolism of the Alalakh seals are well studied by various scholars (Wiseman 1953; Collon 1975, 1982, 1987, 1995, 2010) and are beyond the subject of this dissertation. Since the material characterizations done by Woolley are quite confusing due to the fact that he defined the seals as being made out of paste, glazed frit, or lapis lazuli paste, the material

[82] For detailed information on the museum studies, see Appendices I, II, and III.
[83] For the bead typologies, please see the drawing of each typology in Yener and Yazıcıoğlu 2010 and the bead terminology section in Appendix I.
[84] For a probable glass seal (A03-R1326), see Collon 2010: 97, fig. 7.4.5.

types were reexamined. In particular, the seals in the Hatay Archaeology Museum were revisited and a consistent terminology was created.

The most difficult part was the reevaluation of vitrified materials found in graves. As mentioned above, most of the frit, faience, and glass grave goods were poorly registered and were not assigned with AT numbers with the exception of seals, amulets, or unique artifacts like figurines. The graves discovered by Woolley were rich in beads of various types and materials including shell, stone, or metal. Some graves yielded hundreds of beads, which Woolley assigned either group numbers or documented them as beads from a grave. Since most of the shapes and materials are quite common, Woolley probably did not probably want to provide what he viewed as repetitive information; this might be the reason why Woolley provided a broad-brush definition of the vitrified beads. The terminological confusions and inconsistencies happened often in his discussions and documentation of grave goods. These problems are clearly noted throughout this chapter. On the other hand, the archaeological contexts and interpretation of the graves are excluded from the discussion (see Ingman 2014, forthcoming a, b).[85]

During the 1936–39 and 1946–49 excavation seasons, Woolley did not recover vitrified material below Level VIII, which is represented by the existence of only one bead. In this part, the assemblage of Level VIII–Level 0 is handled according to the periods Woolley assigned to the artifacts. The comparison to Woolley's levels to Yener's new chronology is given in figure 4.1.

[85] The examination of Alalakh graves was the subject of Tara Ingman's MA thesis and she continues to work on the same subject as a part of her doctoral dissertation.

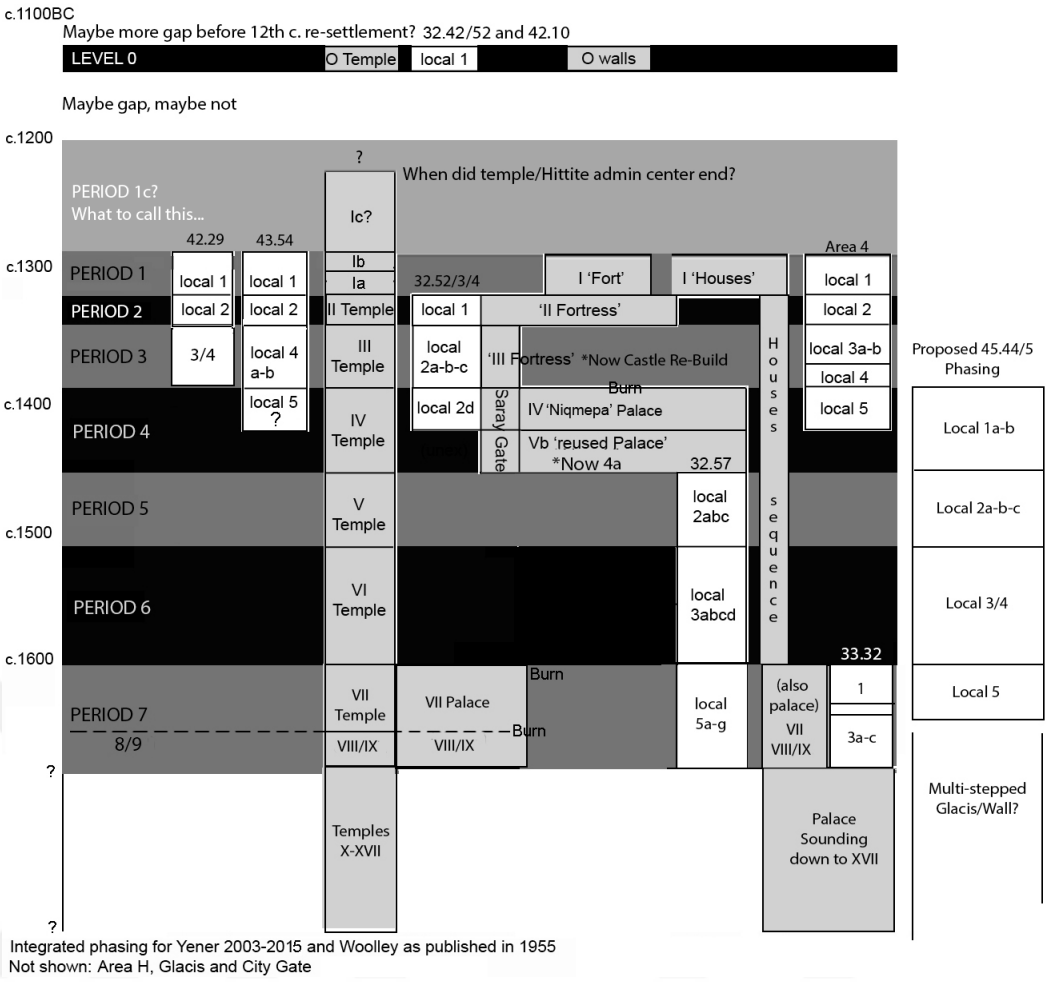

Fig. 4.1: New stratigraphy and its synchronism to Woolley (1955) (Yener et al. in prep).

4.1.1 Level VIII

The vitrified material assemblage of Level VIII is represented by only one frit ball bead found in the grave ATG/47/2 without any AT number assigned (Woolley 1955: 221).

By defining the object as a ball bead, Woolley most probably meant to say spherical bead. Even though the color of the bead was not documented, similar spherical frit beads were known from Acemhöyük from the 19th–18th B.C. levels of Sarıkaya palace (Özgüç 1968: 19).

It is important to note here that this type of bead made out of frit, faience and glass continue to be in use until the final levels of the settlement. This bead type is

also common in the region (northern Syria, Anatolia, Mesopotamia, and the Levant) throughout the LBA. Settlements like Tell Rimah (Carter 1967; Oates 1982), Tell Brak (Oates 1987), Nuzi (Starr 1939; Vandiver 1982) in Mesopotamia, Ugarit in the Levant (Matoïan 2003; Matoïan and Bouquillon 2003) and Amarna (Petrie 1894; Nicholson 2007 with references) in Egypt revealed examples of spherical beads made out of frit, faience and glass. The abundance of spherical beads made out of vitreous materials might be both the fashion of its time and/or convenience of production.

4.1.2 Level VII

Level VII is the first archaeological stratum with a significant vitreous corpus. In this level, most of the assemblage was recovered from the rooms of the Level VII palace. The vitrified materials included only frit and faience objects and there was indefinite evidence for glass in this period based on both Woolley's publications and collections revisited within the limits of this study. Only one reference was made to polychrome glass beads recovered by Woolley in the Level VII temple (Lilyquist 1993: 56), however, Woolley's publications and revisiting of the material do not confirm the existence of glass. Yener's excavations yielded four glass fragments belonging to either two or three spherical beads from the MBII period (AT 15825 from Square 32.57, catalogue number: 4). These bead fragments are discussed in detail in chapter V, though their contextual correlation to Level VII is under study (Yener et al. in prep).

The types of artifacts recovered in Level VII by Woolley included luxury objects of most probably palatial or elite use, like a toilet box lid, a human mask, and cylinder seals of various iconography.[86]

A group of unique vitrified objects was recovered from the rooms in the Level VII palace. In Room 2, a faience human mask was recovered; Woolley described this mask as resembling the Snake Goddess of Knossos.[87] The flat top of the head of the mask was referred as a "*polos* crown," which led Woolley to establish further strong linkages to Crete. He distinguished this faience mask from the other glass and faience figurines of Alalakh[88] by its earlier date (Woolley 1955: 247; pl. LVI, e). In Room 16, a small plain faience cup (AT/39/1) with a square base and circular rim was uncovered (Woolley 1948: 16; 1955: 297, 298, fig. 74a: 1).[89] In Room 18, a fragment of faience (AT/39/234) with a hand relief, which was defined as glazed frit by Woolley, was found (Woolley 1955: 104).[90] In Room 20 of the palace, a light blue-colored toilet box lid (AT/39/248) with four black lines decorating the surface of the object like a star was unearthed (Woolley 1955: 297, 298, fig. 74a: 2).

The Level VII faience toilet box lid with blue and black decoration has parallels at Ugarit (Peltenburg 1987: 15, fig. 1). At Tell Mardikh (Ebla) in Syria, a similar faience vessel dated to MBII was found (Matthiae 1980: 13–14, fig. 14).

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[86] For iconography of cylinder seals see Collon 1975, 1982, 1987, 1995 and 2010.
[87] Woolley recorded AT 39/111 in Pl. LXVIe (Woolley 1955: 297), whereas the object was cataloged in pl. LVIe in the terra-cotta plates and discussed in the "Moulded Human Figurines" section (Woolley 1955: 247).
[88] Woolley referred to this object as faience and then as a glazed figure, which exemplifies the terminological variations in Woolley's publication language (1955: 247).
[89] Woolley first reported on this object in his 1948 report, but he did not assign it an AT number. He defined the object as glazed frit (Woolley 1948: 16).
[90] This chapter does not cover the associated artifacts found in the rooms of the Level VII and Level IV palaces. For the corpuses of palatial rooms, the reader can refer to Woolley 1955: 91–131.

Similar faience cups from the early second millennium B.C. were also recorded in Alişar (Yozgat,) Stratum II, (Schmidt 1932: 111, color pl. III, PL. X: b 1868) and Acemhöyük (Aksaray, Turkey) Level I (Özgüç 1986b: 207–08, fig. 1).

The resemblance of the Alalakh Level VII faience mask to the head fragment of a Kültepe Ib faience figurine is intriguing (Özgüç 1986a: pl.42, 7b). The side-view of the mask provided (Woolley 1955: plate LVI- e) shows typological similarities like the shape of the almond-shaped eyes, full chin and cheeks with the head fragment of the Kültepe Ib figurine. However, Woolley did not provide a frontal-view of the artifact. Furthermore, the artifact recovered at Alalakh is a mask, whereas the Kültepe one is a figurine fragment. Woolley's comparison of the artifact with the Snake Goddess of Knossos may have been related to his intention to establish linkages between Alalakh and the Aegean world. It is not possible to elaborate further without revisiting the original artifact, which could not be found in the visited museums within this study. Saving Woolley's connotations to the Aegean as a possibility for now, the typological similarity between Alalakh and Kültepe is worth noticing.

Above the debris of Room 19 of the palace, a white frit scarab (AT/39/247), 1.3 cm in length, was recovered. Woolley recorded the scarab as being originally glazed and as being the "Hyksos type" with two columns of an unreadable inscription engraved on the base of the scarab (Woolley 1955: 262, no. 20).[91] However, Woolley documented the same object in the Level IV Palace records as found in Room 19–20 with a reservation mentioning that it might belong to Level VI (Woolley 1955: 123). Based on this contradictory information, it is not now possible

[91] The object is today in the British Museum collections with the inventory number BM 130747 and registration number 1939,0613.130. (http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=1638100&partId=1&searchText=atchana+scarab&page=1)

to illuminate the exact context of the artifact. Furthermore, the British Museum records show the object as glazed steatite. Since revisiting this object was not possible, it is not easy to elucidate the object as frit, faience, or glazed steatite for this project.

The graves of Level VII are not rich in terms of vitrified grave goods. The grave ATG/37/24 has some frit ball beads[92] and the grave ATG/48/1 has almost ten faience cylindrical and lentoid beads; however, none of the objects were documented with an AT number (Woolley 1955: 221).

According to Woolley's accounts, there are not more than twenty vitreous objects unearthed from Level VII of Alalakh. The exact number of artifacts cannot be calculated due to Woolley's ambiguous definitions of the grave goods, though it is clear that four of the artifacts were found in different rooms of the Level VII palace. All of the palatial objects are faience and they all indicate luxury consumption and elite use, like the human mask and the toilet box lid. Except for the toilet box lid (AT/39/248), which is blue colored with black decorative lines, Woolley did not record the color of any other objects recovered from the Level VII palace. The rarity of the vitrified assemblage in the palace demonstrates that faience was known by the palatial elites of Level VII at Alalakh, though it was not in common use. The scarcity might be correlated with its high expense or lack of enough demand in that period.

4.1.3 Level VI

From Level VI, more complex faience and glass objects were discovered. Two faience bowl fragments, which were defined as glazed by Woolley, were recovered from this level. AT/39/52 (catalogue number: 474) is part of the body of a bowl with a greenish-blue glaze and black-colored decoration described as

[92] Woolley did not provide the exact number of beads.

resembling a lotus petal (Woolley 1955: 297, 298 fig. 74a: 6). A very similar fragment (AT/47/168) with a greenish-blue base color and brownish-black line decorations were also recovered at the same level (Woolley 1955: 297, 298 fig. 74a: 4). A few fragments of green and blue spoon shaped frit inlays (AT/47/55, catalogue number: 527) were also found at this level, but Woolley had recorded them as glazed pottery (Woolley 1955: 299). From Level VI and the subsequent Level V, green faience circular pendants similar to the type of AT/39/309 were found, though Woolley did not specify the AT numbers and characterized the objects as green glazed frit (Woolley 1955: 271, pl. LXVIIIb: 4). Due to Woolley's general trend of defining faience as glazed frit, this unspecified object might be faience.

Other than faience, several blue frit fragments were also part of the Level VI corpus. A small fragment of an open bowl (AT/47/173) and a part of the head of a bull (?) (AT/39/327) were examples of frit materials recovered from Level VI though without attribution to exact archaeological contexts (Woolley 1955: 297, 298 fig. 74a: 9). A white frit seal (AT/47/85, catalogue number: 10) and glazed steatite scarabs were also recovered, indicating the existence of both frit and glazed stones at the settlement. AT/47/165 (catalogue number: 12) was documented as a "white steatite and originally glazed scarab" seal by Woolley (1955: 262, no. 29) whereas the object is faience. A white steatite scarab with green glazing (AT/47/61) and spiral motifs was recovered from Sq. P14 at Level VI (Woolley 1955: 259, 263, pl. LXI, no. 32). An Egyptian blue seal (AT/39/232, catalogue number: 514) was recovered at Sq. N11 and recorded vaguely as from Level VI–V (Woolley 1955: 263, no. 39).

Scarabs and lotus petal decorated faience objects similar to the ones at Alalakh were found in Egyptian sites like Lisht since the Middle Kingdom period (ca. 2040–1782 B.C.) mostly as grave goods. Though at Alalakh Level VI grave

goods made out of vitrified materials mostly include various types of beads. Faience bowl fragments and faience circular pendants recovered in Alalakh Level VI have parallels recovered in Nuzi Stratum II, dated to the 15th century B.C. and phase II of Tell al-Rimah dated circa 1450 B.C. Compared to the chronology provided in fig. 4.1, these artifacts of Alalakh were quite earlier than its northern Mesopotamian comparatives.

The earliest presence of glass at Alalakh was reported in Level VI and the earliest examples of polychrome glass vases also appeared in this period. Even though Lilyquist reported the existence of glass beads in Level VII temples (Lilyquist 1993: 56), fully developped glass objects first emerged at Level VI. The earliest glass vase fragment with a transparent blue-colored base and white-combed design (AT/39/225, catalogue number: 15) recovered at the site was not only the earliest glass vase of the site, but also the earliest known core-formed glass vase of the second millennium B.C. The fragment belongs to a base fragment with a curvature on the bottom thicker than the walls of the vase. The interior still has the marks of core-forming technology.[93] Barag (1985: 42) recorded the artifact as the lower part of a "broad tubular neck of a bottle." He also referred to the fragment as most probably part of "a bottle high cylindrical neck and piriform body" (Barag 1985: 42). These two definitions are partially controversial since the fragment does not belong to the neck of a glass vase, but to the base. Many bubbles and bubble holes are apparent, which Barag also noted as "pin-prick bubbles" (Barag 1985: 42). The general condition of the fragment is very good and has no trace of weathering.[94]

Not only vase fragments, but also other types of glass objects were found as early as this level. AT/47/59 (similar to catalogue number: 538) is a disk or roundel

[93] For the core-forming technology of the glass vases, please see Chapter III.
[94] For previous studies on this artifact, see Appendix I.

inlay of green glass with yellow and white-colored cruciform decoration with four knobs on each quarter of the surface. The object is slightly concave below (Woolley 1955: 300–01, 298 fig. 74b: 9; Lilyquist 1993: 56). Similar roundels were found in Nuzi Stratum II (Starr 1939, pl. 120, WW). A turquoise colored discoid were also recovered in the Büklükale (Kırşehir, Turkey) excavations though typological and archaeometric studies are ongoing on the artifact.[95]Above the destruction debris of Level VII — most probably at Level VI[96] — a gray glass bead (AT/47/60) with white quatrefoil designs was found in Sq. O 13 (Woolley 1955: 301, 298 fig. 74b: 10; Lilyquist 1993: 56).[97] This bead was found together with the frit bowl AT/47/173. Such floral-designed artifacts were also found in Nuzi Stratum II (Starr 1939, pl. 121, B), however, those are generally inlays rather than beads.

One of the most exciting glass findings of Level VI is the figurine (AT/48/4, catalogue number: 14) defined as a "naked votaress" by Woolley (1955: 247). Known also as the "naked glass figurine" or the "Astarte figurine," this glass object is the earliest example of a glass figurine recovered in the second millennium B.C. It was found at the western corner of the Level VI temple (Woolley 1955: pl. LVIb). The archaeological context of the artifact directly attributes religious significance to the artifact. Woolley recorded this object with its terra-cotta comparatives in plate LVIb and documented its information in the section on "Moulded Human Figurines" (Woolley 1955: 246–49).

[95] Kimiyoshi Matsumura and Julian Henderson are investigating the glass assemblage of Büklükale. I would like to thank them for organizing the Late Bronze Age glass conference in the Japanese Institute of Anatolian Archeology in 2014 where we shared information and ideas on Anatolian glass.
[96] The assignments to particular levels belong to Woolley's definitions.
[97] The exact context of the bead is not clear. Woolley mentioned that the bead AT/47/60 might also less probably be dated to Level V (Woolley 1955: 269).

An interesting feature of this figurine was documented in 2015. This figurine was known as blue glass; however, a possibly fresh break close to the head, on the back of the figurine, shows that the figurine is actually opaque olive-green colored glass. The confusion in colors might be attributed to its blue-colored twin (AT/39/106, catalogue number: 231), which was recovered at Level V and became quite popular as a part of the Alalakh selections in the showcases of the British Museum Levantine galleries. Scholars, while referring to the British Museum figurine, confused the levels and documented it as a Level VI artifact, which most probably caused this discrepancy.[98]

Similar female figurines sometimes defined as "naked votaress", "Astarte", or "Ishtar" were found in Kültepe level Ia and Ib (Özgüç 1986b; see chapter 3 section 3.3.3) though the examples were made out of faience. Furthermore parallel figurines to Alalakh were recovered in Ugarit levels dated ca. 1400–1300 B.C. again made out faience (Matoïan 2000, cat. 156, 168). A fragmentary glass figurine was recovered in Boğazköy Level Ib dated to 14th–13th century B.C. (Boehmer 1972, Tafel LXV, 1861). Alalakh yielded two more examples from later strata, which are discussed below with parallels.

The graves of this level are fairly rich in grave goods made out of vitrified material. ATG/39/92 yielded a few white frit beads without any assigned AT numbers (Woolley 1955: 220). Another grave (ATG/39/81) yielded four tube frit spacer beads, glass cube-shaped beads, and white frit ring and tubular beads and ATG/39/106 yielded white frit ball beads, none of them with any documented AT number (Woolley 1955: 220–21).

[98] Woolley also documented the object as blue. This might be due to his confusion of the Level VI and Level V twin figurines in his final publication. The Level VI figurine is in the Hatay Archaeology Museum and he might not have a chance to revisit the color of the artifact for the final publication (Woolley 1955: 247).

4.1.4 Level V

From Level V, one of the most unique objects is a part of a bowl (AT/46/223, catalogue number: 230) (Woolley 1947: 60; 1953: 94; 1955: pl. LXXXIIIh; Gates 1981: 10, nos. 49, 29:8e; Ritner forthcoming).[99] This faience bowl, recorded as blue glazed frit (bleached white) by Woolley, was decorated with a lotus at the bottom and quatrefoil patterns on the two sides of the body. Between the quatrefoils, a seated figure of a man in front of a table offering food was incised. The inscription accompanying the scene was lost, but the title of scribe for the depicted person survives (Woolley 1947: 61). Even though Woolley referred to the bowl as a local product, he also referred to the object as an Egyptian faience vase (Woolley 1955: 71). The object is recorded as 8192 in the Hatay Archaeology Museum and Robert K. Ritner reexamined it in 2007 to report on the inconsistent definitions and interpretations made by Woolley and Marie-Henriette Carre Gates. His comments and new evaluation of the artifact is forthcoming in the second Alalakh monograph.[100] In short, Ritner argued that the artifact is definitely Egyptian in origin due to its highly skilled Egyptian iconography with the well-known "Nunschale" or "Nun-bowl" type, a type linked to the water god Abyss (Nun) (Ritner forthcoming; Stefanova 2015). The object is faience according to the terminology that this dissertation relies on.[101]

Another faience bowl fragment (AT/39/310), similar to the Level VI faience pieces AT/39/52 (catalogue number: 474) and AT/47/168 (catalogue number: 13),

[99] Woolley erroneously records this object, as in pl. LXXXIIIa (Woolley 1955: 297).
[100] For the detailed reexamination of the artifact, see R. K. Ritner forthcoming; I thank him for allowing me to see this section.
[101] Woolley referred to the object as faience in the first publication and suggested it as evidence of the existence of an Egyptian officer in the local government of Alalakh; thus, Alalakh was under Egyptian control (Woolley 1947: 60). Woolley did not mention this argument in the 1955 publication.

were recovered from Level V (Woolley 1955: 297, 298 fig. 74 a: 3). A complete faience vase was found in grave ATG/39/80. This vase (AT/39/197) is almost 18 cm tall and has a black layer, possibly due to fire (Woolley 1955: pl. LXXXIIIe).[102]

The faience beads of the hub type also started to appear as early as this period and continued to be in use until Level I (Woolley 1955: 269, pl. LXVIIIa, no. 28).[103] These types of beads are strongly associated with the Mycenaean cultural zone and are dated to the Late Helladic III period (ca. 1400–1150 BC) (Nightingale 1998, 2009) however the examples from Alalakh provide an earlier and wider time scale for this typology. This situation caught the attention of Woolley and he underlined the fact that the examples of hub beads found at Alalakh could not be used as markers to change the dating of its Mycenaean counterparts. However, existence of hub-beads at non-Mycenaean sites would challenge its value as evidence for dating (Woolley 1955: 269).[104] Furthermore, Yener's excavations yielded hub-beads (AT 7269, 17881) in the craft-related zone. Archaeometric investigations done one of the fragmentary hub-beads demonstrate clues on local production (see chapter VII). This new evidence does not downgrade the typological attestations to the Mycenaean cultural zone but indicate stronger overseas relations.

At Level V, fragments of polychrome glass were also existent. Below House 39B, a glass vessel (AT/47/51) with seed (or drop) pattern decoration was recovered (Woolley 1955: 297, 298 fig. 74a: 5). This fragment was documented as fine glazed frit whereas it is actually a weathered fragment of a glass vase. Fragments of blue

[102] Woolley erroneously records this object, as in pl. LXXXIIIb (Woolley 1955: 299).
[103] This type of faience bead was not found in Level III. Woolley defines the material as glazed frit instead of faience (Woolley 1955: 270).
[104] For the Mycenaean counterparts and their chronological evaluation, see Nightingale 1998, 2009.

and yellow wave-decorated glass vases (AT/39/76, catalogue number: 473) were recovered at this level from the same house.[105]

The vitrified seals found in Level V were made out of frit. AT/39/134 is a white frit seal recovered from the neck of a body in Sq. H 15 (Woolley 1955: 263, no. 36). AT/47/152 was also made out of white frit and recovered from the "via sacra" area in Sq. U12 (Woolley 1955: 263, no. 38). Another white frit (AT/39/53, catalogue number: 512) seal was found in Level V–VI Sq. N11. This seal is faience. Woolley referred to it as originally glazed (Woolley 1955: 263, no. 46).

The graves of Level V are rich in frit, faience, and glass goods. Among the most important grave goods of Level V is a glass female figurine (AT/39/106, catalogue number: 231) clasping her breasts. This figurine is blue glass and was recovered from a Level V grave (ATG/39/44) along with silver and bronze artifacts (Woolley 1955: 220). The artifact is heavily weathered, and therefore appearing opaque white today.

The earliest example of a glass female figurine was found in Level VI of Alalakh. Similar glass figurines were recovered in Tell el-Rimah Level II, Nuzi Stratum II in northern Mesopotamia, Boğazköy in central Anatolia (see above), Hama, Beth Shean temple stratum dated to the 14th century B.C., Megiddo Stratum IX and Lachish in Syria and the Levant, and Kouklia and Milia dated to 16th–15th century B.C. in Cyprus. Mycenae and Kakova, Tholos A also yielded fragmentary examples dated to the 16th–15th century B.C. (Barag 1970: 188).

[105] In the second paragraph on page 300, Woolley records AT/39/76 (catalogue number: 473) as being from Level V 39B. On the same page but in the last paragraph, Woolley documents the same fragment (no. 3) as from just above the ruins of the Level VII palace. Based on this information, he further dated the object as either from Level V or Level VI (Woolley 1955: 300–01, 298 fig. 74b: 3). In this chapter, the object is reported in the section on Level V, but due to the confusion that Woolley's leveling created, it might well be recorded in Level VI.

Beads were the most popular vitrified grave goods at this level. Among the graves attributed to Level V, in ATG/39/89, frit and blue faience beads (AT/39/245) were found. Lilyquist also documented these beads by focusing on their granular appearance (Lilyquist 1993: 56, fig. 29:a) (similar probably same as catalogue number: 551).[106]

In ATG/39/110, tubular and fluted frit beads and two frit pomegranate-shaped beads (AT/39/271) were recovered (Woolley 1955: pl. LXVIIIb, no. 9, 219–20). The grave ATG/37/27 yielded white frit ring beads along with white date-shaped beads and small blue tubular beads of frit. The same set has a half-survived frit cylinder seal along with bird-shaped beads all cataloged as AT/37/180 (Woolley 1955: 216). In the grave ATG/39/80, a group of vitrified materials cataloged as AT/39/80 include two white frit beads what Woolley called "nasturtium seed beads" along with frit tubular beads. This object group was restudied at the Hatay Archaeology Museum in 2014; however, the blue frit cylindrical bead could not be found in the same set (Woolley 1955: 216). In the graves ATG/39/97 and ATG/39/99, frit tubular and ball beads were unearthed. ATG/39/111 yielded only one glass ball bead without any assigned AT number (Woolley 1955: 216–17). In ATG/46/4, beads of tubular and banded polychrome glass (AT/46/318) were found (Woolley 1955: 217). White and black frit ball beads were found in association with a faience ribbed bead and an Egyptian blue bugle bead (AT/49/18) in the grave ATG/49/5 (Woolley 1955: 219). From an undefined grave, a green faience bead[107] (AT/49/19) resembling a rabbit (?) was also unearthed.

[106] Lilyquist pointed to Nuzi Level II pink granular beads as a parallel for these granular beads in order to attribute this level chronologically to the 15th century BC (Lilyquist 1993: 56).
[107] Woolley refers to the bead as green glazed frit (Woolley 1955: 271).

4.1.5 Level IV

A significant amount of vitrified materials were found in the rooms of the Level IV Palace of Alalakh. In Room 7, a faience tubular object (AT/38/88)[108] and in Room 8, a pear-shaped frit[109] pendant without an assigned AT number were recovered (Woolley 1955: 119–20). Room 17 yielded three faience objects (AT/38/86), which Woolley defined as "glazed frit ditto" (Woolley 1955: 122).

In Room 30 of Level IV Palace, fragments of a nearly 15 cm tall green faience bottle was found, though much of the glaze was washed off (Woolley 1955: 299). In the same room, a red glass ingot was unearthed (catalogue number: 436). This ingot (catalogue number: 436) was not documented by Woolley in any of the Alalakh reports, but reported by Barag according to Woolley's index cards from his excavation (Barag 1985).[110] Ian Freestone scientifically analyzed the object. The details of the research and new comments on the artifacts are summarized in the second part of this chapter.

A group of three polychrome glass vessel fragments from the same room of the palace were documented as AT/38/181B (catalogue number: 555) (Woolley 1955: 126). Barag also noted these glass vase fragments with the same number, though he referred to them as one body fragment of a beaker (Barag 1970; 1985: 43, no. 10A). However, when the author revisited the fragment in 2014, it was nothing but a lump of vitrified material resembling a glass vase fragment, but it is very hard to claim it as a piece of a glass vase.

Above Room 30 of Level IV Palace, several small fragments of glass sherds were recovered belonging to the rim and neck of a core-formed bottle (AT/38/181,

[108] Woolley recorded AT/38/88 as a tube of glazed frit (Woolley 1955: 119).
[109] Woolley recorded it as glass paste pendant (Woolley 1955: 120).
[110] The object is now in the British Museum. It appears as a green lump at first sight; therefore it might not be able to be defined as a red glass ingot fragment.

catalogue number: 441).[111] The surviving glass core of the bottle appears light blue or green. The body was decorated with white and yellow zigzag designs and the rim has blue-white twists (Woolley 1955: 302, 298 fig. 74b: 4). These fragments were first found at a higher level than Level IV and thus attributed to Level III. But, for an unknown reason, Woolley later attributed all of the fragments back to Level IV. These fragments were mended sometime before 1970 — and most probably during Woolley's time — since Barag recorded the object as mended in 1970 (1970: 151–52).

In Room 30 or 31, fragments of glass vases were found, which Woolley broadly mentioned (Woolley 1955: 126). In Room 31 of the palace, a part of a glass bowl with yellow and blue waved patterns were found (AT/38/176) (Woolley 1955: 126, 300, 298 fig.74b: 2). This fragment belongs to a piece of rim with feather decoration in a darker gray color.

The rooms of the Level IV palace also yielded several frit seals. In Room 4, a white frit cylinder seal (AT/38/184, catalogue number: 427) was found (Woolley 1955: 263, no. 54). AT/38/61 is also a white frit seal found in Room 8 of the palace (Woolley 1955: 264, no. 80). In addition, Room 26 yielded a white frit cylinder seal (AT/38/201). Woolley observed the remains of red glaze on this artifact, though this might well be red pigment (Woolley 1955: 264, no. 84). Another white frit cylinder seal (AT/38/281) was discovered at an undefined part of the palace (Woolley 1955: 263, no. 59). In the courtyard room C1, two other white frit cylinder seals (AT/38/190, catalogue number: 428; AT/38/191) were recovered (Woolley 1955: 263, nos. 60, 61). In Room C6, an Egyptian blue one (AT/38/189), which Woolley defined as imitation lapis lazuli, was found (Woolley 1955: 264, no. 72). It is

[111] This object is also referred to as AT/38/181A (Woolley 1955: 126; Barag 1985: 42, no. 8).

important to note that Woolley recorded all the frit cylinder seals as either white or blue paste in the descriptions rather than using the terms faience or Egyptian blue.

In the temple area of Level IV or early III, a vase handle fragment (AT/47/174, catalogue number: 432) was recovered. This fragment has a white base and two surviving floral designs incised on the main body and colored blue (Woolley 1955: 297, 298 fig. 74a:8). Woolley defined this fragment as the best example of Amarna style and reported that "at Alalakh glazed frits should have been so little used for vases (it was common for beads) when in Egypt faience vases were so popular" (Woolley 1955: 297). This statement shows that what Woolley referred as glazed frit at Alalakh was nothing but faience.

Level IV graves have a significant amount of glass and frit objects including not only beads, but also vases. In the grave ATG/39/85, in a deposit just above the Level V "Mithraeum," fragments of gray, yellow, and opaque glass vases were found (AT/47/144) (Woolley 1955: 301, 298 fig. 74b: 6) together with broken bottles of a similar type (AT/39/320). Associated with those glass objects, fragments of more or less three complete bottles, one of which has a fine quality ribbing on the neck and body (AT/47/145), were recovered (Woolley 1955: 302). Woolley defined this object (AT/47/175) as the finest quality with rich coloring parallel to Amarna examples.[112]

ATG/39/30 yielded a frit pendant slightly resembling a ram's head (AT/39/80) together with blue frit and glass beads (Woolley 1955: 213). Similar objects of this type were also recovered at later Levels II (AT/37/28, AT/37/83). In grave ATG/39/47, blue frit ball beads (recorded as paste) and oval white frit beads

[112] For AT/47/175, Woolley was not sure whether the fragments belonged to Level IV or early Level III. He referred to them as Level IV on page 301 and as Level IV — possibly early Level III — on page 302. In this chapter, they are attributed to Level IV, but they might well be attributed to early Level III, too, based on the reference that Woolley made on page 302.

together with five white frit ball beads, black striated ball beads, and one gray colored frit bead were found. ATG/60/90 yielded blue frit (documented as glass paste) beads (AT/39/148) (Woolley 1955: 210).

In the grave ATG/39/85, fragments of a polychrome glass vase (no AT) was found along with frit ring-, ball-, and tubular-shaped beads (AT/39/238) (Woolley 1955: 210). More glass beads (AT/39/278) were found in ATG/39/93. In grave ATG/47/8, Woolley recorded glass ball and frit ring beads along with a white frit scaraboid (AT/47/76) (Woolley 1955: 211). On the other hand, he recorded the same white frit scaraboid as a grave good from ATG/47/8 dated to Level III (Woolley 1955: 208), which has created an insecure context for the scaraboid (AT/47/76).

In inhumation grave ATG/37/37, a faience cylinder seal with an undocumented AT number was recovered, along with a string of blue faience beads (no AT). White glass beads (AT/39/35) were found in grave ATG/39/7; glass double conical beads, frit ball beads, and small frit tubular beads (AT/39/46) were found in grave ATG/39/15 (Woolley 1955: 209).

A group of objects were also recovered from the graves, which were not exactly dated but were attributed to Level IV. In inhumation burial ATG/37/33, date-shaped, discoid, and tubular beads of frit, a glass tubular bead, and a faience amulet in the shape of a lion's head were recovered. All these objects have the number AT/37/182 (Woolley 1955: 212). In a similar type of grave (ATG/37/34), a group of tubular-striated and ring-shaped frit beads were cataloged as AT/37/168 (Woolley 1955: 212). ATG/38/15 yielded a group of vitrified beads, mainly frit examples white and yellow in color and spherical in shape (AT/38/222). Woolley recorded them as paste and paste balls (Woolley 1955: 212). Graves ATG/38/17 and ATG/38/24 also yielded frit ball beads of white and yellow colors, though without

any AT numbers assigned (Woolley 1955: 213). In the inhumation grave ATG/39/35, which contained three bodies, white and blue frit beads were recovered from an infant skull along with a glass and lapis lazuli ring (AT/39/91) (Woolley 1955: 214). In ATG/39/38, white frit ball beads, green frit tubular beads, and a glass ball bead were reported without a catalog number (Woolley 1955: 214). In the grave ATG/39/45, almost 120 blue faience beads were documented and cataloged as AT/39/98 (Woolley 1955: 214). ATG/39/42 yielded two white frit beads: one tubular and one ball-shaped without an AT number assigned (Woolley 1955: 215). In ATG/39/49, tubular, date-shaped, and ball-shaped blue and white frit beads were found and documented as AT/39/101. In ATG/39/62, a group of beads, including a white frit scaraboid, white frit ball and disk beads, and two frit barrel beads, were recovered and cataloged as AT/39/151 (Woolley 1955: 215). The grave ATG/39/77 yielded green spacer beads for four strings, white and yellow frit ball beads, and a yellow frit cube-shaped bead documented as AT/39/224 (Woolley 1955: 215). Finally, the grave ATG/39/101 yielded 25 white frit ring beads without an assigned AT number (Woolley 1955: 215).

4.1.6 Level III

Level III produced a fair amount of polychrome glass objects. Wavy-designed glass vase fragments and a white glass vase with oval spot inlaid (AT/46/144) were recovered at this level.

White frit cylinder seals were recorded from this level. AT/39/215[113] was found in Sq. L13, which was dated to this level with uncertainty (Woolley 1955: 264, no. 85). In Sq. G16, another white frit cylinder seal (AT/39/73, catalogue number:

[113] This object was first reported as from the Level III or Level IV houses (Woolley 1948: 7).

515) was recovered with the possibility of being dated to a later period (Woolley 1955: 264, no. 89). AT/46/73 is a white frit seal found in Sq. L 15. Similarly, AT/39/181 and AT/39/191 (catalogue number: 440) were made out of the same material and found below a Level II floor; therefore they're dated to Level III (Woolley 1955: 264, nos. 90, 94, 98). AT/39/59 (catalogue number: 439) is an Egyptian blue cylinder seal found in the house site of Sq. L 12 (Woolley 1955: 264, no. 91). A scaraboid seal (AT/39/189) was also unearthed from Grave 39/1 of this level (Woolley 1955: 264, no. 95). AT/39/161 (catalogue number: 513) is a white frit cylinder seal found below the foundations of the Level III town wall; therefore Woolley dated it to Level III or IV (Woolley 1955: 265, no. 105).

The vitreous beads of Level III were mainly discovered in graves. On a necklace recovered from grave ATG/39/48, six fly pendants and two hedgehog-shaped beads all made out of faience[114] were found, though Woolley did not assign any AT numbers (Woolley 1955: 270).[115] ATG/39/48 is an inhumation burial with a group of beads containing six amulets of faience, a discoid glass pendant, two hedgehog (?) frit or faience amulets, glass ball beads, and spacer beads. This set is numbered as AT/39/108 (catalogue number: 500) (Woolley 1955: 208). While revisiting the corpus in the Hatay Archaeology Museum, object number 7183a shows a very similar set of beads, though there is no AT number assigned in the museum inventory. Based on the similarities, it is possible that AT/39/108 (catalogue number: 500) is object 7183a in the Hatay Archaeology Museum.

[114] Woolley defined the material as glazed frit (Woolley 1955: 270).
[115] Woolley reported several green glazed (where he means green faience) frog-shaped pendants (e.g., AT/37/139) found in grave ATG/37/32 and AT/39/57 unearthed in grave ATG/39/20, but he dated them as later than Level V without providing a secure context (Woolley 1955: 270).

There are also a few objects discovered in graves attributed to Level III. In grave ATG/39/71, 11 glass and frit beads, three ribbed white frit beads, and a white frit pendant in the shape of an animal head was found with the number AT/39/189 (Woolley 1955: 208). In the grave ATG/47/8, glass ball beads along with lozenge beads and a frit scaraboid (AT/47/76) were recovered (Woolley 1955: 208).[116] In ATG/46/3, small yellow and frit ball beads, which Woolley referred to as paste, were recovered (AT/46/320) (Woolley 1955: 209). Based on the confusion with Woolley's terminology of "paste," these beads might be frit.

4.1.7 Level II

One of the well-known and well-preserved vitrified objects of Level II is a slender vase (AT/48/18, catalogue number: 442) with a couchant lion-shaped handle (Woolley 1947: 60; 1955: 297, pl. LXXXIIIi).[117] It was found in the Level II temple annex associated with a lapis lazuli figurine and fragments of glass vessels (Woolley 1947: 60).[118] While defining this object, Woolley used the term "blue glass paste" and "lapis lazuli paste" and distinguished lapis lazuli paste from what he called "normal frit."[119] According to his definition, lapis lazuli paste was supposed to be glazed. He further argued that in lapis lazuli paste, the glaze did not survive and the recovered objects appeared matte, powdery, and light colored. Based on this argument, Woolley suggested that the slender vase AT/48/18 (catalogue number: 442) may have been preserved for longer time, like an heirloom. On the other hand, this vase was made out of blue frit, most probably of Egyptian blue, which defines a

[116] Woolley documented the scaraboid bead AT/47/76 also as a grave good of ATG/47/8 from Level IV (Woolley 1955: 211).
[117] Woolley erroneously records this object, as it is in pl. LXXXIIIf (Woolley 1955: 297).
[118] The AT numbers of the glass vessels were not documented (Woolley 1947: 60).
[119] Woolley defined the material as blue paste in a 1947 article and as lapis lazuli paste in the 1955 publication.

vitreous material with different properties and is not glazed as Woolley suggested (Woolley 1955: 297). Based on the artifacts recovered from the Level II temple, Woolley drew attention to the wealth and cosmopolitan nature of the Alalakh culture (Woolley 1947: 60).

In the Level II courtyard of the temple, a large blue glazed pot was recovered (AT/46/118). Even though such glazed pottery is unusual for such a period, Woolley mentioned the secure undisturbed soil context of the object (Woolley 1955: 299).[120] A blue glass vase fragment with horizontal yellow stripes was unearthed in the "annexe" of the Level II temple. This fragment has yellow festoon patterns together with white spots (AT/47/33) (Woolley 1955: 301).[121] In Sq. N19, a white glass vase (AT/46/114) with slightly green-yellow oval inlay was recovered (Woolley 1955: 301).[122] AT/47/33B (catalogue number: 452) is a blue colored fragment that was found in Sq. J15, just 60 cm below a Level I floor. It was designed with the technique of combing and inlay with white wavy lines.

A white glass vase with an oval spot inlay (AT/46/75) was recovered at this level among many other glass vase fragments. AT/46/22 was found in the "treasury" of Level II and was a part of the rim of an open bowl, probably ca. 7 cm diameter (Woolley 1955: 301, 298, fig. 74b: 1). It is blue glass with white and yellow decorations and the rim has a feather decoration in yellow. A similarly fine example decorated with blue- and yellow-colored comb and meander designs on the opaque white base (AT/39/149, catalogue number: 454) belongs to a fragment from the body

[120] Woolley recorded his suspicions on this object as being a Roman artifact, but after excavating similar fragments of the same pot in the undisturbed soil, he accepted the authenticity of the artifact.
[121] AT/47/33 is documented as AT/47/53 in fig. 74b: 7 (Woolley 1955: 298). It is unclear still which number is correct for this fragment.
[122] AT/46/114 is documented as AT/46/44 in fig. 74b:8 (Woolley 1955: 298). It is still unclear which number is correct for this fragment.

of a core-formed vase, though Woolley claimed it as a neck fragment of a bottle (Woolley 1955: 301, 298 fig. 74b: 5; Barag 1985: 43, no. 9).[123–124]

A frit figurine depicting a figurine head (AT/47/5, catalogue number: 525) was recovered either from this level or Level I. The exact context being unknown, Woolley defines this object as glass paste, which is actually white frit (Woolley 1955: 247). He mentioned another head fragment (AT/37/243, catalogue number: 455) from this level at the house site, whereas the object was not illustrated in the publication. Barag identified this object from Woolley's index cards and noted that it was found 1.2 m below the foundation of the outer level of Level IB (Barag 1985: 44, no. 16).

A faience head (AT/46/14) was recovered from the floor of the Sq. O12 house, which was referred to by Woolley again as blue glazed frit (Woolley 1955: 247).[125] The faience head is not a fragment but a complete object, which led Woolley to think that it might be a part of a composite figurine. A ram's head (AT/37/83) made out of frit with glass eyes colored green-gray[126] was found in the loose soil between Levels IB and II (Woolley 1955: pl. LXVII, no. 8). This pendant was described as being made out of white paste, which actually means white frit. A similar and smaller version resembling a ram's head was found in Level II (AT/38/28) (Woolley 1955: pl. LXVII, no. 7).

In Level II or Level I, polychrome eye beads made out of glass and faience were found (Woolley 1955: 269–70, pl. LXVIIIa: 25). Handled ball type beads made out of glass and faience were found mainly in Level II (Woolley 1955: 269–70, pl.

[123] For previous studies on this fragment, please see Appendix I.
[124] Barag noted a similar vase from the tomb of Maherpra from Egypt dated to about the 15th century BC; based on typology, he suggested a Mesopotamian origin (Barag 1970: 183, fig. 94).
[125] Woolley erroneously referred to its illustration as fig. 64, which belongs to House 37's architectural plan. AT/46/14 is documented on page 298 fig.74a: 10.
[126] The coloring of the eye inlay is due to due to weathering of glass. It is probably not the original color.

LXVIIIa: 26). Handled ball type beads also have shell versions. Even though Woolley mentioned only the late occurrence of these beads in Levels II and I, Yener's excavations encountered earlier examples of polychrome eye beads.[127]

AT/39/193 (catalogue number: 453) is a thistle-head pendant recovered from along the foundations of Level I and thus was dated to Level II by Woolley. Woolley described this pendant as blue and yellow glazed frit (Woolley 1955: 271) and referred to the object as characteristic Egyptian glaze of the Tell el Amarna type. However, the research done in the British Museum with binocular loop showed that the object is made out of blue and white/yellow glass. It is a molded pendant with a broken attachment at the back, which is flat. After molding it from blue glass, the artifact was then probably dipped into another colored glass, which today looks white due to weathering. A tortoise (?)-shaped pendant (AT/39/218) was also uncovered in this phase, which Woolley also attributed to Level III due to the mixed nature of the archaeological context (Woolley 1955: 271).

A unique glass object (AT/46/93, in catalogue referred as AT/46/93 b; catalogue number: 468), which Woolley defined as bugle shaped, was also recovered from Level II with several other beads (Woolley 1955: 271, pl. LXVIIIb: 6). Even though Woolley recorded it as made out of white paste, the object was studied in the Hatay Archaeological Museum and recorded as glass. It is mold made and the white color on the surface is due to a thin layer of weathering. The object is most probably blue glass, but it could not be determined despite a fresh break at the cross section, which could help to verify the original color.

Vitreous seals were also recovered both at the house and grave contexts of Level II. In House 39/C Room 15, a white frit cylinder seal was found (AT/39/167)

[127] Yener found examples of glass eye beads in the Late Bronze I contexts of Area 4, Square 64.72. Levels II and I of Woolley date to the Late Bronze II period.

(Woolley 1955: 265, no. 118). Between the houses and city wall dated to Level II–I, another cylinder seal (AT/37/9, catalogue number: 507), which is faience, was found (Woolley 1955: 265, no. 122). Woolley recorded it as the only glazed paste cylinder seal though several other examples have been recorded both in his corpus as well as the new Yener corpus (Woolley 1955: 261).

AT/39/59 (catalogue number: 439) is a white frit cylinder seal found in Grave 39/18 in Sq. L11 (Woolley 1955: 265, no. 99). Another white frit cylinder seal (AT/39/163, catalogue number: 429) was uncovered in Grave 39/64 (Woolley 1955: 265, no. 102) with 14 glass eye beads along with a faience hub bead and frit ball-shaped beads (AT/39/164) (Woolley 1955: 206). [128]

In the grave ATG/39/23, which belonged to an infant, a glass figurine was recovered (AT/39/66, catalogue number: 446); it was described as glass paste by Woolley most probably due to the heavy weathering still visible on the surface of the artifact (Woolley 1955: 247–48). Compared to its Level VI parallel (AT/48/4, catalogue number: 14), the decomposition on this figurine is worse. This figurine is less frequently mentioned in the literature most probably due to Woolley's terminology, which refers to the weathered glass artifacts as glass paste. He also documented the same artifact in the not accurately dated graves section where he assigned Level II, or probably Level III, for the date of grave ATG/39/23 (Woolley 1955: 222).

From Grave I, a white frit made seal (AT/38/11), which decayed extensively, was recovered (Woolley 1955: 261, 265, no. 108). Above an archaeological context recorded as "above the Niqme-pa palace," AT/38/25B and AT/38/45, two white frit

[128] Possibly the object 7190c recorded in the Hatay Archaeology Museum collections.

seals, were found (Woolley 1955: 265, nos. 100, 101). The only blue seal example is an Egyptian blue cylinder seal (AT/38/1) (Woolley 1955: 265, no. 113).

The grave ATG/39/63 yielded large and small faience beads, which Woolley defined as glazed frit and did not record any AT number (Woolley 1955: 206). In ATG/39/72B, a short cylindrical frit bead and a glass (?) bead were documented as AT/39/180 (Woolley 1955: 206).[129]

There are also grave goods made out of glass, faience, and frit from the graves, which did not belong to but were attributed to Level II. Among those, ATG/38/7 provided five yellow frit (?) beads and a glass ball-shaped bead; ATG/39/76 yielded two frit beads, which were reported as paste beads (Woolley 1955: 206–07).

In the inhumation graves attributed to this level, ATG/38/38 yielded two frit(?)[130] beads along with several fragmentary glass beads (Woolley 1955: 207). ATG/39/90 has a set of faience beads along with carnelian ring and ball beads numbered AT/39/219 (catalogue number: 447) (Woolley 1955: 207).

4.1.8 Level I

The main vitreous corpus of Level I was discovered in the graves. There are two artifacts documented as found in non-grave contexts. At the temple in Level I, phase A, a polychrome glass vessel was found without an AT number (Woolley 1947: 60). The other intriguing find is a green glazed plumb bob (AT/46/35, catalogue number: 465), which resembles a Roman artifact but was found imbedded in the bricks of the northwest wall of the sanctuary (Woolley 1955: 298 fig. 74a: 7).

[129] Woolley reported the ball bead as glass paste (Woolley 1955: 206).
[130] Woolley recorded them as paste (Woolley 1955: 207).

Due to its context in the wall, Woolley put forward the possibility of the object belonging to Level II (Woolley 1955: 299).

The grave ATG/37/1 yielded a plain cylinder of glazed steatite and one frit bead both without AT numbers (Woolley 1955: 204). Four heavily vitrified spacer beads with four tubes, four spherical faience beads, and one frit dumbbell-shaped bead were uncovered from grave ATG/37/3 (Woolley 1955: 204). All of the objects were given the inventory number AT/37/67 (catalogue number: 457). Based on the research done at the British Museum in 2014, this set of objects was matched with BM 136467 (registration number 1951,0102.4) and documented as such in Appendix I. Even though the British Museum does not document an AT number assigned to these objects, Woolley's description revealed an exact superimposition with this set.

In cremation burial ATG/38/2, a group of beads without an AT number was discovered. This set of beads includes small frit rings, two stone rings, and faience hub beads, which Woolley defined as Type 28 in pl. LXVIII (Woolley 1955: 204). In the grave ATG/39/68, a group of frit beads, frit serrated balls and wheels and dumbbell-shaped beads, and a spacer made out of faience or frit were found. This group is labeled as AT/39/196 (see, catalogue number: 584) (Woolley 1955: 205). The inhumation burial ATG/38/5 yielded a string of alternating black and white beads probably made out of frit, but defined as paste by Woolley, as well as a string around the neck of the adult skeleton with frit and steatite beads and another group of frit beads, which Woolley claimed as having been once blue glazed (Woolley 1955: 205). However, a specific excavation number was not recorded.

In the simple inhumation grave of ATG/38/37, small black and white frit ring beads were recovered along with a wheel-shaped frit bead. The inventory number was recorded as AT/38/253 (Woolley 1955: 206). Finally, in ATG/39/72, which was

a grave dug into the Level II ruins, white striated frit beads were recovered along with a carnelian drop pendant and a pebble barrel bead (AT/39/194) (Woolley 1955: 206).

4.1.9 Level 0

In Level 0, all of the assemblage was recovered from grave contexts. In Grave 37/2, a scarab (AT/37/47, catalogue number: 458) made out of white paste bearing the cartouche of Neb-Maat-Re was found (Woolley 1955: 265, pl. LXVI: 131, Ritner forthcoming). Other items recovered from the same grave include a globular pendant of blue glass (AT/37/33), beads of various types and materials, including tube and ball beads of glass, a scaraboid, and frit beads, of which one was striated and the others were plain, according to Woolley (Woolley 1955: 203–04).

4.1.10 Level Uncertain

Artifacts discovered by Woolley could generally be traced back and documented according to their general levels (i.e., Level VIII, VII, VI, etc.) with reservation regardless of any detailed archaeological context information. However, Woolley defined several artifacts as "level uncertain" since he could not assign these artifacts properly to archaeological strata. This section attempts to summarize the vitreous artifacts with an undefined level. Even though it is archaeologically less meaningful to evaluate such artifacts, they are part of the Alalakh assemblage.

Among level uncertain fragments, AT/38/221 (catalogue number: 456) has special importance due to its inscription. It is a white frit scarab inscribed as Amen-Re, who dates to after the Tuthmosis II period. The artifact was found in the topsoil (Woolley 1955: 265, no. 132). Another scaraboid with an unknown AT number was found in the loose soil (Woolley 1955: 266, no. 134).

AT/37/214 (catalogue number: 122) is a white paste cylinder seal found above the Niqme-pa Palace at an uncertain level (Woolley 1955: 266, no. 138). AT/38/141 is a white frit cylinder seal and was found in Sq. T7 at a level that Woolley defined as uncertain (Woolley 1955: 266, no. 142). AT/37/65 is a faience cylinder seal and was found at the house site though from an unclear zone (Woolley 1955: 266, no. 144).

Graves that were not accurately assigned to a level also yielded vitrified grave goods. ATG/39/29 (could be dated between Levels IV–V or Level VI–V) yielded white frit tubular, date-shaped, and cylindrical beads along with a terra-cotta naked female figurine all documented as AT/39/75 (Woolley 1955: 222).[131] In the grave ATG/46/15, which might be dated most probably to Level VI, V or early IV, ball, lentoid, and ring beads of frit were documented as AT/46/321 (Woolley 1955: 223). ATG/39/27 was the final grave with the possibly of belonging to Level IV, V, or VI where Woolley noted one white and one green frit ball bead in the grave (Woolley 1955: 223).

4.2 Concluding Remarks on the 1936–39 and 1946–49 Excavation Seasons' Vitreous Corpus of Alalakh

Woolley's excavations at the site uncovered a distinguished corpus of glass, faience, and frit artifacts. The emergence of vitreous artifacts started with Level VII, which yielded a limited assemblage composed of frit and faience artifacts. The earliest glass artifacts started to appear in Level VI where a core-formed vase fragment and a glass female figurine were found. These artifacts are unique examples for second millennium BC vitreous material production and for decades

[131] For the terra-cotta female figurine, see pl. LVIc in Woolley 1955.

have been referred to as milestones of the glass industry among scholars. The existence of such artifacts point to a flourishing and well-developed glass industry for the period, though it does not necessarily provide evidence of local production. There is continuity in the existence of vitreous materials until Level 0, designating a continuous demand for objects made out of vitrified materials. Based on the evidence he had, Woolley recorded glass objects as luxury imports for a royal city. He admitted the fact that by the middle of the fifteenth century vitreous artifacts had become common, but according to Woolley, at no time were the vitrified materials so numerous to suggest a local industry (Woolley 1955: 301).

Frit, faience, and glass from Alalakh were represented with several examples though the glazed pottery from the site remains a mystery and thus needs to be reported here. Woolley recorded glazed pottery (ATP/38/218) from Alalakh as early as Level IV, whereas as he also discussed in a small paragraph that there was no parallel for such early technology for glazing pottery (Woolley 1955: 299). He stated that the transition from the quartz to clay core occurred at the beginning of the first millennium BC, which is the necessary transition to produce glazed pottery.

The main difficulty in glazing pottery is the fact that glazes do not easily adhere to clay bodies like they did to the silica-rich bodies of faience or stones like quartz or steatite. For example, in Egypt the earliest glazed pottery appears in the Roman period. Some examples of glazed pottery were found in Indus Valley as early as the third millennium B.C., but there was no indication of such an industry (Marshall 1931: 517, 577.). Such technology became visible in northern Mesopotamia and Syria in the 16th century BC when normal clay vases started to be thickly coated with blue glazes (Peltenburg 1971: 7).

The unexpected discovery of glazed pottery at the site as early as Level IV led Woolley to argue that the glaze of Alalakh was made according to the 17th century B.C. Babylonian recipe where clay was prepared with copper and vinegar and glazed with lead. Such an argument makes Alalakh's glazed pottery unique since those examples would be the earliest examples of such a technology dating back to about the 17th century B.C. On the other hand, according to the analysis done by Peltenburg, it was found that the glazes of Alalakh were not lead but alkaline, like the common glazes of its period, and the vessels were slightly more silica rich than clay vessels (Peltenburg 1969: 80, n. 33).

In this dissertation, this unique glazed pottery example could not be further investigated scientifically due to the restrictions of the Hatay Archaeology Museum. But if Peltenburg was right in his scientific examination, it would mean that either the Alalakhian crafts or crafts somewhere around the region achieved an advanced stage of glazing pottery, whereas Mesopotamian and Egyptian craftspeople dealing with glazing could not overcome the problem of adhering the glaze to the clay body, so the common media was quartz and steatite. Furthermore, it is not only Alalakh, but also a tripod bowl from Nuzi (Starr 1939: 23, pl. 92x), other fragments from Ashur (Haller 1954: 115), and Tell al-Rimah (Carter 1967: 286) that show a step forward for this technique.[132]

4.3 Stylistic and Typological Similarities of Tell Atchana, ancient Alalakh with its Neighboring Sites

Alalakh is one of the sites that yielded the earliest vitreous examples of its type such as core-formed glass vase and the figurines. Both of the earliest examples

[132] This method was mastered by the Assyrians after the 7th century B.C. by adding lead to ordinary glass and preparing the core-clay with copper acetate, which was guarded as a secret since the Babylonian tablet.

were found in Level VI indicating an established infrastructure for vitreous industries since that level at the site if not earlier.

In section 4.1 and in its subsections, I presented vitreous artifacts recovered by Woolley within the limits of his publications and my later observations done in 2012–2014 in the museums. I also provided parallel examples from the neighboring regions and settlements mainly for the artifacts, which could be considered as significant such as female figurines or hub-beads.

On the other hand, several vitreous artifacts such as lentoid beads, ring beads, tubular beads, spacer beads, amulets, or pendants were less emphasized above. It is not because these artifacts are less important, but because these artifacts are very common in almost all of the second millennium B.C. settlements. Rather than listing each single bead, pendant or amulet, a general view to these types seem more rational. Acemhöyük (Özgüç 1968; Özgüç 1986b), Alişar (Schmidt 1932; von der Osten 1937), Boğazköy/Hattusha (Boehmer 1972; Baykal-Seeher and Seeher 2003), Konya Karahöyük (Alp 1954, 1968), Kültepe/Kanesh (Özgüç 1986a–b), Gordion in Anatolia (Mellink 1956; Özgüç 1986b), Assur (Andrae 1922, 1925, 1935; Beck 1934; Haller 1954; Haller and Andrae 1955; Edzard 1964), Chagar Bazar (Mallowan 1937, 1947), Mari (Parrot 1975), Nineveh (Thompson and Mallowan 1933; Perkins 1949; Stone and Thomas 1958), Nuzi (Starr 1939; Vandiver 1982), Tell al-Rimah (Carter 1967; Oates 1982), Tell Brak (Oates 1987), and Tepe Gawra (Tobler 1950) in northern Mesopotamian, Eridu (Hall 1930; Barag 1985), Kish (Mackay 1925, 1929; Watelin 1934; Pollard and Moorey 1982; Kaczmarczyk and Hedges 1983; Caubet and Kaczmarczyk 1989), Nippur (Neumann 1927; Gibson 1990; Vandiver and Yener 2009), and Ur (Woolley 1965, 1974, 1976) in southern Mesopotamia, Ebla (Matthiae 1980), Oylum Höyük (Engin 2014), and Tell Chuera (Moortgat 1967; Moortgat and

Moortgat-Correns 1976) in northern Syria, Byblos (Dunand 1958), Megiddo (Loud 1948; Barag 1970), and Ugarit (Matoïan 2003; Matoïan and Bouquillon 2003) in the Levant, and Malkata (Lucas and Harris 1962; Nicholson 1993; Shortland 2012), and Amarna and Qantir (Petrie 1894; Nicholson 2007 with references) in Egypt yielded assemblages of beads made out of frit, faience and/or glass with the same typology. Similar typologies could be found in various media such as ceramics, stone, and metal.

4.4 Part II: History of Scientific Research on the Vitrified Material Assemblage

4.4.1 Peltenburg's Comments on Glazing Technology

Archaeometric research on Alalakh vitrified materials and production technologies started at the end of the 1960s when a limited assemblage and selected artifacts were considered. Peltenburg is the first scholar who commented on the technology of the Alalakh vitrified material assemblage. He reported on the glazes of Alalakh and defined the Alalakh glazed pottery (ATP/38/218) from Level IV as alkaline glaze, contrary to Woolley who suggested the use of lead glazing at Alalakh (Peltenburg 1969: 80, n. 33; Woolley 1955: 299). For such a statement, Peltenburg discussed the analysis of the glazes though he did not clearly define any scientific background of these interpretations nor did he explain any methodology, which raises questions for the information he provided. Peltenburg also remarked on the glazing technology of Alalakh where he noted that the glazing technique used at Alalakh to produce faience was the direct application of glazes to cores.[133] On the other hand, he documented the information with the remark "unpublished" (Peltenburg 1971: 9) and he did not publish any details of this statement in another

[133] For the direct application technique, please refer the section on manufacture of faience section in Chapter III.

article. It is therefore not clear on which bases he founded his statements; he could have conducted scientific examinations, which he was about to publish, he could have grounded his arguments on regular examination of the artifacts, or he could have reflected possible personal communications with Woolley, who passed away almost a decade prior to Peltenburg's 1970 publication.

4.4.2 Barag's Typological and Scientific Research on Alalakh Glass

In *Glass and Glassmaking in Ancient Mesopotamia*, Barag wrote a chapter on Mesopotamian core-formed glass vessels (1500–500 BC) in 1970 (1985), where he dedicated a section to Alalakh glass artifacts.[134] He typologically examined sixteen bottles, goblets, and glass fragments, most of which were reexamined in detail in Barag's catalog of *Western Asiatic Glass* (1985). Barag defined Alalakh as "outside Mesopotamian" settlement with local Mesopotamian glass products (1970 [1985]: 135). He referred to the chronological levels of Alalakh as complex, but in terms of glass, the main consideration that he made was the appearance of this material as early as Level VI (1970 [1985]: 150, fn. 93). The typological investigations on the glass artifacts let him put forward a chronological synchronism between Alalakh Level VI–V and Megiddo IX, which he accepted as dated to 1550–1470 BC. Barag argued that glass vessels started to be produced in Mesopotamia and Egypt at the end

[134] This booklet was also published as a chapter in *Glass and Glassmaking in Ancient Mesopotamia* by A. L. Oppenheim, R. H. Brill, D. Barag, and A. von Saldern (1985). The *Glass and Glassmaking in Ancient Mesopotamia* monograph was actually published in 1970, though due to Hurricane Agnes in June 1972, the entire book stock in the Corning Museum of Glass was swept away. In 1985, the book was republished. Even though scholars refer to the 1970 volume, this edition is very rare in the libraries. The author found Barag's booklet (1970) in UCL libraries, but the rest of the book used in this dissertation is the 1985 edition. Thus, in this dissertation it is cited as 1970 [1985]. The page numbers are cited according to the 1985 edition.

of the 16th century BC and provided a comparative study including Nuzi, Tell Brak, Tell al-Rimah, and Egypt, which this dissertation touches upon in Chapter II.[135]

The first scientific examination on a vitreous find was done by Ian Freestone and published as an appendix in Barag's catalog (1985) as a "small glass cake ingot." The analyzed object was the glass ingot from Alalakh, currently in the British Museum (registered in 1951 as 0102.115; BM number 136578, catalogue number: 436). The object is a remarkable and important artifact that has long lain unstudied.[136] Woolley did not report the recovery of this piece though Barag documented its inventory from Woolley's index cards at the University College London. According to the index card information, the red glass fragment was recovered from the floor of the Level IV palace, Room 30 (Barag 1985: 111, no. 111). It may thus be roughly dated to the late 15th century BC, whereas new expeditions will clarify the chronology of this palatial area, too.[137]

Tell Atchana red glass is a difficult and poorly known topic, which, as a student of the site's vitrified materials, I have focused on investigating. In the appendix of Barag's catalog, semi-quantitative (SEM–EDX) scientific analyses done by Ian Freestone were provided (Barag 1985: 122) without a contextual and broader examination of the artifact.

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[135] Brill and Stapleton (2012) referred to the scientific analysis in Barag (1970), whereas there was not a scientific investigation on Alalakh material by Barag. Barag's examination depended on typological observations.

[136] The acquisition date of the object by the British Museum is 1951 when Woolley's excavation campaigns had been over for almost two years. Either the museum personnel registered it much later than it was acquired, or Woolley turned the piece in to the museum two years after his excavation was completed in 1949.

[137] http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=1490350&partId=1&searchText=alalakh+ingot&page=1

In February 2014, I was privileged to visit the British Museum depots and take new photographs of the object.[138] Touching this unique glass artifact changed my ideas of referring to this piece as a baked cake-shaped ingot (Barag 1985: 111). As the new photographs in Appendix I show, this glass artifact is very small. According to the British Museum online records, it is 3 x 2.8 x 0.8 cm and has a 7.8 cm diameter. It is almost rectangular with four distinct sides and the surfaces could be considered as fairly flat. When compared to the Uluburun glass ingots, it is hard to refer to this piece as an ingot. Additionally, my observations both with the naked eye and with the aid of a binocular microscope show that there is clay residue on the surface of the artifact. That clay surface led me to argue that this piece could be not an ingot, but the remains of red glass on the base of a broken crucible. The clay surface is vitrified and seems slightly more curved than the upper surface, which is perfectly flat. Furthermore, the edges of the artifact support the idea of it being broken residue rather than an ingot.[139]

The piece is freshly broken into two. It cannot currently be determined whether it was broken during Woolley's excavation, when later research done on the artifact between 1949 and 1955, or during scientific analysis. Online records of the British Museum confirm the broken condition. A triangular fragment is missing between the junctions of two pieces, which was probably taken for scientific analysis (see Barag 1985, analysis in appendix by Freestone). Freestone reported that the XRD analysis on the freshly broken section at the center of the red glass indicated

[138] At the end of February 2014, the British Museum also published photographs of this artifact online.

[139] Professor Julian Henderson explained (while we are discussing another blue fragment) that sharp corners of glass are generally good indicators of crucible fragments.

the existence of cuprite, which is a common crystal for the red-colored glass of the Late Bronze Age.

There is only a small amount of red glass surviving in the middle of the piece. The rest (the green parts) is highly weathered and the colors include a wide range of greens and yellowish greens. Shoer and Rehren observed a similar weathering pattern on the red glass of Qantir, where the small preserved red core is surrounded by weathered glass of a different color (Shoer and Rehren 2007; see fig. 4). However, the colors of the weathered sections of the Alalakh and Qantir samples are completely different. The colors of the weathered portions of Qantir glass are light green and turquoise, whereas weathering on Alalakh glass is mainly emerald green. This variation may result from the differing chemical composition of these glasses, and additionally from the weathering conditions of the depositional context where the pieces were found.

To investigate the chemical compositions of Late Bronze red glass, I have created a chart comparing the levels of iron oxide and aluminum oxide. These two oxides vary generally in the glass compositions of different settlements and their relative presence in glass may be used as a scientific tool to suggest use of different raw material sources and especially silica (sand) for glass artifacts. The iron and aluminum levels may reflect different preferences or availability for raw materials in different production zones of glass, where both iron and aluminum can be considered a contaminant in local materials. Mesopotamian glass of green and blue color is generally known for low levels of aluminum whereas Egyptian glass has higher levels (higher than 1%). In terms of iron, both Mesopotamian and Egyptian glass tended to have lower than 1% iron oxide as an impurity (Shortland et al. 2007).

Currently there is no trace element data available for the red glass of Alalakh to allow a comparison with other regions' samples. An alternate angle of analysis is comparing changes in the major and minor elements, which also carries valuable information for basic regional comparisons in glass composition and production.

While glass is composed primarily of silica, soda, and lime, iron and aluminum are two critical elements that may contribute to glass compositions, most possibly as impurities in the sand. It is also possible that iron and aluminum may have been added glass as impurities in colorants that are metal oxides in form of ores. Comparison of just these two oxides provides evidence that Egyptian and Alalakh red glasses have significantly different chemical compositions in iron and alumina (fig. 4.1). Egyptian red glass is generally known to have low iron and aluminum. As the chart in figure 4.1 shows, Egyptian red glass contains low iron whereas Alalakh glass is higher in iron, but has a slightly lower aluminum concentration.[140]

Unfortunately, there has not been any scientific analysis of Mesopotamian red glass that could be compared with the Alalakh and Egyptian red glass.[141] Research in Mesopotamia has been mostly done on blue and turquoise glass as Late Bronze Age red glass is a rare find.

Based on the research done so far, we can say that Alalakh and Egypt were producing red glass with different compositions, which may signify the use of different raw material sources and/or glassmaking recipes.

Even though Qantir was dated slightly later than Alalakh, it could be used as a valuable example to understand possible red glass production at Alalakh. Rehren

[140] At Alalakh, NAA (Neutron Activation Analysis) and XRF (X-Ray Fluorescence) tests on local ceramics have revealed high levels of iron and also aluminum (Erb-Satullo et al. 2010; Dardeniz 2013).

[141] A red glass sample of unknown provenance, shown as a green triangle in figure 5, is argued to be of Mesopotamian origin (Shortland and Eremin 2006).

suggests a specialized red glass production at Qantir (Rehren 1997). Based on scientific and archaeological research, Rehren's theories on specialized glass coloring workshops were accepted among the glass scholars. If he is correct in his theory, then since the British Museum artifact from ancient Alalakh provides earlier evidence for locally made (?) red glass, it may be used as an indication of technology transfer from Anatolia and the Levant to Egypt in terms of color-specialized glass production. It is also a possibility that Alalakh imported red-colored glass from somewhere else in Mesopotamia, but not Egypt. Even though Mesopotamian red glass production indicates a different recipe than Alalakh, the limited number of red glass samples evaluated here is not enough to provide a final conclusion. However, it is important to underline that the evidence to argue for a color-specialized production does not exist at Alalakh at this stage.

Research done on the primary catalogs of Late Bronze Age glass, together with observations of the red glass artifact in the British Museum, have led me to argue that this Alalakh glass "cake" ingot is not an ingot but a remnant of a fragment from a crucible.[142] If this size would have been enough for the red glass to be an ingot, that red glass should have been extremely valuable. It is obvious from its findspot that the Alalakh royal court was using red glass, but to my knowledge there is not a textual record providing an idea of its value.

Compiling rare scientific data on red glass showed that ancient Alalakh had a different glass recipe, or different raw materials, than Egypt. If Qantir red glass may be considered a typical sample of the long-term tradition of red glass production in Egypt, than Alalakh red glass shows an idiosyncratic production pattern not similar with Egyptian counterparts. Red glass found in Alalakh could have been locally

[142] It would be better not to further elaborate on this as either a glassmaking or glass-working crucible. There is not enough evidence to argue more.

produced or an import from somewhere in Mesopotamia like Tell Brak or Nuzi, which were generally famous for their blue glass, but not known for their red glass.

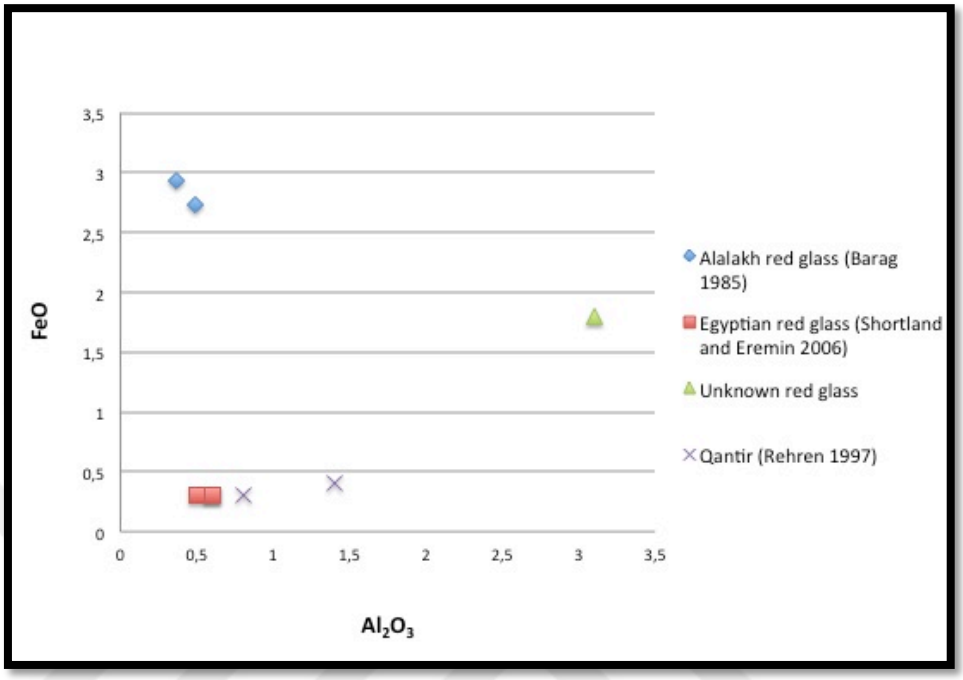

Fig. 4.2: Levels of FeO vs Al_2O_3 in the LBA red glass samples. The analysis of Alalakh red glass shows significantly high iron compared to Egyptian examples (chart made by the author).

4.4.3 Yener's and Walton's Archaeometric Research for the 2003–04 Excavations Vitreous Materials

The 2003–04 excavations vitrified corpus became a part of the small finds chapter in the first Alalakh monograph (Yener 2010a). Particular attention was drawn to three artifacts: one polychrome glass fragment with alternating blue and white twists (A03-R1380), one glass artifact resembling a key, and another resembling a double-ax (A03-R1512) (Yener 2010a: 107). Yener referred to the possibility of local vitrified material production at Alalakh with reservation. She mentioned ongoing XRD and XRF analysis (probably the ones continued by Walton at the time) on pyrotechnological installations excavated in Areas 2 and 3, where silica-rich material exposed to high temperatures were observed as an indicator of the fact that high temperatures had been reached at the excavated pyrotechnological

installations.[143] Kiln linings, slag, and vitrified material were investigated in more detail confirming possible vitrified material production at the area (Dardeniz 2012, 2013).

Mark Walton became interested in the Alalakh assemblage in 2007 when he was doing his research at the Getty Conservation Institute. He analyzed some remains excavated in the 2003–04 excavation seasons at Alalakh from the area called the "craft quarter." Based on the high content of iron in his analysis, he suggested a metallurgical operation at the area. The same area was the subject of the author's MA thesis and a vitreous production was suggested at this area and the details of this research are discussed below.

Walton analyzed a group of materials from Temple 7 of Alalakh by a portable XRF[144] at the Getty Conservation Institute Museum Research Laboratory and wrote a report about the initial results on June 13, 2007. Based on this initial report, the glass of Alalakh is plant ash based.[145] He later put down a proposal on the technical analysis of Alalakh vitreous material, especially glass vessels and polychrome beads, where he suggested EPMA and ICP–MS analyses on the corpus. However, Walton did not continue his research and did not publish any of his findings in detail. In this dissertation, none of the Walton's analytical results were used since all of the information is still his intellectual property and waiting to be published.

[143] Ian Freestone commented on the materials from one of the installations (Installation 2) through e-mail correspondence with Yener in November 2006. He suggested that Installation 2 is a ceramic kiln since the temperature that the kiln reached was 800^{o} C. Freestone is right in his suggestion for Installation 2, though he did not work on the other installations. Freestone also mentioned the similarity between Alalakh Installation 2 and Nuzi kilns (Starr 1939: 54–55, pl. 22B).
[144] The portable XRF he used is a Keymaster Tracer III–V portable model.
[145] He also analyzed bone, ceramic, and a metallic inlaid eye.

4.4.4 Brill's Chemical and Isotopic Characterization on Alalakh Glass

Robert H. Brill of the Corning Museum of Glass, Corning, New York, USA, procured a set of samples on October 1, 2009,[146] from Yener labeled as WD2009 (Brill and Stapleton 2012: 46). WD refers to the Woolley Depot and Yener probably selected the samples while she was organizing the new Alalakh dig house depot. Brill and Stapleton reported all of the samples as very small and some as mostly weathered. There are 28 samples including transparent blue, opaque yellow, opaque white, and amber-colored glasses together with green and brown materials, flakes of debris, and weathering products (Brill and Stapleton 2012: 46). Elemental analyses were conducted on the samples and some samples were selected for X-ray diffraction (XRD), lead isotope, and strontium isotope analysis. None of the samples were exactly attributed to levels by Brill; only the laboratory and analysis numbers are provided, such as 7161 (AY-S1), 7188 (AY-S28), and so forth. Thus, the Brill samples are missing clear archaeological contexts. Among the 28 samples, the results of six of the samples were listed: two with quantitative system analysis (QSA), two with microprobe, one with both QSA and microprobe, and one with quantitative analysis (Brill and Stapleton 2012: 46). The rest of the analytical information together with the results of three lead isotope and three strontium isotope ratios were published as a report by Brill (Brill and Stapleton 2012: 262–68). Based on this report, one sample with laboratory number 7179 was analyzed with inductively coupled plasma (ICP) and ten samples (laboratory numbers[147] 7161, 7162, 7164,

[146] Brill and Stapleton (2012) noted the arrival of the samples in 2010 on page 263. The samples must have arrived sometime at the end of 2009 or the beginning of 2010.

[147] In order to prevent confusion between the museum and Yener's inventory numbers and Brill and Stapleton's laboratory numbers, this reference is used for each sample.

7175, 7176, 7178, 7179, 7180, 7184, 7188) were analyzed with X-ray fluorescence (XRF).[148]

Based on the elemental analysis, Brill suggested that most of the objects came from only a few parent objects rather than all being different artifacts (2012: 263). The mean composition of Alalakh glass was calculated based on three samples[149] and were found as 67.10% silica, 17.87% soda, 6.03% lime, 3.69% potash, 3.98% magnesium oxide, 0.75% alumina, and 0.58% iron oxide. Brill stated these results as consistent with Barag's suggestion of Alalakh glass as Mesopotamian, probably originating somewhere from the region (Barag 1962: 20–21; Brill and Stapleton 2012: 264).

According to the analytical results that Brill and Stapleton provided, for transparent blue-colored glass, copper was used as a colorant. As an opacifier for white opaque glass, antimony (Sb) was used in the form of calcium antimonite ($Ca_2Sb_2O_7$). The use of antimony was confirmed through XRD analysis.[150] For the amber color, an iron-sulfur complex was suggested as colorant. Antimony and lead (Pb) were detected in yellow opaque samples (laboratory numbers 7164 and 7188), where lead was responsible for the yellow color and antimony worked as an opacifier. A green weathering product (laboratory number 7180) was found as rich in copper and was argued to be a weathered fragment of red glass. Another green material (laboratory number 7162) was found rich in iron.

[148] Analyses of Alalakh samples were conducted through collaborators of Brill and Stapleton. To see the collaborators, refer to Brill and Stapleton 2012: 263.
[149] These samples are the samples with laboratory samples 7176, 7184, and 7185. Among those, 7184 was analyzed twice. The reasons why Brill and Stapleton choose those samples are not clarified. It might be the well-preserved condition of the samples. 7176 is transparent blue colored. 7184 is amber colored with opaque white decorations. 7185 is amber colored (Brill and Stapleton 2012: 46, 263).
[150] For details of XRD analysis, please refer to the scientific methodologies chapter.

Strontium $^{87}Sr/^{86}Sr$ ratios were also used in this research for three samples to investigate further the possible origins of Alalakh glass.[151] The isotopic values for amber-colored (laboratory number 7161), blue-colored (laboratory number 7173), and white-colored (laboratory number 7187) glass were found as 0.707920, 0.707835, and 0.707854, respectively. These ratios match the strontium values of the Mesopotamian glass from Tell Brak and Nuzi analyzed by the authors (Brill and Stapleton 2012: 266).

Three glass fragments (laboratory number Pb 3500, Pb 3501, and Pb 3502) were also subjected to lead isotope analysis. Among those, Pb 3502 (laboratory number 7175), which is an opaque white glass, falls into a group that Brill described as Type-M Mesopotamian, whereas the other two samples show a completely different picture. According to Brill, values obtained from samples Pb 3500 and Pb 3501 fall in a different group,[152] which is surprisingly close to Nimrud glass inlays of ivory.[153] Even though Brill suggested western Iranian sources for the lead in the Alalakh glass, broader research on lead isotopes is necessary for the vitreous material corpus of Alalakh. Furthermore the technique lead isotope technique has also problems reflecting directly its archaeological interpretation. For example, ores from different regions but from a similar geological formations provide same isotopic values or use of any recycled metal will misrepresent possible source(s). Thus, the lead isotope data must be interpreted more cautiously.

In the conclusion of his report, Brill stated the necessity of further scientific research and wrote, "what fine postdoctoral projects such studies would be" (Brill in

[151] For the method and archaeological importance of the strontium isotope for ancient glass research, refer to the scientific methodologies chapter.
[152] Brill defined these lead isotopic groups of Nimrud as Type-E and Type-S. For definition of isotopic groups, see Lilyquist and Brill 1993.
[153] The lead isotopes of inlays were outliers to general isotopic values of Nimrud glass.

Brill and Stapleton 2012: 268). It is interesting that the publication of Brill and Stapleton's volume and the initiation of this dissertation were at the same year.

4.4.5 Dardeniz's Study on the Pyrotechnology

Lastly, the pyrotechnological units excavated in Area 2 of Alalakh in the 2003–04 excavation seasons established for the first time the possibility of local vitreous material production at the site. The archaeological context and the details of the scientific investigations done on the installations have been published elsewhere (Dardeniz 2012, 2013, forthcoming (a)). Briefly, the wall linings and slag of three installations out of eight were analyzed with a scanning electron microscope (SEM), XRD, and XRF (Dardeniz 2012, 2013, forthcoming (a)). The SEM results indicate high temperatures confirming the capacity of the pyrotechnological installations in achieving high degrees. The XRD patterns show the presence of diopside and augite, two phases familiar to the devitrification of glass phases. These minerals are also intermediate phases of glassmaking, which point out consistent evidence for the possibility of glass making, though not necessarily proving glass making.[154] These analytical results demonstrate that the vitreous slag found in one of the installations (Installation 5) of Area 2 dated to the Late Bronze Age II period yielded evidence of possible vitrified material/glass-related activity practiced in and around the installation. This study led the author to focus on vitreous material crafting at Alalakh as the subject of her dissertation.

[154] The analytical results were discussed with R. H. Brill in March 2012 through e-mail correspondence.

CHAPTER V:

ARCHAEOLOGICAL CONTEXTS WITH VITREOUS REMAINS

Beyond the activities of great powers, kings, and states (see chapter II), everyday life in Syria, Mesopotamia, Anatolia, the Levant, and Egypt actually carried on following similar patterns. While there were differences between the lifestyles at various levels of society, the majority of the population must have experienced a common lifestyle, such as being a farmer, herder, or craftsperson.

The most of the second millennium B.C. texts mention the activities of kings, their courts, and high-status people. Monumental architecture, like palaces, administrative buildings, or temples, mostly provides information on higher status individuals (Shortland 2012). On the other hand, information on other segments of society, among which crafts might have played a significant part, is hidden in the archaeological record.

Archaeologists of the early 20th century did not pay much attention to the houses, activities, and common lifestyles of the non-elites. In the last few decades, especially with the increasing influence of household archaeology, there has been growing interest in the records left by ordinary people. Archaeological excavations focusing on non-monumental and non-elite architecture started to reveal insights about everyday lifestyles within which workshops producing pottery, metals, stone, textiles, and other materials like glass, faience, and frit were significant (Shortland

2012: 37–38). These craft-related zones are not only crucial to understand ordinary lifestyles, but they also indicate parts of social systems where the production of various goods might be used within a settlement or might be introduced into a network of trading, which is another way to enrich exchange systems. Thus, an examination of crafts and craftspeople provides information for two dimensions: first, how ancient craftspeople lived and produced items; and, second, how goods were interlinked within the economic systems. Vitreous materials, considered luxury commodities, were produced and traded within economic systems, such as the long-distance trade of the second millennium B.C. Thus, the detailed examinations of archaeological contexts that bear vitreous materials are important to understand such dynamics.

This chapter introduces the archaeological contexts that have yielded vitreous materials at Tell Atchana, ancient Alalakh. Only some of the contexts with glass, faience, or frit finds reveal production areas or installations. In this section, the main focus is on the contexts where a Late Bronze I (LBI)–Late Bronze II (LBII) transitional period workshop with pyrotechnical installations and various production activities has been recovered. Within the limits of this dissertation, only vitreous artifacts and relevant associated remains are discussed. Archaeological features and ceramic, bone, stone, or metal corpora revealed at the contexts are subject to ongoing research. Furthermore, production activities, which must have been performed along with vitreous material manufacture, are the subject of other dissertation(s). A theoretical assessment of the integrated crafting and multi-functional production areas is provided in chapter VIII.

5.1 The Middle Bronze II (MBII) Contexts

So far, the earliest known levels of Tell Atchana, ancient Alalakh, are the MBII contexts, where only four objects were recovered during the Yener excavation campaigns. The MBII vitreous assemblage was all collected in Area 1. Out of four artifacts, three of them were found in Square 33.32. All of these objects are faience. Among these artifacts of 33.32, AT 8957 (catalogue number: 3) is a horn-shaped decorative fragment whereas the other two are beads.

One object, including fragments of two or three beads (AT 15825, catalogue number: 4), was recovered in Square 32.57. All of the fragments of AT 15825 are turquoise-colored glass. It is important to underline that the existence of glass in the MBII context is unique at this stage for the settlement; however, it is not possible to suggest any further theories regarding the emergence/production of glass in this premature stage of evidence for MBII glass. As mentioned in detail in chapter IV, a unique reference to polychrome glass beads from the Level VII temple (Lilyquist 1993: 56) was not confirmed. Thus the evidence of MBII glass at Alalakh is weak for the time being.

All of the MBII artifacts were found in mixed archaeological contexts. In the excavation system at Tell Atchana, the specialists defined/used “mixed context” to refer to archaeological deposits that could not be securely dated due to the nature of the deposit, which was usually disturbed due to natural and cultural formation processes. Thus it is not possible at this stage to consider the existence of any local production centers for vitreous artifacts. Recovering all of the MBII objects only from Area 1 of the mound does not indicate that vitrified assemblages are unique to that zone; this is because the Yener excavations reached the MBII contexts only in Area 1 between the 2004–2014 excavation campaigns.

5.2 The Middle Bronze II (MBII) – The Late Bronze I (LBI) Transitional Periods Contexts

In the transitional period from the Middle Bronze II (MBII) to the Late Bronze I (LBI), three objects were recovered during the Yener excavations. All of these objects were found in Square 45.44 of Area 3. Among those, AT 19269 (catalogue number: 7) includes two glass beads and a fragmentary faience bead. These objects were recovered in the discrete context of a grave (Locus 152, Lot 691) along with 22 stone and shell beads. AT 18693 (catalogue number: 6) is also a glass bead and AT 18071 (catalogue number: 5) is a frit bead. However, both of the objects were recovered from mixed archaeological contexts.

Based on the information obtained thus far from the excavated MBII–LBI transitional phases of Alalakh, all types of vitrified material exist simultaneously at the site. However, three objects from a specific part of the mound are not sufficient to elaborate neither on their production technologies nor statistically significant enough to make additional suggestions.

Like the MBII contexts, the recovery of transitional period artifacts solely from Square 45.44 in Area 3 does not suggest that vitrified assemblages are unique to this zone, but rather it has to do with the fact that the Yener excavations only reached these transitional period contexts for Area 3 during the 2004–2014 excavation campaigns.[155]

It is important to note that in the 2015 season, the LBI–MBII levels were reached in Area 4 in Square 64.72 and frit, faience, and glass objects and fragments were recovered from that area. However, the excavation director decided that the

[155] Square 45.44 continued to yield vitreous artifacts, especially beads, in the LBI and LBII periods.

assemblage used in this dissertation would exclude finds after 2014 (but including 2014 season finds).

5.3 The Late Bronze I (LBI) Contexts

In terms of the number of artifacts, the Late Bronze I (LBI) period offered a rich corpus. A total of 213 artifacts were recovered from Area 1, Area 2, Area 3, and Area 4. Divided among 16 excavated squares, 14 artifacts from 32.34, 53 from 32.57, one from 32.53, eight from 32.54, four from 32.59, eight from 32.59/60, 34 from 42.29, ten from 43.54, nine from 44.85, four from 44.86, four from 44.94, six from 44.95, two from 44.96, 16 from 45.44, one from 45.45, and 29 from 64.72 were collected. The pattern of distribution according to area is shown in figure 5.1.

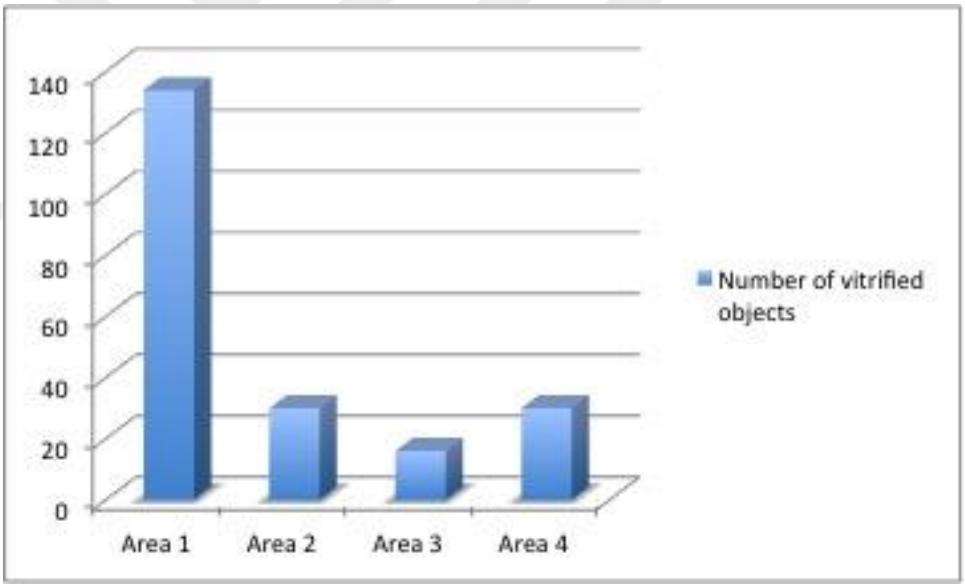

Fig. 5.1: Distribution of LBI artifacts among the excavated sections of Areas 1–4.

As figure 5.1 clearly demonstrates, Area 1 has the densest accumulation of vitreous artifacts dated to the LBI levels. This is due to the excavation strategies, which specifically focused on the LBI levels mainly in this sector of the mound. As the discussions in sections 5.4 and 5.5 will show, even though the LBI phase is less densely represented in Area 4, this sector has potential for vitreous materials production.

Of the squares located in Area 1, Squares 32.34 and 32.54 have a limited corpus mostly bearing glass beads. AT 10424 (catalogue number: 21) is a unique faience vessel fragment recovered in Square 32.34. This is a small fragment of a vase with white surface color and wavy, amber-colored decoration. This decoration is common among glass vases, though this is a faience example. Its clay core is visible on one side of the fragment. This is an important fragment since it offers evidence that similar designs were applied or at least had been tried to be applied both on faience and glass vases in the LBI. However, the artifact was found in a mixed context. In Area 1, the densest accumulation of vitreous artifacts was unearthed in Square 32.57. The most significant artifact is a faience cylinder seal (AT 4373, catalogue number: 72) from a mixed context. The seal was found in association with a frit bead (AT 4390, catalogue number: 73). Another important archaeological context in this square is locus 65 (lot 662), which was a pit floor that yielded glass and faience beads (AT 10773, catalogue number: 83; AT 10774, catalogue number: 84; AT 10775, catalogue number: 85; AT 10777, catalogue number: 86; AT 10778, catalogue number: 87; and AT 10779, catalogue number: 88).[156]

In Square 42.29, AT 10339 (catalogue number: 105) and AT 10341 (catalogue number: 106) are two important artifacts for glass studies. Both of these are blue-colored glass rod fragments with a length of approximately 1.5 cm. These glass rod fragments in the LBI contexts suggest that glass-related activities were mostly in the form of glassworking rather than glassmaking because there has been no evidence to support the latter for the LBI. Even though the excavation of a dump area in locus 31 of the square yielded metal, pottery, worked stones, and slag with

[156] Square 32.59/60 yielded seven glass and faience beads from mixed contexts; thus they are not described in detail within this chapter.

three glass beads (AT 17181 and AT 18235, which has two glass beads; see catalogue number: 114), this corpus is still not enough to push the claim for such practiced activities. Another significant artifact from Square 42.29 is a faience cylinder seal (AT 16570, catalogue number: 108). The area also yielded glass and faience beads of various types (barrel, spheroid, and ring beads). In locus 34 of the square, a pottery kiln was excavated with collapsed bricks and ceramic fragments; a glass bead was also unearthed (AT 18736, catalogue number: 124). The artifact could not be made available for a detailed examination to assess whether it was a vitreous artifact or vitrified ceramic. A human burial (locus 44/lot 237) yielded 11 glass, faience, and frit beads that were probably the fragments of a necklace. The beads are ribbed, spherical, or olive pip shaped, but most of them are heavily weathered. Such burial gifts also support the appreciation of the vitreous artifacts as grave goods in the LBI. AT 19306 (catalogue number: 131), AT 19312 (catalogue number: 132), AT 19314 (catalogue number: 133), AT 19320 (catalogue number: 134), AT 19322 (catalogue number: 135), AT 19323 (catalogue number: 136), AT 19326 (catalogue number: 137), and AT 19333 (catalogue number: 138), which contain complete and fragmentary glass and faience beads, were found in a dumping area (locus 41/lot 239) in Square 42.29.

Squares 43.54, 44.85, 44.86, 44.94, 44.95, and 44.96 yielded vitreous beads and bead fragments mostly from mixed and poor contexts. There is only one object worth mentioning here: AT 15448 (catalogue number: 168) from Square 44.86, which is a glass vase fragment with a blue base and yellow (amber) zigzag decorations. This artifact has similar patterns to the faience vase (AT 10424, catalogue number: 21) excavated in Square 32.34.

In Area 3, Square 45.44, which is part of the burial area of the mound, is rich

in vitreous artifacts. In locus 21 (lot 66), 23 glass beads and one faience bead (AT 3225, catalogue number: 184) were recovered from a burial with a mixed context. Another human burial (number 08-04 in locus 55), yielded a group of glass, faience, stone, and metal beads (AT 4959, catalogue number: 189). Similarly, human burial 08-12 in locus 71 yielded 116 faience beads of various shapes, sizes, and colors (AT 7659, catalogue number: 192). Square 45.45 yielded vitreous materials as grave goods. AT 7910 (catalogue number: 196) included 24 beads of various types, sizes, and materials, including faience, stone, and shell beads found with human burial number 08-01. These two squares evidence the use of vitreous beads as grave goods along with metal, stone, and seashell beads in LBI Tell Atchana, ancient Alalakh.

In Area 4, Square 64.72 is the only area that had LBI levels during the 2004–2014 excavation seasons at the site. Most of the square's assemblage includes glass, faience, and frit beads (only two frit beads were recovered in the LBI context of the square); however the contextual information of these finds is still being processed at the time of this dissertation. Besides beads, a very fragile glass vessel fragment (AT 20522, catalogue number: 221) and a faience cylinder seal (AT 19888, catalogue number: 206) with wavy lines, plants, and a human figure were among the noteworthy artifacts recovered in this square. As the following sections (5.4 and 5.5) discuss in detail, Square 64.72 has continuously yielded vitreous artifacts for the LBI–LBII transitional period and the LBII period. Furthermore, craft-related areas were also discovered in the square.

5.4 The Late Bronze I (LBI) – The Late Bronze II (LBII) Transitional Period Contexts

The unique LBI–LBII transition period exists in Square 64.72 in Area 4 located at the southern part of the mound. The 2011 excavations yielded an

incredible amount of glass, faience, and frit artifacts together with the architectural features of a workshop that included a pyrotechnological installation.

The architectural plan of Square 64.72 shows that a kiln is situated near an apsidal structure in the northeastern section and an entrance to a possible room was excavated on southwestern side of the trench (fig. 5.2). The kiln has a diameter of approximately 80 cm, was made of mud bricks, and was almost oval in shape. The kiln suffered from heavy destruction and had been cut by another architectural (most probably pyrotechnical) unit. It is not possible at this stage to comment further on the kiln and its features, such as the level of vitrification or plastering. Compared to the fully excavated glass kilns of Amarna (Nicholson 1997), the kiln at Tell Atchana is heavily damaged. Thus the artifact corpora in and around the kiln are used to establish a solid backbone for production-related activities in the area.

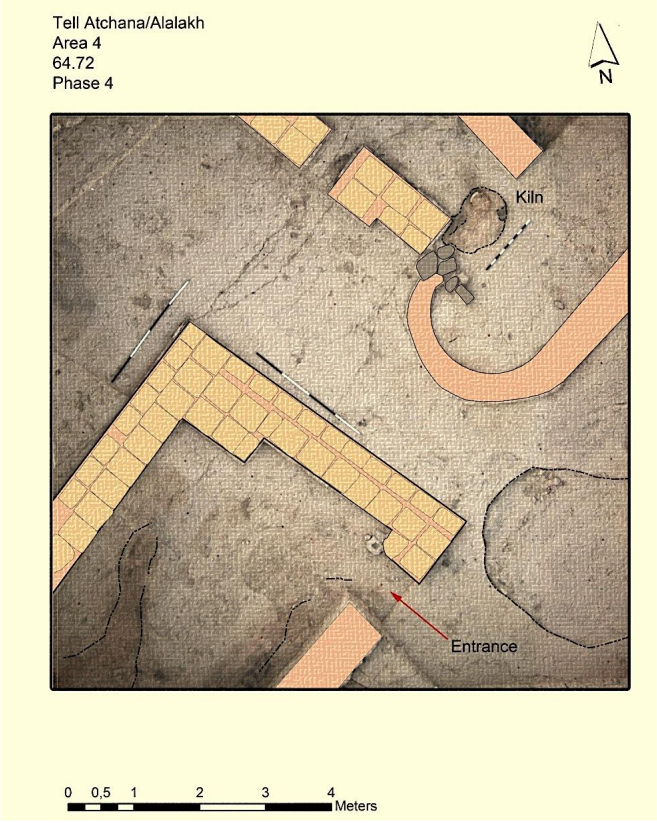

Fig. 5.2: Architectural plan of Square 64.72 (The Alalakh Excavations archive).

In terms of the artifact assemblage, metal fragments have the majority with 143 finds, including copper and bronze pieces with only one lead wire. Beads follow the metal assemblage in number. Most of the beads found in the area were glass, faience, and frit. The rest were made out of stone, dentalium, shell, or carnelian. A total of 326 vitrified objects and fragments within the 102 AT numbered sample bags (some tags contain more than one fragment) were collected from the area by the end of 2011. It is important to note here that pottery or bone fragment bags are not included in this count since this area yielded tremendous amounts of pottery sherds, including material from a possible pottery kiln. Excavations in 2014 reached the floor of the area and fragments of burnt mud bricks were found. On the other hand, a complete ceramic kiln was not recovered. The fragments might belong to a ceramic kiln, but since the later strata damaged them, it is impossible to designate an exact function for the remnants.

Square 64.72 ended up being a fertile area for glassy material; even the first day of the excavation started with a colorful piece of vitrified material (AT 13157, catalogue number: 235) found in the middle of the trench (Locus 55, Lot not given). The southeastern corner of the trench that is located at the southern part of the kiln yielded lots of pottery, burnt pottery sherds, bones, metal fragments, and an ashy layer (Locus 55, Lot 223). Even the supervisor was confused about the accumulation of the assemblage:

> "…there is a huge amount of PT coming out of this lot. We already had opened a Temp Tag half way through." (Square 64.72 field book, p. 31)
> "…what amazes me are the burnt shards and bones coming from Lot 223." (Square 64.72 field book, p. 33)

The northwestern corner of the square is significant since two important artifacts were found in this zone. This part (Locus 61, lots 227 and 230) was

excavated as fine grids and fine grid #3 yielded a piece of Egyptian blue[157] (AT 13915, catalogue number: 240) stuck to mud. Another artifact found in the same grid is one of the milestone artifacts not only for this square, but also for second millennium B.C. glass production in the region. AT 13916 (catalogue number: 241) was a piece of glass stuck on a ceramic sherd, which provides spectacular evidence that glass was being produced in this region. Detailed scientific analysis regarding this piece is discussed in chapter VII. Archaeologically, a similar artifact to AT13916 (catalogue number: 241) was found in Qantir Pi-Ramesse and analyzed by Melina Smirniou and Rehren (2011) and is one of the key artifacts to suggest glass production in 13th century B.C. Egypt. These two artifacts also show the distribution of production-related debris and artifacts in the northwestern corner of the area.[158]

The southwestern part of the trench (southern section of Locus 61) also yielded a similar artifact assemblage in terms of spongy, greenish gray-colored slag imbedded in orange-colored earth (Locus 63, lot 279). Pieces of mud bricks and basalt were uncovered together with glass fragment AT 15065 (catalogue number: 260). This fragment is blue with yellow stripes resembling the decoration of Nuzi glass vases (see chapters III and IV). An object of interest here is a so-called pivot stone with quadratic fashion, which may have been used as a tool for glassworking. Vitreous material workers must have used these flat stones to shape objects like beads or vases; glass crafters may have employed such tools for shaping while the

[157] AT 13915 (catalogue number: 240) was labeled as blue piece of faience by the area supervisor (64.72 field book, p. 39), though I think it is a piece of Egyptian blue. I could not sample the artifact it since it was too tiny – like dust – to analyze.

[158] The soil samples collected from this area (Locus 61, lot 223) should be analyzed for another research project.

glass was still molten and viscous (see chapter III).[159] Furthermore a blue glass (?) fragment (AT 15070, catalogue number: 261) was also found in this locus.

The debris just above the pyrotechnical installation (Lot 70, locus 266) was full of ash, which continued down together with fragments of yellow mud brick, orange-colored soil, bits and pieces of pottery, and frequent amount of bones. Two beads — one faience (AT 14765, catalogue number: 251) and one clear blue glass (AT 14764, catalogue number: 250) — were uncovered here.[160] The removal of the yellow-orange-colored burnt first layer of the pyrotechnical installation (Lot 79, locus 336) yielded faience fragments (AT 16939, catalogue number: 288) and a piece of metal (AT 16940).

The area in direct contact with the pyrotechnical installation is especially important in terms of understanding the use of the working area and activities performed around it. So far, the excavated limits of the installation (Locus 86, lot 319) were orange colored and full of ash that yielded metal (AT 16341) and glass (AT 16343, catalogue number: 277) fragments together with two stones with flat surfaces (AT 16340).[161] In the northeastern corner of the trench just above the installation (Locus 83, lot 314), a glass bead (AT 16318) and some metal fragments (AT16324) were found in relation with yellow mud brick detritus and whitewash traces (Locus 84, lot 314). Glass bead fragments (AT 16333, catalogue number: 276; AT 16334) were also recovered from the same place.[162] A possible extension of the pyrotechnological installation and working space is imbedded inside the northeastern

[159] Flat stones are still in use by glassworkers to shape objects, especially vases. This idea was inspired by my work with Sadi Asfuroğlu, who is a glass artist in Antakya. Several times during our work on a glass vase, he used two flat stones perpendicular to each other to shape the surface of the vase.

[160] AT 14765 could not be sampled since it was intact. AT 14764 was sampled and analyzed. For the analytical results of AT 14764, see Table 1 in the Appendix.

[161] Soil samples taken from this area (AT 16358) could be a part of another research project.

[162] AT 16318 and AT 16334 only mentioned in field notebooks though later records related to those artifacts are missing.

part of the apsidal wall (Locus 89; lots 333, 334, 345) where many glass beads and fragments (AT 16923, catalogue number: 286; AT 16966, catalogue number: 290; AT 16968, catalogue number: 291; AT 16969, catalogue number: 292; AT 16970, catalogue number: 293; AT 16928, catalogue number: 287) were found.

Out of 326 vitrified samples collected from the area, 136 were collected from the aforementioned loci. The remaining 76 samples were distributed in this 10x10 m area without having a special pattern. To confirm that Square 64.72 operated as a glass production zone, further evidence is required both archaeologically and scientifically. The detailed scientific evidence will be introduced in chapter VII.

For the LBI assemblage, a bar graph for distribution is not provided since all the artifacts were collected from the same square. Furthermore, this square and its neighboring squares continued to yield vitreous assemblages in the LBII, which points towards a continuous craft-related zone on this side of the mound.

5.5 The Late Bronze II (LBII) Contexts[163]

In the Late Bronze II (LBII) contexts, a total of 133 complete artifacts and fragments were recovered from Areas 1–4. According to the squares, one artifact from 32.52, six artifacts from 32.53, three from 32.62, four from 32.63, one from 32.64, seven from 42.06, three from 43.54, one from 44.45, two from 44.54, one from 44.55, five from 44.68, six from 44.69, three from 44.79, three from 44.80, one from 45.71, 22 from 64.72, 12 from 64.73, 22 from 64.82, six from 64.83, one from 64.84, and 17 from 64.94 were unearthed. The distributions of the number of artifacts according to area are given in figure 5.3.

[163] For the LBII contexts, a further chronological distinction such as LBIIa-b is specifically avoided in this dissertation. These chronological classifications are useful in archaeological research, such as for ceramic studies, but studies related to ancient glass and vitreous materials are not that sensitive to such specific separations like LBIIa and LBIIb.

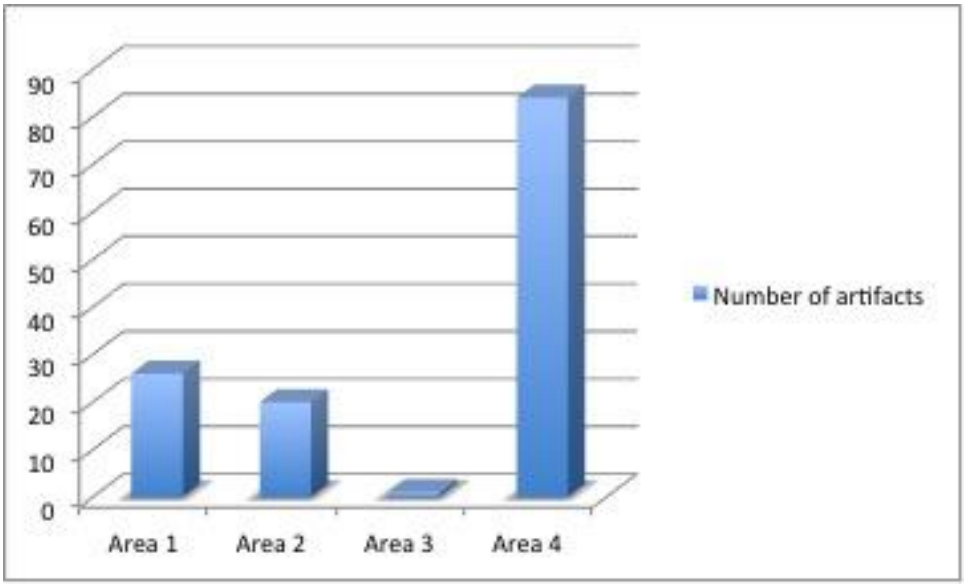

Fig. 5.3: Distribution of LBII artifacts among the excavated sections of Areas 1–4. The number of artifacts was based on number of AT tags. It is important to note that one AT tag might include more than one object. For example, a necklace can have more than a hundred glass, faience, and frit beads, but it might have been counted as one artifact with one AT tag. In this graph, the item tags, which are used as the major excavation data, are shown.

Most of the artifacts were found in mixed or poorly preserved archaeological contexts; however, it is critical to overview the contextual origin of certain artifacts. Square 32.53 yielded a molded glass amulet shaped like a ram's head with slightly visible horns; this artifact is unique. Molded glass artifacts were known from Woolley's excavations — such as the molded female figurines — but small glass molded amulets were rare. The same square yielded a frit and a faience bead as well as three glass beads. Square 32.53 yielded a frit cylinder seal (AT 4546, catalogue number: 302) from a poor context, and a frit and a faience bead from a mixed context. Square 32.63 only yielded two faience and two glass beads with undefined context qualities. Square 42.06 yielded one frit, two faience, and three glass beads; however, the contexts were unidentified when this research was completed. Square 43.54 also yielded a faience fragment possibly belonging a cylinder seal (AT 8296, catalogue number: 318) from a mixed context. The same square also yielded two faience beads and a glass bead. In the Area 2, only glass and faience beads (14

faience and 7 glass beads in total) were recovered from Squares 44.45, 44.54, 44.55, 44.68, 44.69, 44.79, 44.80, and 45.71.

Among the squares, the most relevant to this dissertation is the corpus of Area 4 and especially Square 64.72, which shows a consistent continuation from the LBI to the LBI–LBII transition periods. Therefore, a detailed discussion for the LBII levels of the square is necessary.

Square 64.72 is located in Area 4 on a sloping side of the mound. It had been excavated continuously from 2006 to 2011. Excavations in 2006, 2008, and 2009 yielded LBII levels. In 2011, a glassmaking context, which was dated to the LBII–LBI transition period (see section 5.4), was fully excavated. In 2012 and 2013, the square was not excavated. In 2014, the LBI levels were reached in the square. Excavations in and around the square still continue at the time of this dissertation, but this analysis covers only the vitreous assemblage of the settlement excavated between 2004–2014.

Square 64.72 was opened as a new trench in 2006.[164] It was opened together with 64.82 so that synchronic work could be undertaken in both trenches in order to understand Area 4 to a larger extent. The first vitreous artifact found in this square was a blue faience bead from the topsoil in the middle of the trench (AT 100).[165] In the first year of excavation, another faience bead (AT 446[166]) was found with a Mycenaean type body sherd (mid- to late 14th century B.C.). Even though these two artifacts were recorded in the field books, further information on these two beads was not available in the excavation database or the museum. The first floor level that was reached dated to local Phase 2 of the trench; two tandoors were recovered in a room (in locus 11), but a specific activity was not designated for these installations.

[164] The square supervisor was Ekin Demirci and the square assistant was Nurettin Bataray.
[165] Locus 2, Lot 11. Field book 2006, p. 16. Later records on the artifact are missing.
[166] Locus 4, Lot 18. Field book 2006, p. 26. Later records on the artifact are missing.

The second season in Square 64.72 started after a year-long break. The aim was to understand its relationship with neighboring Square 64.82, to identify the third phase, and to stratigraphically relate these two trenches. In the northeastern part of the trench, excavators recovered tandoor fragments with chipped stones, metal objects (AT 6313, AT 6317, AT 6319, AT 6323), and worked stone objects (AT 6321).[167] The trench supervisor, Ekin Demirci, defined this area as an "activity area" but she did not provide any further information on what type of activity this zone might have supported. On the other hand, the mud brick fragments, which were defined as tanoor or taboon fragments, may have served as a pyrotechnological installation. For this archaeological context, Demirci stated that she recovered lots of worked shells that were mainly white in color and most of them appeared to have holes.[168] Furthermore, bone fragments, pottery pieces, and ash layers were unearthed from the same locus (local Phase 3 or 3b?). In the southeastern corner of the square, a large amount of pottery, chipped stones (AT 6717, AT 6722), bead fragments (AT 6710, AT 6715), and stones were found. The number of the artifacts recovered from that area continued in the deeper lots (for example, AT 6702, AT 6706, and AT 6708). An important object recovered here was a mortar (AT 6709), which is a strong indication of outside production activity; also found here were beads (AT 6719, catalogue number: 353; AT 6720, catalogue number: 354), metal slag (AT 6715), and fragments (AT 6725). Large amounts of sherds were scattered around stones and the area yielded tandoor fragments supporting an open activity area.[169] Lot 162 of locus 40 continued yielding further production activity-related artifacts like pestles (AT 6764, AT 6777) and stone and basalt installations (AT 6770).[170]

[167] Locus 37, Lot 143. Field book 2008, vol. 1, pp. 50–52.
[168] Field book 2008, vol. 1, p. 52.
[169] Locus 40, Lot 155. Field book 2008, vol.1, p. 72.
[170] Locus 40, Lot 162. Field book 2008, vol. 1, pp. 80–82.

More beads (AT 6762, AT 6765), figurines (AT 6766, AT 6778), and metal artifacts (AT 6767, AT 6774, AT 6779, AT 6780) were found in this workshop area. Though the context was mixed at the floor level of the southeastern corner of the square, a glass vessel fragment (AT 7265, catalogue number: 359) was found with smashed pottery, chipped stones, as well as basalt stones. This fragment is a small section of a glass vase probably from where the body ends and the neck starts. It is decorated with white and brownish yellow wavy lines reflecting a Mesopotamian style. In association with this fragment, a faience hub bead (AT 7269, catalogue number: 360) with opaque white and turquoise colors was found. All these artifacts together – metal, stone, pottery, mortars, and seashells – point towards a multi-functional production area. Details will be discussed in chapter VIII, but suffice to say for now that these archaeological contexts have the potential for understanding second millennium B.C. multi-tasking production areas.

Locus 46, which was located at the center of the square, yielded various metal pieces (AT 8036, AT 8037, AT 8039, AT 8040, AT 8044) and bead fragments (AT 8023, catalogue number: 363; AT 8029, catalogue number: 364; AT 8045) dated to local Phase 2 of the trench.[171] One of the most interesting features of Phase 3 was the basalt stones (three fragments with flat surfaces and eight small fragments) recovered from next to the tandoor fragments. These features indicate possible activity areas and might have been used for grinding activities of raw materials. In this locus, in an open space with tandoor fragments, ashy layers and clayish soil, two faience beads (AT 7298, catalogue number: 362; AT 8023, catalogue number: 363), and a glass bead (AT 8029, catalogue number: 364) were recovered. Below locus 46, in locus 55 (lot 206), small amounts of pottery, bones, and lots of pebbles and basalt

[171] Field book 2008, vol. 2, p. 14.

stones were recovered from local Phase 4. However, the general picture of the context could not be clarified in 2008.

Another square in Area 4 is 64.73, which is adjacent to 64.72. It yielded glass and faience beads of various types (AT 2736, catalogue number: 366; AT 3062, catalogue number: 367; AT 3313, catalogue number: 368; AT 3326, catalogue number: 369) from the pits located in the middle of room found at and below locus 7 within ashy, sandy, and brown soil from mixed/poor archaeological contexts. Further examples were recovered from unidentified or mixed contexts.

The archaeological contexts of Square 64.82, where mainly glass and faience were recovered, were unfortunately undefined. An artifact that is noteworthy is an Egyptian blue cylinder seal, which has been registered as faience in the database. Locus 35 yielded a faience bead and two glass beads in association with each other (AT 4844, catalogue number: 386; AT 5850, catalogue number: 387; AT 5885, catalogue number: 388).[172]

In Square 64.94, beads were recovered from topsoil or discrete contexts. In locus 5, in a possible pit with a significant amount of slag, ceramic, and bone remains, two glass beads were unearthed (AT 4112, catalogue number: 414; AT 4117, catalogue number: 415). The most exciting vitreous finds of the square were excavated in a burial belonging to an adolescent under the age of 14 (L25) (Ingman 2014). A single half-bead (AT 17880, catalogue number: 419) and full string of beads made out of glass, faience, frit, stone, carnelian, sea shell, and metal were recovered from the same grave (AT 17881, catalogue number: 420; AT 17883, catalogue number: 421; AT 17884, catalogue number: 422; AT 17892, catalogue number: 423; AT 18612, catalogue number: 424; AT 19151, catalogue number: 425;

[172] Square 64.84 yielded one lentoid-shaped glass bead (AT 18285).

AT 19180, catalogue number: 426). The grave itself yielded 551 complete beads. The grave and its burial practices are beyond this project and they will be a part of other dissertation(s).

5.6 Concluding Remarks on the Archaeological Contexts

This chapter summarizes the archaeological contexts of vitreous artifacts recovered in Yener's excavations at Tell Atchana, ancient Alalakh. Figure 5.4 demonstrated the trend in the number of excavated vitrified materials versus archaeological periods. According to this figure, the MBII period and the transition period between the MBII and LBI yielded a limited number of vitreous artifacts. However, a drastic increase in the number of vitreous artifacts was visible in the LBI (dated to 1500–1400 B.C.). This corresponded to the emergence of glass technology in the region. Based on the pattern displayed in Figure 5.4, it would be logical to argue that use of glass along with faience and frit became widespread in the LBI and this trend continued in the LBI–LBII transition period. However, a decline in the number of vitreous artifacts was visible in the LBII period.

In the LBI, not only the amount of artifacts, but also the types of artifacts also increased. Glass vase fragments and blue glass rods as well as three faience cylinder seals were among the significant artifacts of the LBI corpora. These finds from the Yener excavation campaigns were complementary to Woolley's excavations, which had discovered the first unique examples for second millennium B.C. glass in Levels VI and V (Woolley 1955; see chapter IV).

Figure 5.4 is based on the available archaeological records for the 2004–2014 excavation seasons. Even though this figure provides a meaningful pattern for the existence of vitreous materials at the site, it should not be considered conclusive. The

excavated vitreous corpus is directly connected to the excavation strategies at the settlement, which aims clarification of the chronology. Furthermore, as mentioned in sections 5.1 and 5.2, certain phases have been reached only in some sectors (i.e., Area 1 for MBII and Area 3 for the MBII–LBI transition). Therefore, it would be misleading to suggest that these were the only areas where vitreous materials were found; such finds may be recovered in other sectors. Future excavation campaigns focusing specifically on these sectors of the mound will clarify this ambiguous situation.

Even though archaeological excavations at the site focus on chronology and priority has been given to other archaeological problems, the so-far unearthed vitreous corpora and workshop contexts provide a valuable case study for scholars who try to understand the daily practice of crafts and the demand for vitreous materials in the second millennium B.C.

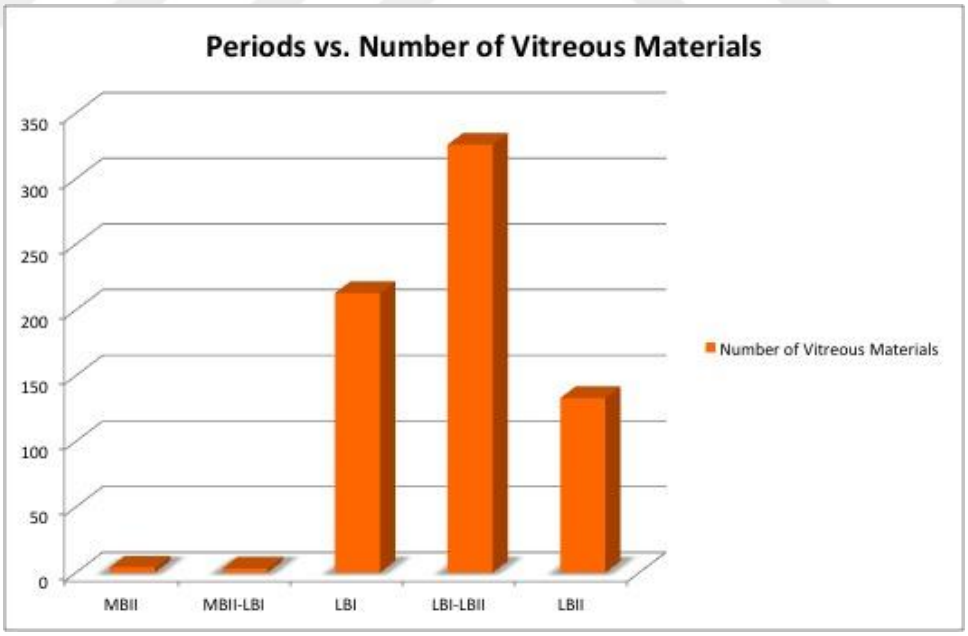

Fig. 5.4: Distribution of number of vitreous materials versus periods. The number of artifacts was based on the number of AT tags. It is important to notice that one AT tag might include more than one object. For example, a necklace can have more than one hundred glass, faience, and frit beads, but was might have count as one artifact with one AT tag. In this graph, the item tags used as the major excavation data are shown.

CHAPTER VI:

THE SCIENTIFIC METHODOLOGIES

Analytical work on vitrified materials began as early as the late 18th century. The chemist, Martin Klaproth, analyzed Roman glass to understand its properties (Klaproth 1798). However, this and several other attempts were not adequate to portray a complete picture for vitreous artifacts (Henderson 2000: 8).

With the introduction of processualist theories into the field of archaeology in the 1960s, archaeologists in collaboration with physicists, chemists and many other scientists from various disciplines started to apply analytical methods to examine the microstructural properties of archaeological materials that are invisible to the naked eye (Binford 1962). Both qualitative and quantitative information gathered through such analytical techniques complement traditional archaeological studies. Since the processualist approach, more precise descriptions are being generated for research concerning archeological problems such as identifying the manufacturing techniques of ancient artifacts. The establishment of wider data sets on a micro-scale opens a fresh ground for diverse interpretations. New information not only serves in the reassessment of old research questions but also brings new archaeological questions. The innovative analytical perspective starting with processual archaeology (i.e. new archaeology) supports the rise of archaeological science (i.e. archaeometry) as a new discipline within which this study is also a part.

This dissertation relies both on archaeological and scientific data from second millennium B.C. vitrified materials excavated in a particular settlement, Tell Atchana, ancient Alalakh. Without establishing relevant connections between archaeology and science, data from both sources become inconclusive for reconstructing ancient vitrified technologies. Thus, the ultimate aim of this research is to combine information from both sources in order to establish a consistent background for reconstructing production processes of the vitrified artifacts within the social, economic, and political spheres of the second millennium B.C. in which these vitrified industries developed.

One of the research questions of this study is to understand the basic material characteristics of the vitrified material assemblage of Tell Atchana in specific detail. Understanding the structural properties of the vitrified artifacts are remarkably important to generate conclusive statements on the production technologies of the settlement within the general setting of Anatolia, the Levant, Mesopotamia, Egypt and the Aegean in the second millennium B.C. This particular aim necessitates the examination of artifacts in detail; that is, in micro-scale, which demands the use of certain analytical methods.

This chapter focuses on the techniques relevant to this dissertation. In this study, a set of selected techniques are applied on archaeological samples to answer specific question(s). Namely, scanning electron microscopy (SEM), electron dispersive X-ray (EDX), X-ray fluorescence spectroscopy (XRF), X-ray diffraction spectroscopy (XRD), inductively coupled plasma-mass spectrometer (ICP–MS), and strontium (Sr) and neodymium (Nd) isotopic analysis (Thermal Ion Mass Spectrometry) are used to solve pinpointed archaeological questions. The description of each analytical method has two parts: (1) the technique, and (2) the sample

preparation and analysis. The technique part presents a general overview of the selected methodology by discussing the scientific background and the instrumentation including some relevant examples of archaeological applications especially in vitrified material studies. The sample preparation and analysis part introduces how samples are prepared prior to the application of the selected methodology, the laboratories and the instruments used in this research, and specific settings and software, which are used to evaluate the raw data.

It is important to note here that all the glass, faience, and frit assemblages of Tell Atchana, ancient Alalakh presented in the catalogue (Appendix II–III) have not been analyzed in this study. A procedure has been followed for scientific sample selection, which takes into account various bureaucratic and technical considerations. According to the legislations of the Turkish Ministry of Culture and Tourism, any scientific instrument, regardless of whether it is a destructive or a nondestructive method, cannot be used on complete artifacts. Only archaeological fragments can be analyzed. Proper permission is necessary to carry the selected fragment to the laboratories where analyses are conducted. For this dissertation, permissions were given by the Hatay Archaeology Museum and samples were sent to the Koç University Archaeology and History of Art Laboratory (hereafter ARHA) depot. The catalogue lists the details on the artifacts, whether they were sampled or not, their reason for selection/elimination, the method of analysis and their current location.

Scientific samples should be representative of the main body of the artifact, which were generally a fragment of a bead, vase or amorphous object in this study's material assemblage. All samples were first examined by the naked eye and with a loop or simple optical microscope if necessary to decide on the most representative section of the artifact. This first selection was followed by photographs, proper

documentation of each sample, and a sampling procedure for further analysis. The information gathered at this stage was archived in the Alalakh Excavations database and the samples were securely stored at the ARHA depot until they were carried to other laboratories for further examination.

Vitrified materials of the second millennium B.C. are not easy to deal with due to the poor conditions of preservation in general. The poor conditions of the objects reduce the precision of the results obtained in any scientific technique used in this research. The major problem is the fact that the glaze and glass undergo a process known as weathering. Weathering is a drawback affecting the chemical composition of the vitrified samples and mainly resulting in a decrease in the soda content, which is one of the major components in vitrified materials from the second millennium B.C. To a lesser extent, lime and colorants in the vitreous composition also suffer from weathering.

Weathered artifacts especially glass, turns to a powder form eliminating the chance of establishing valuable information on the original color and composition of the artifacts (Brill 1999a, b; Henderson 2013 with references cited). This is a critical problem for scientific research on glass though unweathered glass sometimes survives at the core, which can be used for analytical purposes. Weathering can be more severe for faience objects, which have thin glazing on the surface. In case of weathering in faience, one can be left with a porous object appearing in white, gray or beige due to the decay of the glazed surface. There is no way to scientifically prevent weathering in archaeological vitreous materials. However, to obtain results that are both qualitatively and quantitatively reliable, in this research weathered samples were eliminated from the scientific analysis sets.

The final aspect of the sample selection strategy is the archaeological context. Any sample that is suitable for scientific analysis (by size, preservation condition, etc.) is examined though fragments recovered from the workshop areas in and around the kilns and pyrotechnology related futures have been given priority. All of the samples found *in situ* or recovered in primary contexts are analyzed in depth generally using a set of techniques to synthesize as much information as possible. The information gathered from these *in situ* samples establishes the main corpus of scientific data for statistical evaluation. These data also constitute the key evidence for the evaluation of the bigger picture: characteristics of the vitrified material assemblage of Alalakh and production in the second millennium B.C.

6. 1 Scanning Electron Microscopy (SEM) – Electron Dispersive X-Ray (EDX)

6.1.1 The Technique

Scanning Electron Microscopy (SEM) is a widely used method for microstructural analysis with high-resolution imaging from any type of sample; in this study, vitrified materials. SEM generally works under high vacuum and a dry environment so that a high-energy beam of electrons can be created for imaging and analysis (Echlin 2009:1). In SEM, the energy source is an electron gun. Electrons scan across the surface of the sample so that they can interact with the sample in various ways. Scattered signals are collected as a result of this interaction and then are used to create an image (Reed 1996: 77, Henderson 2000: 19–20).

The SEM can be installed with either Energy Dispersive (EDS, EDX: Electron Dispersive X-Ray can be used as well) or Wavelength Dispersive Spectrometer (WDS, WDX: Wavelength Dispersive X-Ray can be used as well). This study uses an EDX installed instrument. Usually, SEM–EDX has two detectors: a secondary electron detector and a backscattered electron detector. Secondary

electrons and backscattered electrons are actually two primary signals used to form images. The analytical system depends on collected X-rays that are generated by beam-sample interaction (Echlin 2009: 1). The secondary electron detector is suitable for obtaining high magnification for surface structure images whereas the backscattered electron detector is practical for acquiring images for variations in composition.

Among the vitrified assemblage, mainly faience materials are analyzed with the backscattered electron images detector. Faience materials have cores that are coated with glaze, which then can be easily distinguished with SEM imaging. The intersections between the core and the glaze matrixes of faience artifacts, mainly beads, are documented through SEM and provide information for the production technologies of faience. [173]

In this research, the instrumentation at Koç University Surface Technologies Center[174] (hereafter; KUYTAM) was used. The Field Emission Scanning Electron Microscope (FESEM) – EDX is a Zeiss Ultra Plus model with Bruker 123 eV detector. The microscopic principles of this instrumentation are published elsewhere (Goldstein et al. 2004) and is not the subject of this dissertation but the issue with the detection limits needs to be pointed out here. EDX cannot measure elements with an atomic number lower than Boron.[175] Additionally, elements with lower than 5% intensity in the composition cannot be precisely detected with EDX. Even though EDX provides results sometimes for values lower than 5% (either by atom or weight), the results are not reliable and should be evaluated skeptically. In this study,

[173] For production technologies of faience see chapter III.

[174] The photos of the instrumentation are available at http://kuytam.ku.edu.tr/Facilities.

[175] Atomic number of Boron is 5. Atomic number refers the proton number of elements. In the periodic table of elements, atomic number of each element is written on the bottom left of the element symbol such as $_5$B.

chemical compositions calculated through EDX with a “Quantax” software are referred to only in the case the desired elements are higher than 5% in the total composition.

6.1.2 Sample Preparation and Analysis

In SEM, the imaging system depends on the specimen’s electrical conductivity so that incoming electrons from the gun of the SEM go to the ground; otherwise, the image fades. Most of the vitrified materials (frit, faience, glass) are poor conductors so sample preparation is a prerequisite for SEM analysis.

The samples for SEM are either mounted in epoxy resin or directly fixed to proper specimen stages. For mounting in epoxy resins, Metkon resin and hardener are mixed in 3:1 ratio. A double-sided tape is used to fix the sample on the bottom of the stub. The reason for that is to prevent possible suspension of the low-density sample in the high-density resin. The Bruker releasing agent is applied at the interior lateral side of the stub before pouring the epoxy so that the resin slides out easily from the stub after drying. It takes generally 20-24 hours for the epoxy to dry. The epoxy imbedded sample is gently removed out of the stub. A series of polishing is done with sand paper with grits varying from 800 to 2000. The final polishing is done with a velvet textile and diamond suspension of 6 microns followed by 1 micron. While polishing, the sample surface is continually controlled under an optical microscope to obtain the best clear surface and to control the exposure of the sample surface. Exposure of the sample is necessary for EDX since the beam needs to hit the sample. Each polishing process takes almost two hours.

For the samples that are directly fixed to specimen stages, pre-processing is also essential. For those specimens, pre-cleaning is done at the KUYTAM laboratories. With this pre-cleaning, the accumulation of silica or dust is removed

either with bamboo sticks or a proper solution like methanol or generally, acetone. After pre-cleaning, the samples are treated with a high-powered vacuum to remove fragments that are weakly bonded to the main body and can possibly fall into the SEM chamber. Both of these processes are valid not only to protect the chamber of the SEM from dust, falling, and flying fragments of the samples, but also help to obtain better microstructural images of the artifacts. After pre-treatment, the samples are attached to steel specimen stubs with a piece of double-sided carbon tape. The standard specimen stages for SEM are generally 5–10 cm in diameter (Echlin 2009: 13).

The installed samples are highly non-conductive so that they charge high voltages of electrons coming out of the SEM gun. Since the samples cannot conduct energy they start accumulating electrons (i.e. energy), which is called self-charging. The accumulation of high voltages on the samples directly affects SEM-images by creating lines of distortions. To prevent the samples from self-charging during the analysis and to obtain clear images, gold coating is applied as a precaution. For this gold coating, a Cressington Sputter Coater 108 Auto and a Cressington Thickness Monitor mtm 10 extension are used. The coater part works with a high voltage low current and covers the samples with approximately 10–15 nm gold sputtered in 20 seconds.

During the SEM analysis, an electron high-tension value, varying from 1.00 kV to 10.00 kV, is applied depending on how much energy the electrons can charge (i.e., charging capacity) of the samples. The best images are obtained with 10.00 kV electron high-tension values. Short working distances are preferred for high-resolution images whereas long working distances work better for higher depth of field (Echlin 2009: 17). Depending on the condition of each sample, different

adjustments are made with SEM. Setting details, including magnification, electron high-tension value (EHT), working distance (WD), and the scale, are pasted in a frame located at bottom-right corner of each SEM image.

6.2 X-Ray Fluorescence (XRF)

6.2.1 The Technique

The X-Ray Fluorescence (XRF) method is a non-destructive method that provides qualitative and semi-quantitative elemental results for archaeological materials. In the XRF method, high energy X-rays ionize atoms. While the excited (i.e., energized, unstable) atoms are relaxing to their ground states of energy, they emit fluorescence photons. These emitted photons correspond to the characteristic atomic structures of the atoms. A detector measures the emitted radiation of the atoms. Since the radiations of atoms are characteristic, XRF uses this for to distinguish data and provide information on the chemical composition of the sample (Parsons 1997; Mantler and Schreiner 2000).

The emitted fluorescence spectrum can be measured either by wavelength dispersive (WD) or energy dispersive (ED) spectrometers. The WDXRF method calculates the intensity spectrum of characteristic lines versus the wavelength. The EDXRF counts the photons' energy and obtains the X-Ray energy versus the intensity spectrum (Janssens 2013: 88–9).

In this research, a Bruker Tiger S8 Wavelength Dispersive (WD)–XRF at KUYTAM is used. Comparatively large samples such as raw frit materials and glass vase fragments having at least 3–5 cm long flat surfaces or weighing at least 2 gr are analyzed with XRF. A standardless method with the internal standard of the instrument was used. The advantage of XRF is the fairly fast acquisition of results and time-efficient sample preparation methods. However the detection limits of the

instrument, which are listed in Appendix IV, are not as low and thus not as precise as Inductively Couple Plasma. Even though the instrumentation is capable of measuring compositions as low as parts per million, the results needs to be evaluated with some uncertainly.

6.2.2 Sample Preparation and Analysis

To have trustworthy results in WDXRF analysis, as a preliminary step, weathered samples were not analyzed or unweathered parts of the samples were taken for analysis. Three different techniques were applied for sample preparation, depending on the sample's condition. The first group was turned to powder form and was analyzed in 2.5 micron mylar films by directly putting the powder in the XRF holder with the aid of a thin film. These samples were measured under helium.

The second group was pressed into pellets. A minimum quantity of 5.0 g was required to press the pellets, which was generally an impossible amount to obtain from the LBA glass samples. However, most of the time, it was possible to obtain the amount needed. In the pellet method, the sample was first ground in an agate mortar and then the ground sample was pressured in a support layer of boric acid inside steel rings or aluminum cups. In this study, aluminum cups were preferred due to their easy availability and moderate price in the laboratory conditions.

The third and the most successful method was analysis of the sample in the form of fused beads. The aim in this method was to obtain a homogeneous non-crystalline glass. Generally 1.0 g of sample was enough to fuse a bead of 5 cm diameter. The sample was put in a platinum (Pt) gold (Au, 5%) crucible and heated up to 1000 ^{o} C by using modern fluxes: lithium tetraborate ($Li_2B_4O_7$) (920°C), lithium metaborate ($LiBO_2$) (850°C) or a mixture of both. For this study, $Li_2B_4O_7$ was preferred. The flux and the sample turned to a liquid form with the heat, which

was then poured into a bead-shaped plate made out of a similar Pt-Au alloy to the crucible. The liquid cooled in almost 10 minutes and then was removed from the plate. The glass-like fused bead was analyzed with standard methods provided in the software of the XRF.

6.3 X-Ray Diffraction (XRD)

6.3.1 The Technique

X-Ray Diffraction (XRD) is an important method in archaeology especially for research related to ancient pyrotechnological activities. It is a powerful technique for detecting different minerals in a sample, which further leads to determining firing temperatures. Briefly, each mineral has a specific formation temperature. By examining different mineral occurrences in a sample, changes in temperature and different temperatures at which the sample is exposed can be investigated. For example, quartz, which is the pure form of silica and the major element for vitrified materials, occurs in the α form in nature. When it is heated to 573 ± 5 ^{o}C it converts to its β form. Around 867 ^{o}C β-quartz transforms to another crystal formed named tridymite. At 1250 ^{o}C it becomes cristobalite (Henderson 2000: 11). Quartz, β-quartz, tridymite and cristobalite are all composed of silica but in different arrangements and bonding at an atomic level. Indications of these differences in atomic arrangements provide an insight on the firing temperature and thus relates to the production processes.

The XRD method examines the crystalline structures of samples. Microstructures of minerals (crystals) are composed of regularly lined up lattices. The size and spacing between these lattices are characteristic to each mineral. Each mineral has a spectra related to its specific configuration of lattices. In this technique a crystalline type material is exposed to a monochromatic wavelength (a single

wavelength) with a specific angle. With the exposure to the beam, the atoms in the sample diffract into many directions due to the specific alignment of its lattices. By calculating the angles and intensities of the diffracted beams, XRD then examines the mineralogical structure of the samples (Pollard et al. 2006; Janssens 2013).

6.3.2 Sample Preparation and Analysis

XRD analyses were run either with a Brucker Advance D8 or Brucker Phaser D2 instrument in the KUYTAM laboratories. Brucker Advance D8 provided a detailed mineralogical examination of each phase whereas Brucker Phaser D2 gave a quick overview of the crystalline structure of the sample.

For the XRD analyses, samples were cleaned to remove the dust accumulated on the surface. They were cut to a thickness of 0.5–1.0 cm with a Metkon thin section-petrography machine with a Microcut extension. For the Brucker Advance D8 analysis, samples were fixed to a plastic plate with a special white paste. For the Brucker Phaser D2 analyses, samples were powdered in an agate mortar and pressed in special stubs of the instrument. In both of the XRDs, samples were collected over a 2θ range of 30-90^{o,} using copper radiation (Cu-Kα) at 40 kV and 40 mA following the methodology of Walton et al. (2012). After obtaining the XRD spectra of the sample, the peaks were both manually and automatically matched with the mineral data of special XRD software to identify the crystalline phases in the sample. This method identified mineralogical phases and thus the possible production temperatures of the samples.

In this research, XRD was extremely useful to detect mineralogical phases in frit and Egyptian blue. These two vitrified materials are generally referred as the same whereas the different crystalline phases idiosyncratic to Egyptian blue indicated through XRD helped to distinguish these two similar materials.

6.4.Inductively Coupled Plasma-Mass Spectrometry (ICP–MS)

6.4.1 The Technique

Inductively Coupled Plasma (ICP) found its first applications in archaeology in the mid-1980s (Hart and Adams 1983; Hart et al. 1987). Since then, the method has been commonly used for trace element analysis because the detection limits of the instrument are at or below the part per trillion (ppt) level for much of the periodic table.

ICP is a destructive method, which is based on dissolving the sample in certain acids. The ICP method atomizes the liquid sample into its elements and turns it into plasma at temperatures above 8000^{o} C. The charged ions are then directed into the mass spectrometer and strike the electron multiplier, which serves as a detector. With the impact of the ions, electrons are released, which are amplified until they become a measureable pulse (Heyworth et al. 1991).

To determine the concentration of elements, the software needs a reference point to compare the intensities of the measured pulses. These reference materials, also known as standards, include known concentrations of elements. Based on these concentrations, a calibration curve (a linear graphical representation) is prepared for each element. By using calibration curves, the unknown amount in the sample is calculated. Since the amounts are measured based on the standards, the key step while operating ICP is the calibration of the equipment. After that, this system will work efficiently at each run where more than 40 elements can be measured simultaneously (Heyworth et al. 1991).

It is possible to add a Laser Ablation (LA) attachment to the ICP–MS, which allows working with solid samples without dissolving them first, thus making the method less destructive. This technique allows bulk analyses of archaeological

samples comparable to ICP–MS, XRF, and Neutron Activation Analysis (NAA). On some of the glasses from Alalakh corpus, LA was practiced as trial however the results are not used within this dissertation. The reason behind is that the LA results are obtained as electron counts instead of weigh percentages, ppm or ppt. In order to obtain a consistency among the results only ICP–MS was selected as the major method.

ICP–MS is a powerful technique capable of measuring almost all elements in the periodic table from lithium (atomic number 3) to uranium (atomic number 92) with the exceptions of noble gases (helium, neon, argon, krypton, xenon, radon) and carbon, nitrogen, oxygen, fluorine and chlorine. The detection limits are as low as part parts-per-million (ppm), billion (ppb) or trillion (ppt) in some elements. With the use of this method, a wide variety of archaeological materials including ceramics, glass, pastes, obsidian, minerals, and even human teeth may be analyzed with high precision (Speakman and Neff 2005: 1; Salgán 2015). With the advantage of low detection limits, ICP–MS, and LA–ICP–MS is widely used for provenance studies of archaeological materials (Speakman and Neff 2005; Shortland et al. 2007; Jackson and Nicholson 2010; Walton et al. 2012).

6.4.2 Sample Preparation and Analysis

In this research, an Agilent 7700x ICP–MS instrument connected to an ASX – 500 series auto sampler at KUYTAM is used. The system gas is argon. The sample preparation was done in Koc University chemistry laboratory where a special fume hood is available for strong acids.

For ICP–MS analyses, samples were prepared by the standard methods of acid digestion using combinations of hydrochloric (HCl), hydrofluoric (HF) and nitric acids (HNO_3). First of all, unweathered pieces were selected and cleaned under

microscope in order to make sure that samples are completely decontaminated from weathering products. Then each sample was weighed in the Teflon cups of the microwave digestion system. Available unweathering samples generally were varying between 0.02–0.1grams. After weighing, 1ml HCl, 3ml HNO_3, and 6ml HF were added respectively and digestion progress was started in the Milestone SK-10 microwave digestion instrument. Each set of digestion included of ten samples since this is the capacity of the microwave instrument. Out of ten, one sample is blank and the other one is standard one universal calibration standard for glass SRM 612, which is the only available glass standard within the laboratory facilities. Thus, in each run only eight glass samples were digested. Including blank and reference material in each set is crucial in order to calibrate the instrument and observe possible error while working with the instrument.

After the addition on acids, the Teflon cups were closed and put inside the pressure-resistant outer cups. The digestion occurs at 200 ^{o}C and 800 W and continues 2 hours. Then the system cools down to 50 ^{o}C or lower degrees, the Teflon cups were opened and 25 ml 4% boric acid solution was added in each cup in order to neutralize the strong acid and fluorine content in the cup. The same microwave procure were run again.

After the second digestion, samples were transferred in to 250 ml polypropylene bottles and diluted to 50 ml with 2% nitric acid. These solutions are diluted with serial dilution according to the calibration of the ICP–MS.

Dissolving glasses in acid was not an easy process. It necessitated the use of concentrated and dangerous acids. Furthermore, the microwave digestion necessities a long time to guarantee that the entire sample was dissolved and the number of samples processed is limited to eight.

While analyzing the material, which was ionized to plasma in the ICP–MS torch and carried with the system gas to the MS part of the instrument. The ions of the sample were accelerated with high voltage and passed through a series of instruments including ion optics, electrostatic analyzer, and the magnet. At the magnet, the ions were separated according to their mass/charge (Z) ratio and were moved to the detector (Speakman and Neff 2005: 2).

The complete signal was subsequently interpreted using the 'Mass Hunter' software package. Calcium (Ca) was the internal standard element while normalizing data obtained from the samples. Analyses were calibrated against NIST (National Institute of Standards and Technology) SRM 612 glass reference. The values together with standard deviations and mean values obtained in this research are listed in Table 3 in appendix IV.

During the ICP–MS analyses, the lowest detectable concentration was set as 0.5 ppb (ug/L), even though the instrument's detection limits can be 100 times lower than this value at the best conditions. The exceptions were the detection limits of phosphorus (P) ans sulphur (S), which are higher than 250 ppb and 1000 ppb respectively. A phenomenon known as positive ionization is problematic with these elements especially with low concentration in the acidic solutions, which were used for the ICP–MS analyses of this dissertation.

6.5 Thermal Ion Mass Spectrometry for Strontium (Sr) and Neodymium (Nd)

Examinations of major and minor elemental composition of ancient glasses are not enough to clarify the nature and the geographical location of the raw materials used in glass production. Scholars are aware of the fact that fire-related processes affect the elemental compositions of the final products which disables certain conclusions about raw materials and production locations. Due to the paucity

of other methods to solve raw material and provenance related questions, the use of isotopes in ancient glass studies has become the routine over the last decade.

Isotope studies on vitrified materials is limited to selected stable and radiogenic isotopes, mainly oxygen, lead, strontium, and neodymium systems so far. All of these systems work with the basic principle that heat related processes have small effects on the isotopic ratios of the final product (Degryse et al. 2009 with references). This section extends the discussions on strontium and neodymium isotope systems due to their relevance to this study.

6.5.1 General Principles about Isotopes and Radioactive Decay

Isotopes are atoms of elements with different quantities of neutrons. Each element in nature has a specific atomic number (the proton number) but the number of neutrons may vary which affect the atomic mass of each particular element. For example, hydrogen has a single proton (positive charge) in the nucleus, whereas an isotope of it (deuterium) contains one proton and one neutron.[176] They are both stable isotopes of hydrogen though have different atomic weights. Many light elements like hydrogen, carbon, oxygen and nitrogen are defined as stable due to their low radioactivity.

Radioactive decay is the spontaneous disintegration of an unstable radioactive isotope (parent isotope) to a radiogenic isotope (daughter) and a stable nucleus. Many heavy elements are radioactive, unlike the stable light elements. The radiogenic isotopes produced as a result of radioactive decay are generally used as dating tools for geologists, like dating the age of minerals and rocks since the decay

[176] For the basic concepts of modern chemistry and physics the exact references of original papers like Thomson, Fermi, Einstein etc. are not cited. Readers should consult a standard textbook such as Petrucci, R. H., Harwood, W. S. and Herring, F. G. 2002. *General Chemistry Principles and Applications, 8th* edition, Pearson.

process is time-dependent. The principles of radiogenic dating and applications is explained in detail in Gunter Faure's publications (1986, 2001). The concern in this study is the application of these radiogenic isotopes into the ancient vitrified material research. Such isotopes are useful in provenance studies in archeology since different geological raw materials have different geological ages or chemical compositions (Degryse 2013).

Mass Spectrometry (MS) measures isotopic ratios and is used to make isotopic research possible. In MS, atoms of the chemical element are ionized in a vacuum chamber to measure their isotopic composition. The ions produced are then accelerated by using an energy around 3^20 kV. This acceleration causes the ions to create an electric current, which then passes through a magnetic field. In this magnetic zone, the lighter and the heavier ions are deflected differently. The lighter ones are deflected more than the heavier ones so that the ions can be separated based on their differences in mass (Pollard et al. 2006; Allégre 2008: 2).

6.5.2 The Technique in Strontium and Neodimyum Isotopes

Strontium (Sr) is an alkali earth metal with a standard atomic mass 87.62 amu (atomic mass unit). Strontium has four isotopes with varying natural abundance, which refers to the abundance frequency of these isotopes in nature. ^{88}Sr is the most abundant isotope with 82.58%, followed by 9.86% ^{86}Sr, 7.0% ^{87}Sr and the least common isotope is ^{84}Sr with 0.56% existence in nature.

Among the four isotopes of strontium, only ^{87}Sr is radiogenic. The other three isotopes are not products of radioactive decay. The radiogenic isotope, ^{87}Sr forms by beta decay[177] of ^{87}Rb. This decay has a half-life of 48.8 billion years. Due to its

[177] Beta decay (β) is a type of radioactive decay where one proton converts to a neutron or vice versa in the nucleus.

radiogenic character, ^{87}Sr has two sources of formation: as primordial referring to its formation along with ^{84}Sr, ^{86}Sr and ^{88}Sr and as the radioactive decay product of ^{87}Sr. This radiogenic character is used in geological investigations and also establishes the basis of strontium isotope research in ancient glass studies.

Strontium has similar properties to calcium.[178] Due to the similar chemical characteristics, strontium has a tendency to substitute calcium in chemical compounds. Based on the difference in the radiogenic characters of strontium isotopes, the ratio of ^{87}Sr / ^{86}Sr provides an estimated age for calcium. The isotopes of strontium, ^{88}Sr, ^{87}Sr, ^{86}Sr, and ^{84}Sr exist in glass due to the calcium that enters into the composition of glass with the lime or shell ingredients, which enter as the major raw materials in the second millennium BC glass composition. ^{87}Sr / ^{86}Sr can also pass into the composition due to plant ash - another component of glass composition. Plants, which take calcium generally in carbonate form from water, also absorb ^{87}Sr / ^{86}Sr which is characteristic to a particular geological zone (for example sand or limestone). Plants containing distinctive ratios of ^{87}Sr / ^{86}Sr are then turned into ash and used as flux while glassmaking. Flux, which is the plant ash in the glass composition, is added to the chemical composition of glass to decrease the high melting temperature of silica. As a result, both the chemical composition and strontium isotopic ratio of plant ash used for glassmaking reflects the age and characteristic of the bedrock on which the plants grow (Freestone et al. 2003; Shortland 2012: 191; Henderson 2013: 328).

The strontium isotope technique then provides valuable information about provenancing glass since it helps to match the characteristic of (local) geologies to

[178] Strontium is located below calcium in the periodic table. Based on the rules concerning the periodic table, elements located in the same column of the periodic table shows similar properties. That is one of the reasons strontium and calcium show similar characteristics.

the artifacts, namely glass. On the other hand, it is important to note that relying only on strontium isotopic ratios does not guarantee an accurate result in terms of revealing the exact location for glass production. The strontium isotopic ratio in glass is not only dependent on the main body of rock but also other sources of calcium like feldspars in soil and sand, limestone as well as seashell fragments in sand (Shortland 2012: 191; Freestone et al. 2003). Furthermore, the value can also vary according to the type of plant, or ^{87}Sr / ^{86}Sr value for plant species can be the same for geological zones that cover vast areas (Montgomery et al. 2006). To overcome this problem, Evans et al. (2010) suggest the determination of ^{87}Sr / ^{86}Sr values for plants within and between the main geological zones that are expected to distinguish regions. Consequently, the results may provide insights into glass trade and/or exchange among these regions. Promising research on the Bronze Age glass shows that Mesopotamian and Egyptian plant ash have different diagnostic values (Henderson et al. 2010).

Another radiogenic isotope used in this research is neodymium. Neodymium is a rare earth element (hereafter; REE) found in trace amounts in all clays and sands. It has a standard atomic mass 144.242(3) amu calculated out of seven naturally occurring isotopes. They are found in the following percentages: ^{142}Nd (27.2%), ^{143}Nd (12.2%), ^{144}Nd (23.8%), ^{145}Nd (8.3%), ^{146}Nd (17.2%), ^{148}Nd (5.7%) and ^{150}Nd (5.6%). The percentages in the parenthesis show that the most abundant isotope is ^{142}Nd. Among many isotopes of neodymium[179], the most relevant to the discussion here is ^{143}Nd. This isotope is a product of the alpha decay[180] of samarium 147

[179] Neodymium has 31 isotopes in total. Only the naturally occurring seven isotopes are mentioned here.

[180] Alpha decay (α-decay), is a radioactive decay where the mass number decreases four and the atomic number decreases by two by emitting an alpha particle. An alpha

(^{147}Sm), which has a half-life of 106 billion years. Similar to ^{87}Sr, the amount of the ^{43}Nd on the earth changes through time due to the radioactive decay of samarium and allows the calculation of the age of the geological formations.

Different geological zones have different ^{143}Nd quantities which is usually compared to ^{144}Nd to obtain the ^{143}Nd /^{144}Nd ratio. This ratio is used to provide age data especially with reference to the earth mantle. Quartz or sand deposits with different geological ages have different ^{143}Nd / ^{144}Nd ratios which can be used to calculate the formation age of that particular rock. Based on this principle, the neodymium isotope becomes a valuable tool in the provenance studies of glass. The quartz pebbles or sand used in glassmaking can be differentiated with the aid of this method. Using neodymium isotopes, sand formed by erosion of metamorphic rocks or sand derived from erosion of a younger rock can be differentiated since they have different ^{143}Nd / ^{144}Nd ratios.

Research concerning second millennium BC glass already noted that Egyptian and Levantine glass have different neodymium isotope values (Henderson et al. 2010). On the other hand, like the strontium isotope, neodymium isotopic ratios do not point out certain locations of production. They indicate a potential provenance that is information not accessible with other methods.

It is important to underline that information obtained through both of the isotopic methods summarized here are relatively new and expensive techniques; thus, their application to second millennium BC research is limited so far. These two isotopes provided successive results in Roman glass research, though data sets concerning Bronze Age glass need to be improved.

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particle is similar to a helium 4 (^{4}He) atom, which consists of two protons and two neutrons.

6.5.3 Sample Preparation and Analysis

Isotopic analysis of glass from Tell Atchana, Alalakh was done at the British Geological Survey (BGS).[181] For strontium and neodymium isotopes, a Thermo Triton multi-collector Thermal Ion Mass Spectrometry (TIMS) was used and the following standard procedure of BGS on the analysis of the Late Bronze Age glasses was applied.

For both strontium and neodymium isotopes, proper permission was given by the Hatay Archaeology Museum for the export of the archaeological samples. Fragments with ca. 1.0 g of unweathered glass were chosen as suitable for isotopic research. Since the technique was very expensive, only samples, which were uncovered from primary archaeological contexts of the settlement, were selected.

The sample preparation was done in the super clean laboratory of the BGS. Glass samples were broken into fragments for pre-cleaning in an ultrasonic bath containing 2.5 ml HCl. This cleaning took 5 minutes and was then followed by three rinses in deionized water for the same length of time. After drying, the fragments were ground to a fine powder in an agate mortar including micro balls. These micro balls help for finer grinding of the sample. Standard silicate dissolution was then undertaken and the strontium and rare earth elements (REE) fractions collected from Dowex resin columns. Neodymium was separated from the REE fraction using di-(2-ethylhexyl) phosphoric acid (di-(2-ethylhexyl) phosphoric acid= HDEHP) columns. The details of the reaction mechanism in the resin columns and process are discussed elsewhere (Dickin 1998)

Neodymium concentrations were determined by isotope dilution using ^{150}Nd

[181] I would like to thank Professor Jane Evans for conducting these analyses at the BGS. I also would like to thank Suna-İnan Kıraç Research Institute on Mediterranean Civilizations (AKMED) for the dissertation grant, which makes this isotopic research possible.

tracer solution, which functions as a standard reference. Neodymium concentrations and ^{143}Nd / ^{144}Nd isotope ratios were measured using a double tantalum (Ta) and rhenium (Re) filament assemblage on a Thermo Triton multi-collector. Strontium concentrations and ^{87}Sr / ^{86}Sr were determined using ^{84}Sr tracer solution and were run using a single rhenium filament, following Birck's method (1986). This method was specifically designed for isolation of strontium from calcium.

The reproducibility of the process depends on the standards applied during the sample analysis. For these analyses, the NBS987 international strontium standard is used together with a standard produced at BGS and named the "J&M standard". The values obtained from the Thermo Triton instrument for the standards are calculated as follows: In NBS987 the ratio of ^{87}Sr / ^{86}Sr is measured typically as 0.710279 with ± 0.000010 deviation (2s, n=19). 2s refers to the measurement time where both of the standards measurements took two seconds. The same ratio is calculated for J&M standard as 0.511102 with ± 0.000004 deviations. For NBS987, a mean value from 19 measurements is calculated whereas J&M standard used the mean of 7 measurements.

La Jolla is the worldwide calibration standard for isotopic ratios. Strontium ratios were normalized to NBS987 = 0.710250 and J&M = 0.511123, which is the calibrated equivalent of La Jolla = 0.511860. Isotope ratios were all determined to $\leq$ 0.000010 (2SE); Nd data are corrected to a $^{146}Nd/^{144}Nd$ ratio of 0.7219.

CHAPTER VII:

SCIENTIFIC RESULTS

The analysis of vitreous materials, especially glass of the second millennium B.C., is a challenging subject. The archaeometric investigations compete with two major handicaps: 1) accessing the material by getting proper permits; and 2) finding unweathered material — especially glass — suitable for instrumental investigations. In this dissertation, none of the artifacts from overseas museums could be analytically investigated due to the limitations of research permits. The same rule applies for museums in Turkey, namely the Hatay Archaeology Museum. Archaeometric research was only conducted on the remains of artifacts that were not handed over to the museum and that were hosted as "research collections" in the Alalakh dig house depot.

At this stage, there were two primary difficulties while carrying out archaeometric research with the excavation material stored in the dig house depot. First, artifacts in good condition were sent to the museum as inventory objects, in other words, as display objects. After they were sent off to the museum displays or depots, it was not possible to conduct archaeometric research on those artifacts. Most of the museum's artifacts are unique and complete and thus are in showcases at museums, and permissions given to conduct research generally specified the condition that touching or sampling any artifact is not allowed. Second, artifacts

stored in the dig house depot(s) are generally very tiny and fragile fragments, or powdery and heavily weathered pieces; thus it is not possible to obtain information on the original compositional characteristics of the artifacts.[182] Especially for glass analysis, unweathered segments are crucial to investigate the ancient elemental compositions as well as to observe the original color of the artifact.

With consideration of the limitations of the analytical examinations briefly mentioned above, this chapter provides the results of the archaeometric investigations done on as many as possible available and suitable artifacts from Tell Atchana, ancient Alalakh. The sampling strategies and details of methodologies of instrumental techniques were discussed in the previous chapter (chapter VI). The raw data of the analyses are provided in Appendix IV. In this section, the results are arranged by chronological assessment. The focus is given to the workshop area dated to the Late Bronze I (LBI)–The Late Bronze II (LBII) transitional period and Area 4, where continuous production activity was archaeologically distinguished.

Analytical results obtained from MBII glass artifacts or LBI–LBII frit artifacts are not statistically significant due to the limited number of artifacts analyzed. However, I decided to include all archaeometric data in order to make the information available, which has the potential to contribute to other scholars' studies and to elucidate vitreous industries. Furthermore, when compared and contrasted with the other Mesopotamian, Egyptian, and — where available — Mycenaean counterparts, each piece is and will be useful to solve the puzzle of ancient technologies.

[182] One possibility to overcome the problems posed by the museum permits could be the use of mobile instruments such as portable XRF (pXRF). When research was being conducted in the museum depots (2013 and 2014 seasons), a pXRF was not available.

7.1 MBII and MBII – LBI Transition Period

From the MBII artifact assemblage of Tell Atchana, ancient Alalakh, only one bead (AT 15825, catalogue number: 4) was analyzed. Its composition shows soda–silica–lime glass with a slightly lower soda content (12.4935%) compared to the average soda content (ca. 16%)[183] of the Alalakh glasses. Its transparent turquoise color was due to copper oxide colorant, which was found as 9859.2685 ppm. Most of the ancient glasses have a soda–silica–lime composition, where the source of soda is plant ash (Lilyquist and Brill 1993: 80). However, the MBII glass objects remain exceptional. Bernard Gratuze (2013: 318) noted, "For more than 90% of the archaeological sites, the number of glass items per site varies from one to a maximum of five." This observation is still valid for the MBII glass of Mesopotamia, Egypt, Mycenae, and the Levant. This sample is unique and is the earliest glass artifact from the MBII strata of the site; it also provides a starting point to understand how the chemical composition of glass changed/continued at the site. As discussed in detail in the following sections, the major elemental composition of the glass at Alalakh did not change.

The MBII faience corpus of Alalakh is limited and an archaeometric investigation was not possible. None of the artifacts were available for research since they are all intact. When possible, an investigation on AT 8957 (catalogue number: 3), which is a horn-shaped decorative fragment, will be a significant contribution to ancient faience and glaze studies since it will be complementary to the MBII faience compositions from the neighboring regions.

The same problem stands for MBII–LBI transition period artifacts. Only three

[183] Brill (2012: 264) provides the value 16.34% for the soda composition of Alalakh glass. The average soda values for Alalakh glass samples are provided in tables in each section (e.g., Table 7.1).

artifacts were found in the dig house depot; however, they are all intact and thus it was not possible to send them off to a laboratory and investigate them instrumentally. For the MBII–LBI transition period, a noticeable feature is the existence of two frit cylinder seals (AT/39/231, catalogue number: 8; AT/47/85, catalogue number: 10) and a faience stamp seal (AT/47/165, catalogue number: 12) in the Hatay Archaeology Museum collections. These artifacts signify that vitreous artifacts, which were part of luxury items during the time of their use, were used also for administrative purposes. It should not have been easy to obtain a frit cylinder seal in the MBII; thus the owners of these luxury vitreous items might have been elites or highly ranked individuals.

A molded glass female figurine (AT/48/4, catalogue number: 14) was recovered from the temple context (Temple VI) of Level VI, which was chronologically attributed to the MBII–LBI transitional period. The earliest known core-formed vessel fragment (AT/39/225, catalogue number: 15) was also found in the archaeological layers dated to this transitional period (see chapter IV). The existence of a glass figurine in temple-associated layers and the presence of a polychrome glass vessel fragment demonstrate that complex artifacts made out of this newly innovated material — glass — were appreciated at Alalakh. This dissertation does not have much to say on the origins of these two early and unique glass examples. Archaeometric investigations, including trace element and isotope, have the potential to answer questions on the composition and thus the origin of these artifacts. Any compositional information on transitional period artifacts has the capacity to clarify technological change or continuity between MBII and LBI glass.

7.2 LBI

From the LBI levels, 18 glass beads (mostly colored opaque white) and two blue glass rods (AT 10339, catalogue number: 105; AT 10341, catalogue number: 106) were analyzed with ICP–MS. The results show soda–silica–lime glass corresponding to the general trend of the second millennium B.C. glasses with average compositions of 64.5226% silica, 17.5308% soda, and 7.3485% lime. Table 7.1 shows the average values for the major element compositions with comparison to Brill's mean compositions for Alalakh glasses (Brill 2012: 264).

The comparisons of the LBI glasses from this research and the glass analyzed by Brill from the secure and non-secure contexts of Alalakh with microprobe and XRF show matching results, especially for soda.[184]

Major element composition (wt%)	***ICP–MS mean compositions for LBI glasses***	***St. Dev. for ICP–MS mean compositions for LBI glasses***	***Mean compositions from Brill (2012: 264)***
SiO_2	64.5226	3.2750	67.10
Na_2O	17.5308	1.5518	17.87
CaO	7.3485	1.1173	6.03
MgO	3.1552	0.7572	3.98
Al_2O_3	0.5264	0.1732	0.75
Fe_2O_3	0.3962	0.1961	0.58
K_2O	2.8733	0.7016	3.69

Table 7.1: ICP–MS mean compositions for LBI glass. In this dissertation, four significant numbers are used to calculate average values and the standard deviations. For the standard deviation values of Brill's analysis, please see the reference cited.

In the LBI analysis, all of the major element measurements have less than 5% standard deviation. On the other hand, some elements have higher than 5% deviation. For example, the standard deviation for antimony (Sb) was calculated as 18.6860 within the LBI samples. This can be explained with the use of antimony only in the opaque glass samples, whereas the translucent artifacts do not contain antimony. Antimony is used as opacifier in the second millennium B.C. (chapter III); thus the

[184] For the details of Brill's analytical work, please refer to chapter IV.

opaque samples have elevated values of antimony whereas the translucent artifacts have relatively lower values.

Most of the opaque white beads contain antimony levels varying between 65.7503 ppm and 5.2634 ppm, the highest being an ivory-colored bead and the lowest being one of the two blue transparent rod fragments (AT 10341, catalogue number: 106). The other blue rod fragment (AT 10339, catalogue number: 105) has 7.4188 ppm of antimony. It is worth to mention that, Back Scattered Electron (BSE) SEM was not used to image any opacifying crystals in these samples.

These rod fragments have 12324.0158 ppm and 12856.2087 ppm copper levels, respectively, proving the use of copper as a colorant. These blue rods also contain high levels of arsenic (203.4592 and 217.6589 ppm, respectively), whereas most of the opaque white and yellow beads have lower arsenic levels than the detection limit.[185] These values are compared with the LA–ICPMS results of the Mesopotamian and Egyptian glasses published by Shortland et al. (2007). Details are discussed and graphs are provided in section 7.5; the high arsenic values point towards the use of scrap metals. If so, only arsenical coppers or purified arsenic containing metal ores might have been used in the case of Alalakh since none of the glass artifacts from this stratum have tin values higher than the detection limit, which is 3.5 ppm.

Three frit artifacts (AT 1555, catalogue number: 45; AT 9710, catalogue number: 143; AT 13595, catalogue number: 165) were also analyzed with XRF from the LBI levels (Appendix IV, Table 2). The results show approximately 65–70% silica, together with lime, magnesia, and potash. The soda levels vary between 1–5%. AT 1555 (catalogue number: 45) and AT 9710 (catalogue number: 143) are blue in

[185] For the detection limits of all the methods, please see Appendix IV, section 4.

color and have 11.02% and 8.57% copper oxide, which cause the blue color. AT 13595 (catalogue number: 165) is white and the copper levels were found to be 3.56%, which is lower when compared to the other two samples. The reason for using oxide weight percentages in the frit artifacts is the selected XRF method, where oxide calibration and calculation were preferred for the analysis. These results are comparable to Amarna, Tell Brak, and Tell Rimah (Hatton et al. 2008: 1595, table 3), though Alalakh frits have elevated levels of alumina and iron, the reason of which is discussed in section 7.5.

7.3 LBI–LBII

Vitreous artifacts collected from the LBI–LBII strata of Square 64.72 have special importance since both the archaeological contexts and the quality of the artifact assemblage display a complete picture of the vitreous techniques practiced at Alalakh (fig. 7.1)

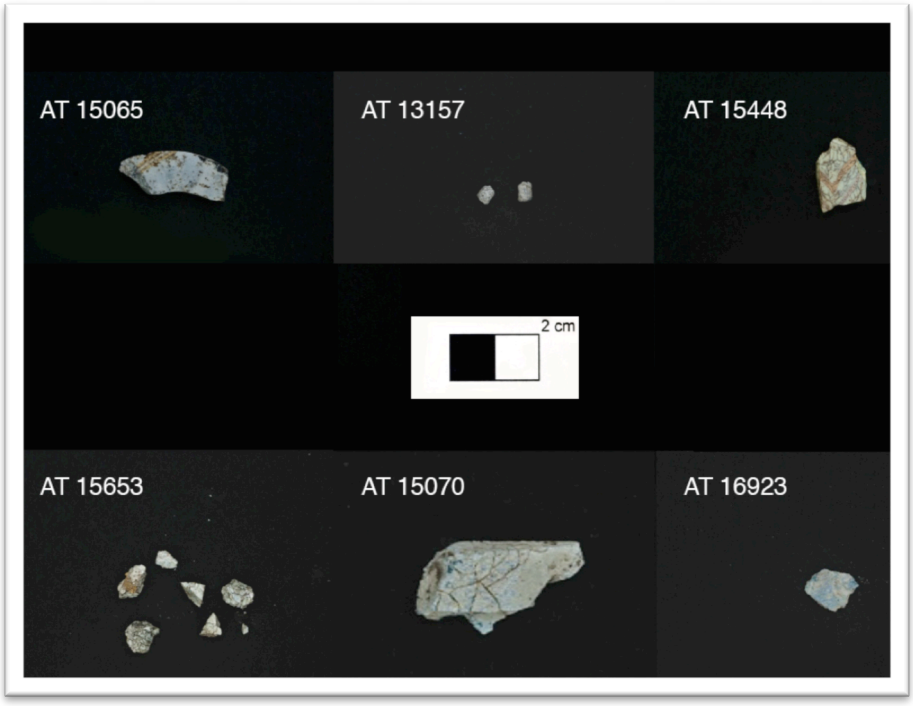


Fig. 7.1: Samples from the vitrified material assemblage of Square 64.72 including glass vessel fragments AT 15065, AT 15448, and AT15653.

The selection of the samples was based on the archaeological contexts. Artifacts recovered from secure archaeological contexts, such as from the floor levels or areas in and around the pyrotechnological installation, were given priority. Some artifacts from Square 64.72 were examined with more than one instrumental method in order to fully investigate all the features of the production technologies practiced at the time of this specific stratum.

The most important piece comes from Locus 61, located in the northeastern part of the installation. This crucible with frit-like material (AT13916, catalogue number: 241) shows a heterogeneous microstructure. The frit-like material is white colored and porous with some holes visible at the cross section. The magnified microscopic view (1000x) shows vitreous character of the surface and the heterogeneity of the structure (figs. 7.2–7.4).

Fig. 7.2: AT 13916. The red asterisk shows the point of SEM imaging (photo courtesy Alalakh Excavations archive).

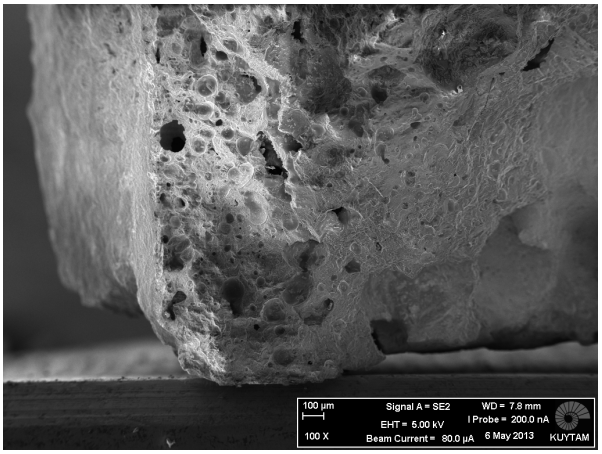


Fig. 7.3: 100X magnified secondary electron SEM image of AT 13916.

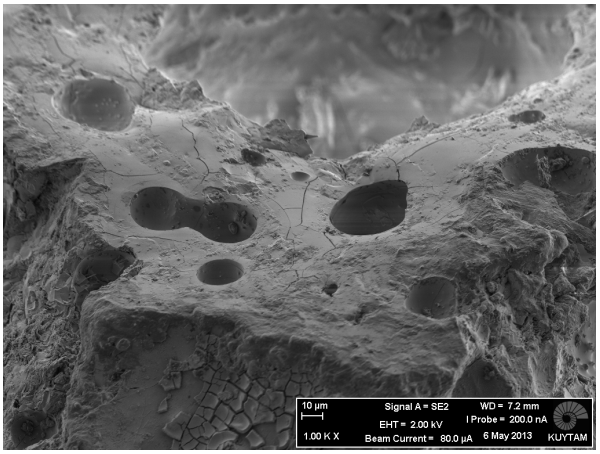
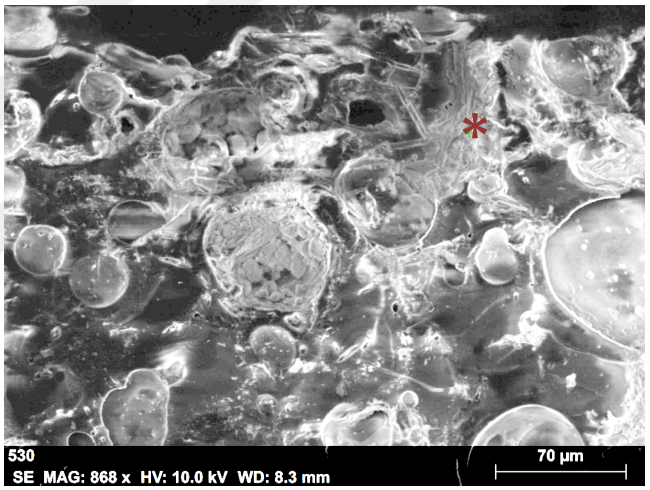
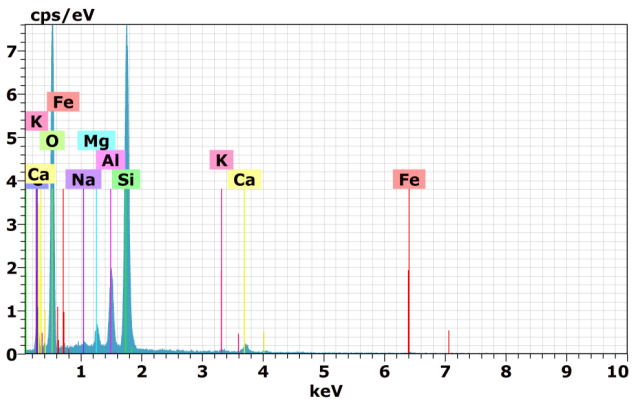


Fig. 7.4: 1000X magnified secondary electron SEM image of AT 13916.

The SEM–EDX shows a highly vitrified microstructure. The EDX graph shows the elemental composition at the selected point and the table shows the quantitative weight percentages of the elements (figs. 7.5a–c). Oxygen has the highest weight percentage, followed by silica, as expected. Carbon is coming from the carbon tape used to stabilize the artifact to the SEM stub. As mentioned in chapter VI, EDX has a lower level of precision as well as having the disadvantage of calculating components as elemental forms instead of oxide forms, which is a generally used in glass studies. To obtain oxide weight percentages, the sample was run in XRF.



(a)



(b)

Spectrum: Acquisition

El	AN	Series	Net	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error (1 Sigma) [wt.%]
O	8	K-series	23157	46.85	45.41	53.72	5.94
Si	14	K-series	31599	32.94	31.93	21.52	1.39
C	6	K-series	2503	11.97	11.60	18.28	2.18
Al	13	K-series	7015	5.06	4.91	3.44	0.27
Ca	20	K-series	980	2.53	2.45	1.16	0.15
Fe	26	K-series	107	2.08	2.02	0.68	0.28
Mg	12	K-series	1648	1.14	1.11	0.86	0.10
K	19	K-series	203	0.40	0.39	0.19	0.06
Na	11	K-series	242	0.19	0.19	0.15	0.05
		Total:		103.15	100.00	100.00	

(c)

Fig. 7.5: (a) SEM image of AT 13916. The red asterisk shows the point where EDX is taken; (b) EDX peaks showing the elements; and (c) EDX elemental results.

XRF shows 80.8% silica, which is higher than expected for the analyzed glasses of the region (Appendix IV, Table 2; Brill 1999; Shortland and Eremin 2006; Smirniou and Rehren 2011). Lime was found as 9.94%, but the soda level could not be determined. The reason for depressed lime and soda levels are due to the weathered nature of the frit-like part. Besides the critical lime and soda contents, the oxide percentages show relatively high percentages of alumina and iron compared to Mesopotamian and Egyptian glass. These elevated values of alumina and iron might be due to the interaction of the frit-like part with the crucible.

A piece of the crucible was also analyzed by the Faculty of Engineering in Nottingham University using a Philips XL30 SEM fitted with a tungsten (W) electron gun and operated at a beam (accelerating) voltage of 20kV and 15nA. Quantitative analyses were determined using an INCA EDX microanalysis system. The analytical results are in preparation for publication, but it is worthwhile to

briefly mention them.[186] In these examinations, the ceramic part of the crucible and frit-like material attached to it were investigated. The interface between the crucible and frit-like material shows pores indicating a release of gas as the raw materials broke down. The quantitative investigations done at Nottingham University have the same results superimpose with examinations in KUYTAM in terms of soda, aluminium, and iron compositions.[187] The low level of soda (max. 2.1%) is most probably due to weathering. The remaining frit-like material is likely highly contaminated by interaction with the crucible.

A similar crucible fragment was found at the later Ramasside (13th century B.C.) site of Qantir and confirmed as a crucible fragment containing the remains of a glassmaking batch (Rehren 1997). In the Qantir sample, diopside crystals were also detected. Rehren and Pusch (2005) have discussed the occurrence of diopside minerals as evidence of glassmaking. The XRD analysis of AT 13916 (catalogue number: 241; Appendix IV, fig. 1) shows crystalline phases, which are identified as diopside and silica supporting the glassmaking at Alalakh.

The crucible fragment is one the most spectacular finds for glass production, and more specifically for glassmaking evidence from the LBI–LBII strata; further examinations were done with ICP–MS on fragments of amber, turquoise, a blue and opaque white-colored beads, vases, and ingot. A total of 14 glass fragments were analyzed. All of them were found as soda–silica–lime glass, reflecting the typical second millennium B.C. major glass composition. The average soda–silica–lime

[186] The author, Prof. Julian Henderson, Prof. Aslıhan Yener, and Martin Roe will publish the results of these sets of examinations in an article entitled "Primary Evidence for Glassmaking in the Late Bronze Age at Tell Atchana, Alalakh (Amuq Valley, Turkey)." Thus, the examinations are not completely the private intellectual property of the author to use within the dissertation.

[187] The complete results of these analyses will be published in the aforementioned article.

levels are provided in Table 7.2, in comparison with Brill's published data of Alalakh.

Within the LBI–LBII assemblage, a blue ingot fragment recovered from the kiln is especially important. Its strontium and neodymium isotopic values are discussed below; the trace element composition demonstrates significant features pointing towards the local production of glass in the Square 64.72 pyrotechnical installation. This transparent blue ingot fragment (AT 16968, catalogue number: 291) was found to be colored with copper (8903.4567 ppm) with a significant amount of arsenic (585.9856 ppm).

In the LBI–LBII glasses, copper was detected as the colorant for blue; however, one blue (AT 16306, catalogue number: 274) and one pale blue (AT 16333, catalogue number: 276) glass fragment have 63.5975 ppm and 59.2387 ppm cobalt, respectively. These two blue glass fragments have the highest levels of cobalt among the whole LBI and LBI–LBII corpus. In general, the cobalt values of the Alalakh glasses vary between 1–3 ppm with only one exception of 6.2119 ppm cobalt in the MBII turquoise bead (AT 15825, catalogue number: 4). Such elevated levels of cobalt in these beads (AT 16306, catalogue number: 274; AT 16333, catalogue number: 276) point towards an Egyptian origin (Kaczmarczyk 1986); however, the high arsenic values (600.4367 ppm and 111.892 ppm, respectively) of the Alalakh examples do not match the Egyptian glasses. The trace element values published by Shortland et al. (2007) show 55.4 ppm as the highest arsenic content from Malkata (sample UPP27, blue rod). In the same study, 165.9 ppm is detected as the highest arsenic level among the group called Mesopotamian glasses, where the sample is a blue ingot (HH 224) from Tell Brak. In another study, Tell Brak glasses were

analyzed with the electron microprobe though the arsenic values were not detected (Henderson 1997: 98, Table 7).

The transparent blue ingot fragment, AT 16968 (catalogue number: 291), has 585.9856 ppm arsenic. Two other light blue and blue artifacts, the latter belonging to vase fragments, have 289.458 ppm and 302.1147 ppm arsenic contents, respectively. However, the opaque white-and-beige-colored beads have lower than 100 ppm arsenic.

The existence of arsenic in copper-colored glasses is also observed in LBI glasses (see section 7.2). This trend seems continuous for the glasses dated to the LBI–LBII transition period. Furthermore, as also observed in the LBI, the tin contents of glasses dated to this transitional period are below the detection limit, except for AT 14764 (catalogue number: 250) and AT 15013 (catalogue number: 256). AT 14764 (catalogue number: 250) is a blue-colored bead and contains 11.8951 ppm tin most probably indicating use of a scrap metal including tin (i.e. bronze). AT 15013 (catalogue number: 256) is an opaque white bead and has 14.6767 ppm arsenic. As the ICP–MS results for the majority of the samples demonstrate, arsenic impurity/addition is more common than tin in copper colored or examples containing examples. As the LBI glasses also demonstrate, if scrap metal had been used as a colorant, rather than tin bronzes, arsenical bronzes must have been preferred.

As reviewed in chapter V, the LBI–LBII archaeological context of Square 64.72 yielded many metal artifacts in association with glass, faience, and frit objects from the so-called workshop area. Investigations on these artifacts are the subject of

Michael Johnson's doctoral dissertation at the University of Chicago.[188] The analytical investigations on these metal artifacts will demonstrate the type of alloying for the workshop debris. If the results confirm the existence of arsenical bronzes, a strong relationship could be made between metal and glass producers in the LBI–LBII period at Alalakh.

The opaque glass samples from this stratum have antimony values at a maximum of 29.9484 ppm and a minimum of 11.8493 ppm, thus indicating the use of antimony as the opacifier. In terms of yellow colorant, the yellow vase fragments (AT 15653-2, catalogue number: 269) have 34.2241 ppm lead. The highest lead content (31.4108 ppm) is found in the turquoise-colored (AT 15070, catalogue number: 261) ingot (?) fragment. The blue ingot has 35.7493 ppm lead. It is known that lead makes glass more viscous and increases the workability of glass. It is noticeable that the highest values of lead are detected in ingot fragments, but statistically two samples are not enough to elaborate further on the relationship of lead contents versus ingots.

Major Element (wt%)	***ICP–MS mean compositions for LBI–LBII glasses***	***St. Dev. for LBI–LBII glasses***	***Mean compositions from Brill (2012: 264)***
SiO_2	64.1120	3.4280	67.10
Na_2O	17.4333	3.6398	17.87
CaO	6.4572	1.7944	6.03
MgO	2.7182	0.7889	3.98
Al_2O_3	1,0581	0.4554	0.75
Fe_2O_3	0.4651	0.2646	0.58
K_2O	2.4531	0.4259	3.69

Table 7.2: ICP–MS mean compositions for LBI–LBII glasses. In this dissertation, four significant numbers are used to calculate average values and the standard

[188] The title of this dissertation has not yet been decided according to my correspondence with Michael Johnson on May 2, 2016.

deviations. For the standard deviation values of Brill's analysis, please see the reference cited.

As I mentioned in chapter V, besides glass artifacts, faience objects were also recovered from this archaeological stratum. The glazed surface of most of the faience objects were washed off. The faience collection was mainly composed of intact faience beads, and thus it was hard to find a piece for archaeometric investigation. Despite these limitations, a faience cup (?) fragment with inventory number AT 16928 (catalogue number: 287) was analyzed. AT 16928 (catalogue number: 287) has a lovely turquoise color at the outer surface, which is the convex side. The concave side, which must have been the interior surface, has an opaque white-partially pale blue glaze (fig. 7.6). The 100X magnified SEM image shows the glaze and the core where the core looks homogeneous (fig. 7.6). In the EDX, silica, calcium, and sodium were detected, together with high levels of aluminum, potassium, and iron (figs. 7.8a–b). Copper is detected at 3.98% in the glaze, serving as colorant for the blue surface. XRF data shows silica as 85.3%, soda as 0.15%, and lime as 5.73% (Appendix IV, Table 2). The low levels of soda and lime must have caused the disadvantage of weathering. Iron (0.477%) and alumina (1.42%) levels could be the result of the interaction between the core and the glaze.

In the SEM image, there is a clear boundary between the body and glaze. The glazing on the surface looks homogeneous with approximately the same thickness, and the interface between the body and the glaze is sharp. Such a boundary provides information on the production technique, which must have been cementation according to the existing evidence (chapter III).

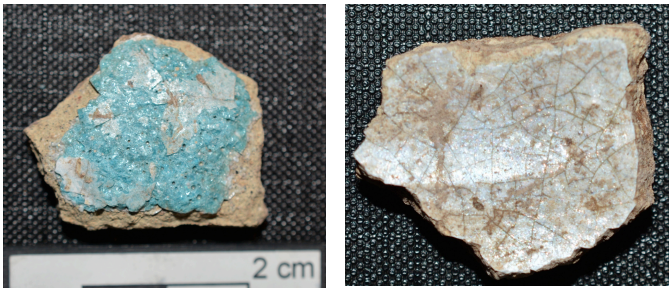


Fig. 7.6: AT 16928

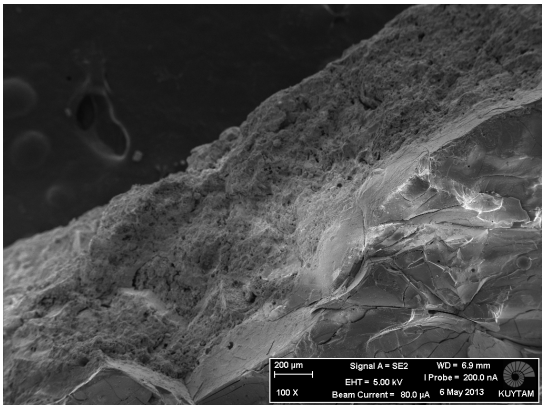
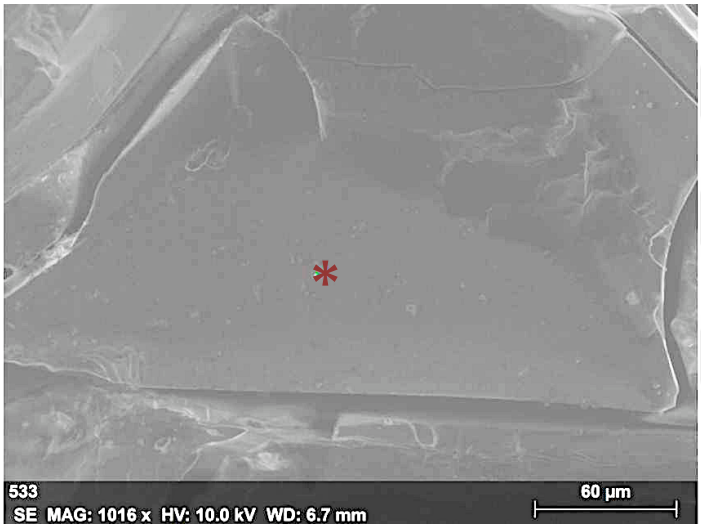
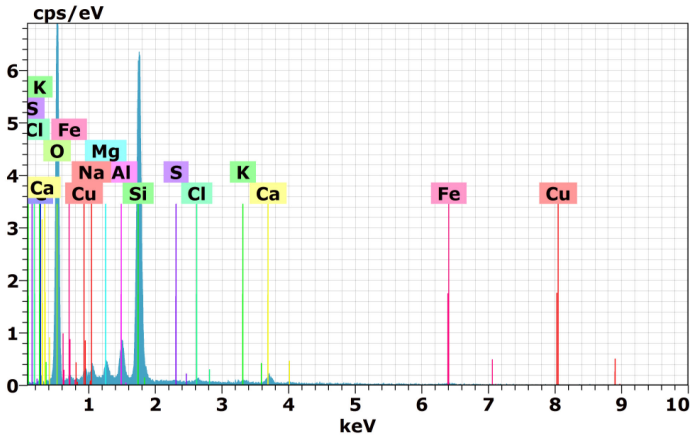


Fig. 7.7: 100X image showing the glass and shard together.



(a)



(b)

Fig. 7.8: (a) SEM image of AT 16928; and (b) EDX graph of the spot shown with red asterisk in (a).

A blue frit fragment dated to this period (AT 16939, catalogue number: 288) was analyzed with XRF and found as colored with 15.67% copper oxide (Appendix IV, Table 2). The matrix was found as silica. Soda (7.18%) and lime (4.86%) were detected as fluxing agents. Alumina and iron levels are 2.03% and 1.98%, respectively, which is consistent with the LBI–LBII corpus of all the vitrified artifacts.

7.4 LBII

A total of 11 samples dated to the LBII levels of Tell Atchana, ancient Alalakh, were analyzed with ICP–MS for major and trace elements. All of them are beads and correspond to the Late Bronze Age major glass composition with contents of silica averaging 63.6833%, soda 16.4971%, and lime 8.0880%. Standard deviations and comparison to other Alalakh glasses published in the literature (Brill 2012) are listed in Table 7.3.

Major element (wt%)	***ICP–MS mean compositions for LBII glasses***	***St. Dev. for LBII glasses***	***Mean compositions from Brill (2012: 264)***
SiO_2	63.6833	2.2615	67.10
Na_2O	16.4971	1.4274	17.87
CaO	8.0880	0.6761	6.03
MgO	3.6594	0.6410	3.98
Al_2O_3	0.5175	0.1026	0.75
Fe_2O_3	0.3470	0.0598	0.58
K_2O	3.6475	0.4333	3.69

Table 7.3: ICP–MS mean compositions for LBII glasses. In this dissertation, four significant numbers are used to calculate average values and the standard deviations. For the standard deviation values of Brill's analysis, please see the reference cited.

In the LBII corpus, AT 19180-3 (catalogue number: 426), AT 19180-4 (catalogue number: 426), and AT 19180-5 (catalogue number: 426) are blue beads sampled from the same necklace (AT 19180, catalogue number: 426), which was recovered as a grave good from Square 64.94 (see chapter V). These three blue beads have copper values of 5693.8392 ppm, 7893.8392 ppm, and 7977.9293 ppm, respectively, indicating the use of copper as the colorant for blue. AT 19180-4 (catalogue number: 426) contains 3.4597 ppm tin. Among the analyzed LBII samples, there are only two beads with tin content. One is AT 19180-4 (catalogue number: 426); the other is AT 4112 (catalogue number: 414) with a tin level of 0.0239 ppm.

The other two blue beads from the same necklace, AT 19180-1 and AT 19180-2 (catalogue numbers: 426), have 8.2286 ppm and 2.4419 ppm cobalt together with 250.5761 ppm and 57.6342 ppm copper, respectively. AT 19180-2 (catalogue number: 426) also contains 107.7656 ppm arsenic. The elemental level of cobalt found in AT 19180-1 (catalogue number: 426) is the highest among the LBII corpus of analyzed glasses. Based on the ICP–MS results, cobalt and copper might have been used together as colorant for AT 19180-1 (catalogue number: 426) or they might be coming from the ore. The same argument applies to AT 19180-2 (catalogue number: 426); however, this bead also contains arsenic, which points towards the use of arsenic-bearing copper or arsenical bronze scrap as colorant.

The analysis of five beads from the same necklace, AT 19180 (catalogue number: 426) (or originally not part of the same necklace, but part of the same grave good assemblage), demonstrates a complex characteristic for LBII glasses found at the site. According to the trace element level compositions, three different groups are visible for blue beads: the first group is colored with copper, the second is colored

with cobalt and copper, and the third group is colored with cobalt and copper and also contains arsenic. It is known that cobalt could be found in association with other minerals such as copper ($2Co_2O.CuO.6H_2O$), arsenic (CoAsS), nickel and iron ((Co, Ni, Fe) As_3) (Henderson 2000: 30).

It is also critical to mention that only bead AT 19180-4 (catalogue number: 426) contains tin, though tin in Tell Atchana, ancient Alalakh, glasses are generally not common (see sections 7.1–7.2). This grave good assemblage points towards more than one supply for blue glass beads. There is a possibility of using locally produced beads together with imported ones, such as Egyptian glasses, if the cobalt-bearing samples were imported from Egypt. It is also possible that different cobalt sources associating with different elements such as copper and/or arsenic might be used for these glass beads. There could have been a dynamic system supplied with both local and imported products, which is discussed in chapter IX.

Besides the five samples recovered and analyzed from the beads of AT 19180 (catalogue number: 426), one bluish gray bead (AT 2736, catalogue number: 366), one light green bead (AT 3326, catalogue number: 369), and one white/gray bead (AT 4112, catalogue number: 414) were analyzed. All of these samples were opaque and were found to contain antimony between 11–22 ppm. The use of antimony as an opacifier is coherent both with the rest of the Alalakh assemblage as well as Mesopotamian and Egyptian glasses dated to the LBA (section 7.5).

From the LBII contexts, three faience beads were available for SEM–EDX analysis. AT 17967 (catalogue number: 374) was recovered in Square 64.73 from loose soil with pottery, bone, and slag. Even though its context was mixed, this bead provided an opportunity to investigate the production technique of faience. The SEM–EDX of the core (fig. 7.9), the glaze (fig. 7.10), and the qualitative results

obtained with EDX are given (fig. 7.11). According to the results, the glaze contains copper, thereby indicating that copper was used as the colorant for blue. Calcium and sodium values were detected as lower than usual and iron and alumina were found to be higher, possibly due to the long interaction between the core and the glaze. The boundary between the glaze and the core is easily visible, indicating cementation as the production technique for this bead.

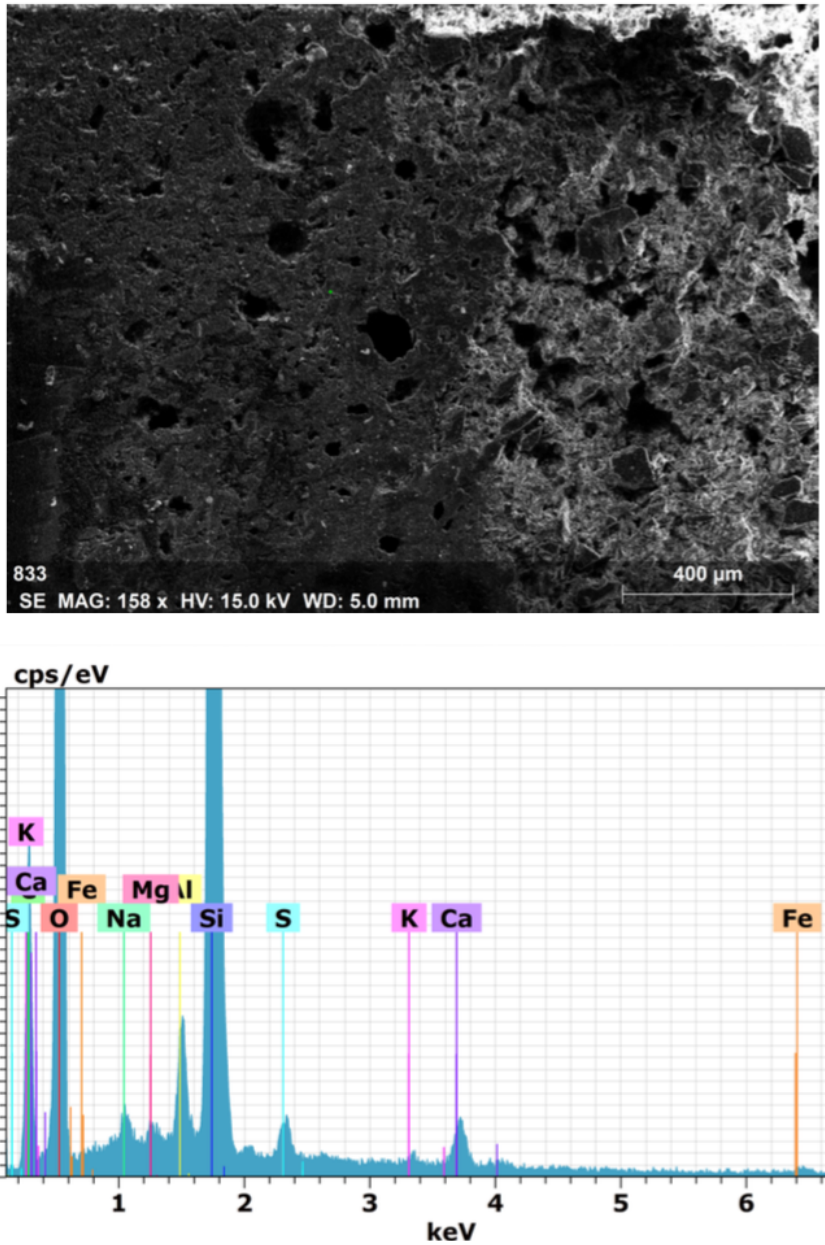
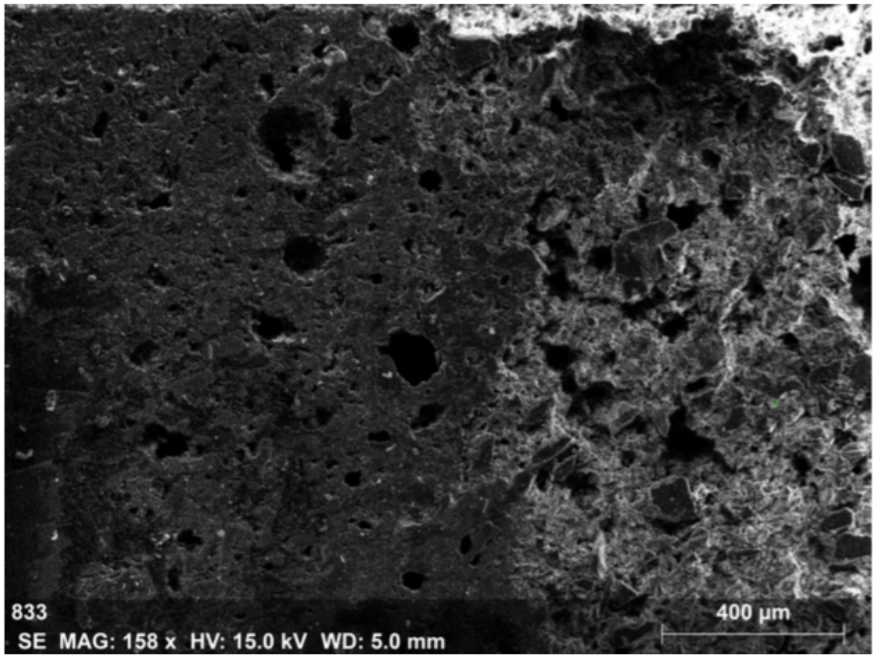


Fig. 7.9: AT 17967, SEM–EDX of the core, a green dot is slightly visible in the image showing the EDX point.



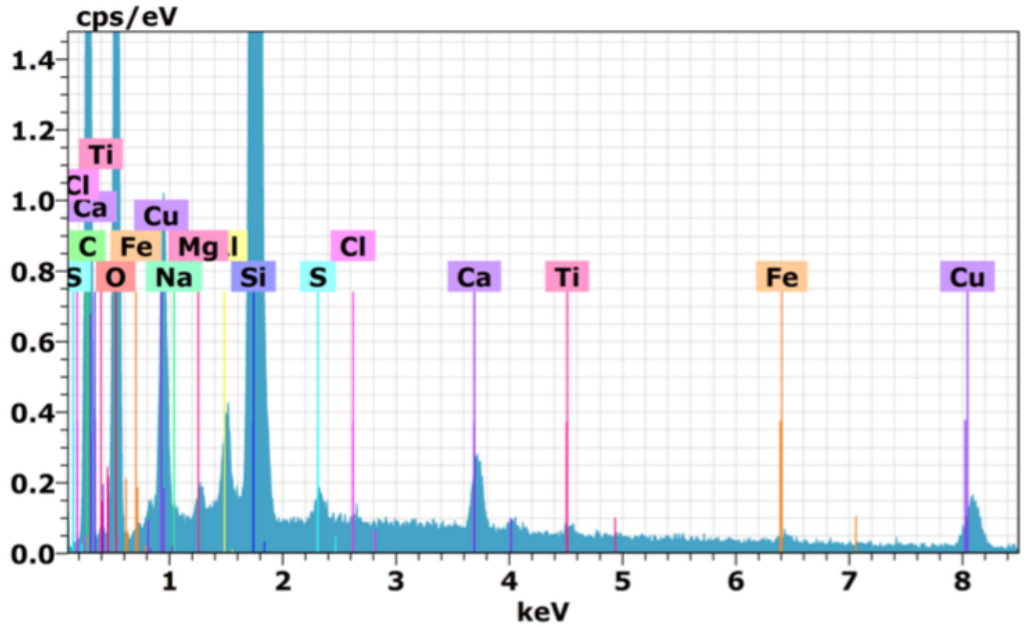


Fig. 7.10: AT 17967, SEM–EDX of the glaze, a green dot is slightly visible in the image showing the EDX point. Copper was detected as the colorant.

Spectrum: Acquisition

Element	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Compound	norm. Comp. C [wt.%]	Error (3 Sigma) [wt.%]
Oxygen	33.32	45.76	63.21		0.00	13.03
Carbon	0.00	0.00	0.00		0.00	0.00
Silicon	26.82	36.82	28.98	SiO2	78.77	3.44
Aluminium	1.01	1.39	1.14	Al2O3	2.63	0.24
Iron	0.55	0.75	0.30	FeO	0.97	0.18
Sodium	0.16	0.22	0.22	Na2O	0.30	0.13
Calcium	1.59	2.18	1.20	CaO	3.05	0.25
Magnesium	0.22	0.31	0.28	MgO	0.51	0.13
Sulfur	0.47	0.64	0.44	SO3	1.60	0.15
Chlorine	0.11	0.15	0.10		0.15	0.10
Copper	8.31	11.41	3.97		11.41	1.07
Titanium	0.26	0.36	0.17	TiO2	0.60	0.13
Total:	72.83	100.00	100.00			

Fig. 7.11: AT 17967, glaze composition obtained with SEM–EDX.

Three fragments of light blue faience beads (parts of AT 19180, catalogue number: 426) are analyzed with SEM–EDX (figs. 7.12–16). Even though SEM images are obtained with 100x and 200x magnifications, a quantitative analysis with EDX was not possible due to a vacuum problem in the chamber of the instrument (chapter VI). That problem could not be solved in time for this dissertation. Even though the elemental compositions are not available, the back-scattered electron images show how the glaze was applied to the core. Similar to the other analyzed faience artifacts, all of the microscopic images indicate the cementation technique for the production of these artifacts. The glaze and core are distinguishable and the glaze coating appears homogeneous and to have the same thickness in the SEM images, which supports cementation as the manufacturing technique.

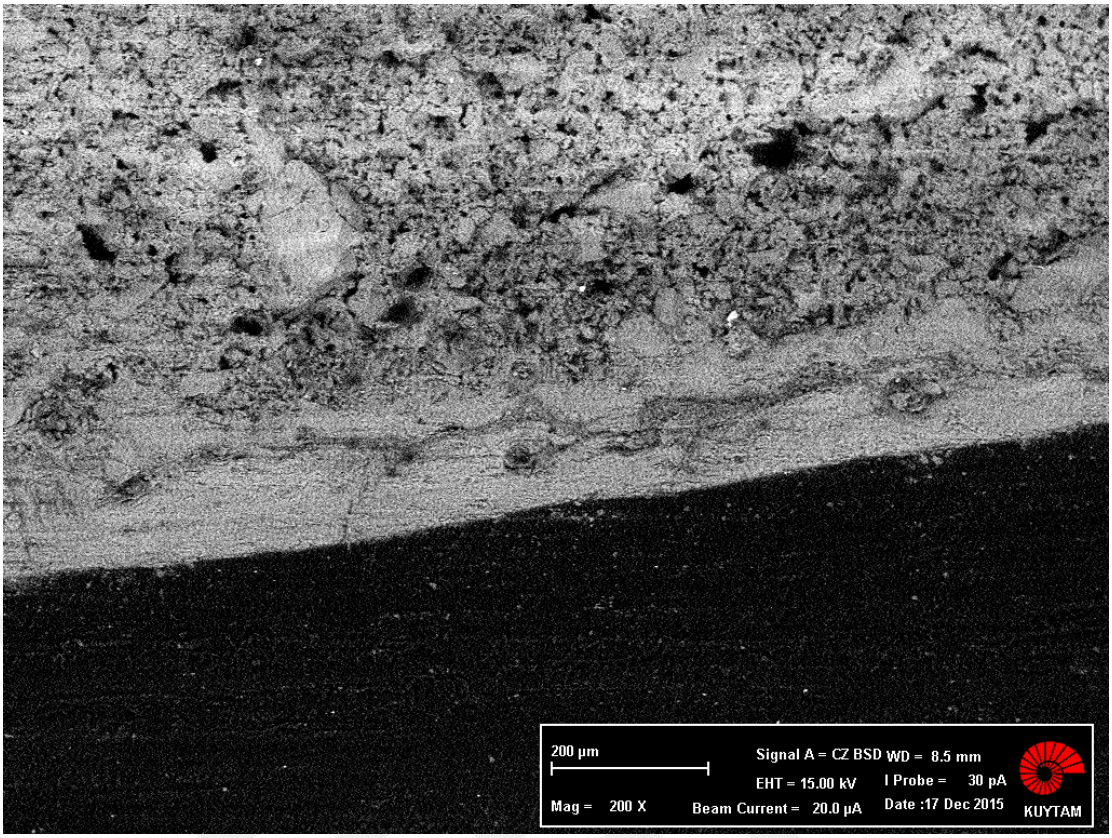


Fig. 7.12: A faience bead fragment (AT 19180a) from the necklace documented with the inventory number AT 19180. 200x magnification.

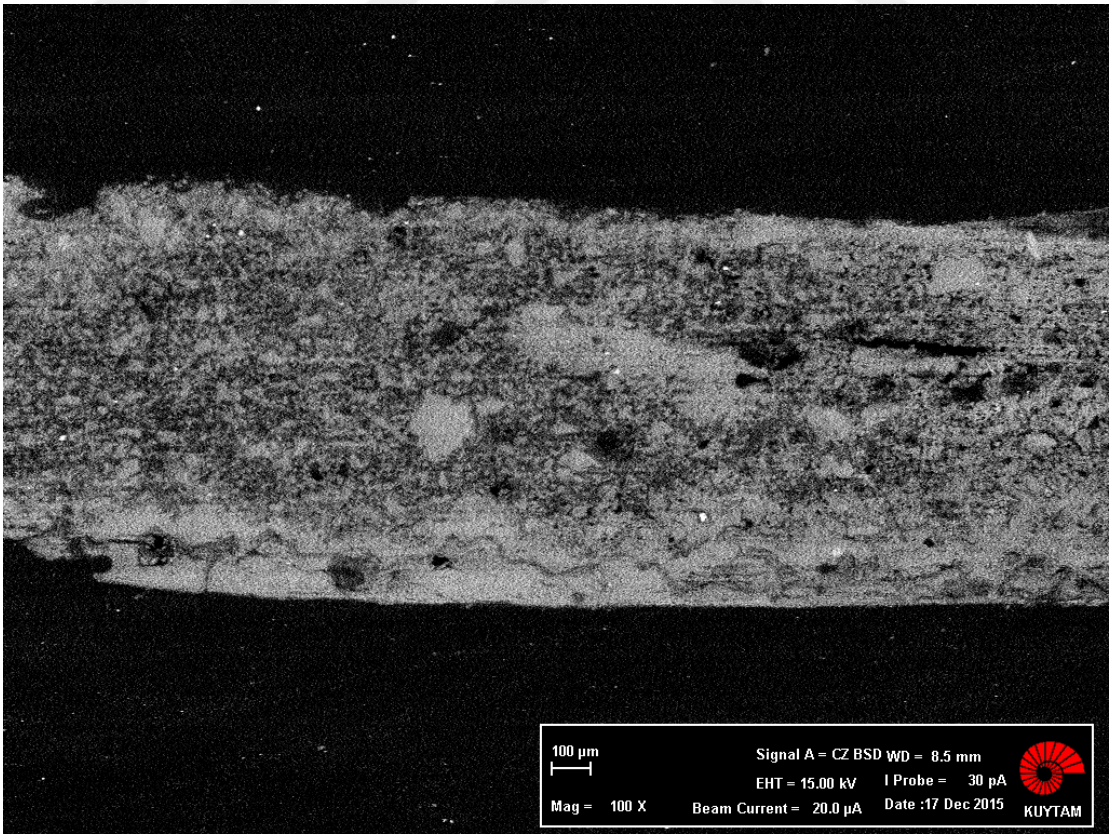


Fig. 7.13: A faience bead fragment (AT 19180b) from the necklace documented with the inventory number AT 19180. 100x magnification.

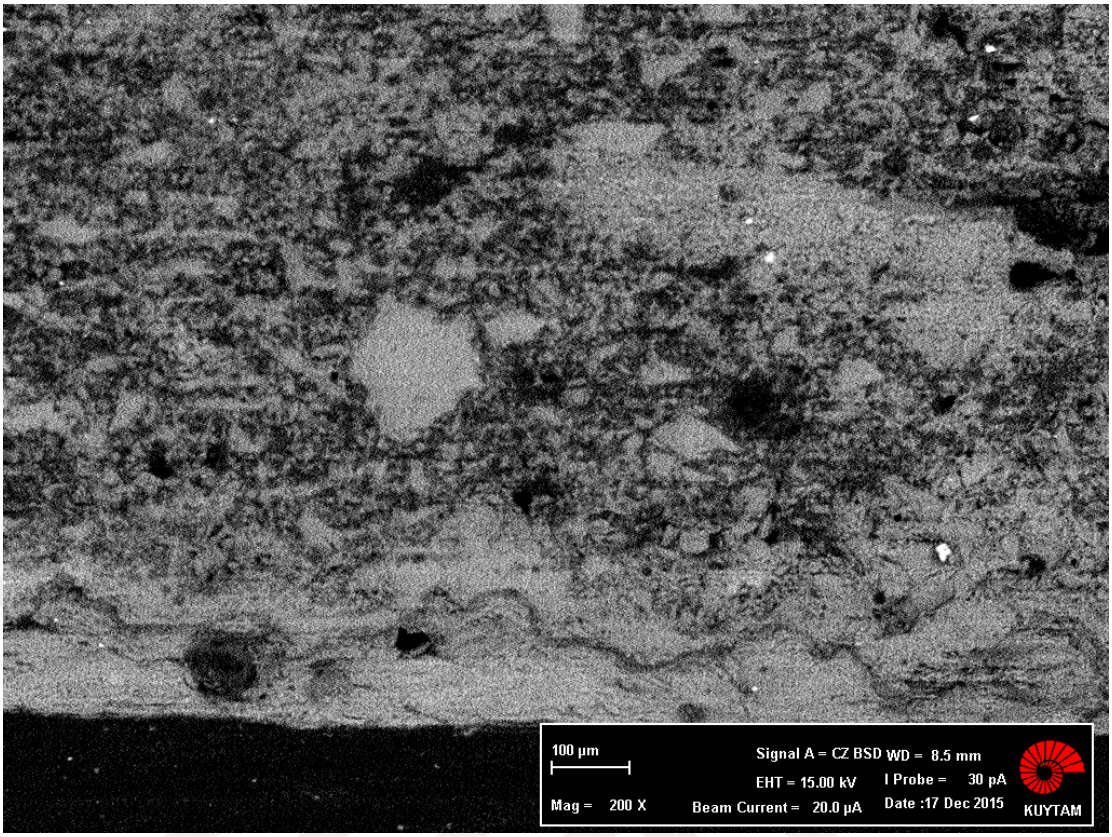


Fig. 7.14: A faience bead fragment (AT 19180b) from the necklace documented with the inventory number AT 19180. 200x magnification.

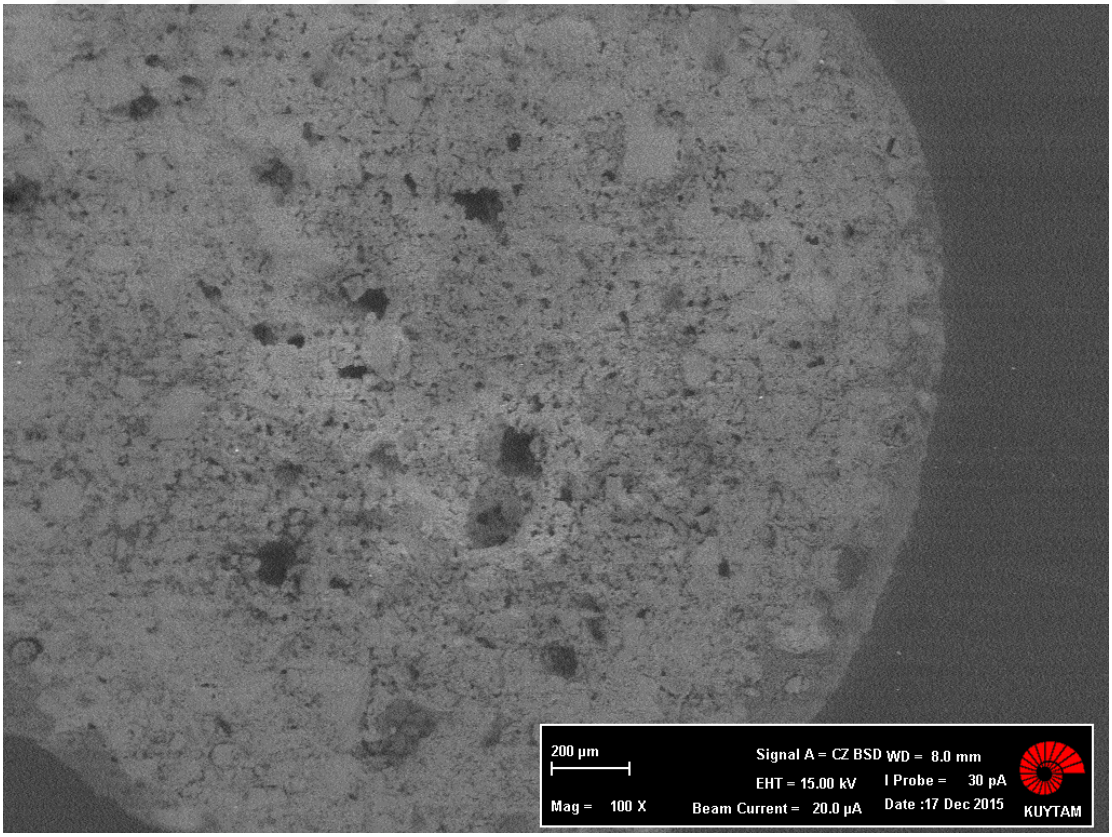


Fig. 7.15: AT 17892, blue faience bead. 100x magnification.

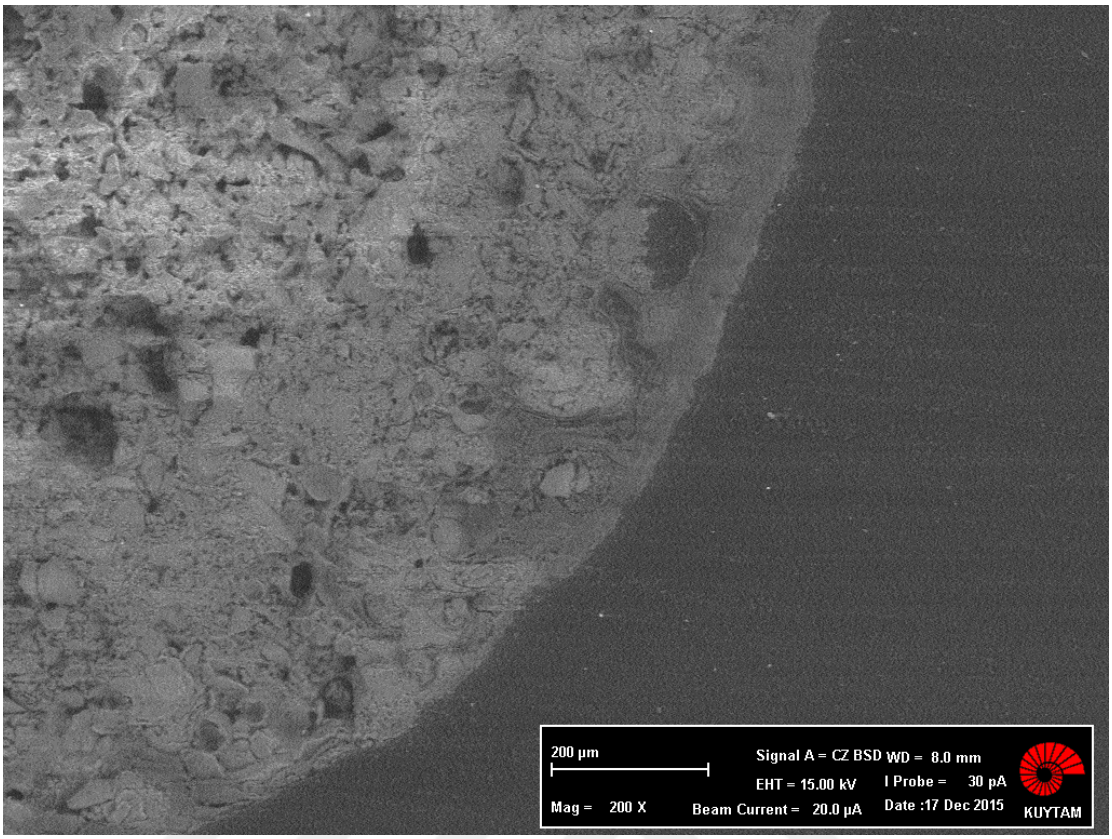


Fig. 7.16: AT 17892, blue faience bead. 200x magnification.

For the LBII levels, there is another artifact that needs attention. Even though the chronology of the level is under study, in 2012, Square 42.10 temple sounding yielded an amorphous, spongy, Egyptian blue chunk (AT 18864, fig. 7.17). A similar one was found in Nuzi and identified as pigment for Egyptian blue by Susanne Kirk (2009) in her doctoral dissertation. The XRF analysis on the Egyptian blue fragment (AT 18864) shows silica (70.12%), calcium (lime; 10.23%), and soda (2.22%), along with 12.86% copper oxide indicating that copper was the colorant. These values are similar to the Egyptian blue and green frits known from Amarna, Tell Brak, and Tell Rimah (Hatton et al. 2008). More lumps of Egyptian blue were recovered, especially in the Area 4 locations related to the craft quarter zone, though they will not be covered within this dissertation since they were excavated in the 2015 season.

Figure 14: Egyptian blue pigment, raw lump and close up of interior

(a)

(b)

Fig. 7.17: (a) Nuzi Stratum II, Egyptian blue pigment (Kirk 2009); (b) Alalakh AT 18864, Square 42.10.

7.5 A General Comment on the ICP–MS Analysis of Alalakh Glass

7.5.1 Major Element Compositions

All 46 samples analyzed with ICP–MS conform to the typical range of the second millennium B.C. glasses. The silica levels of all samples average 63–64% and soda levels are 16–17%, with slightly higher values of soda in the LBI–LBII transition period (Table 7.1–7.3; fig. 7.18). These values are within the range of Mesopotamian (Tell Brak) and Egyptian (Amarna) glasses of the LBA as known from the literature (fig. 7.19) (Shortland et al. 2007 with references cited).

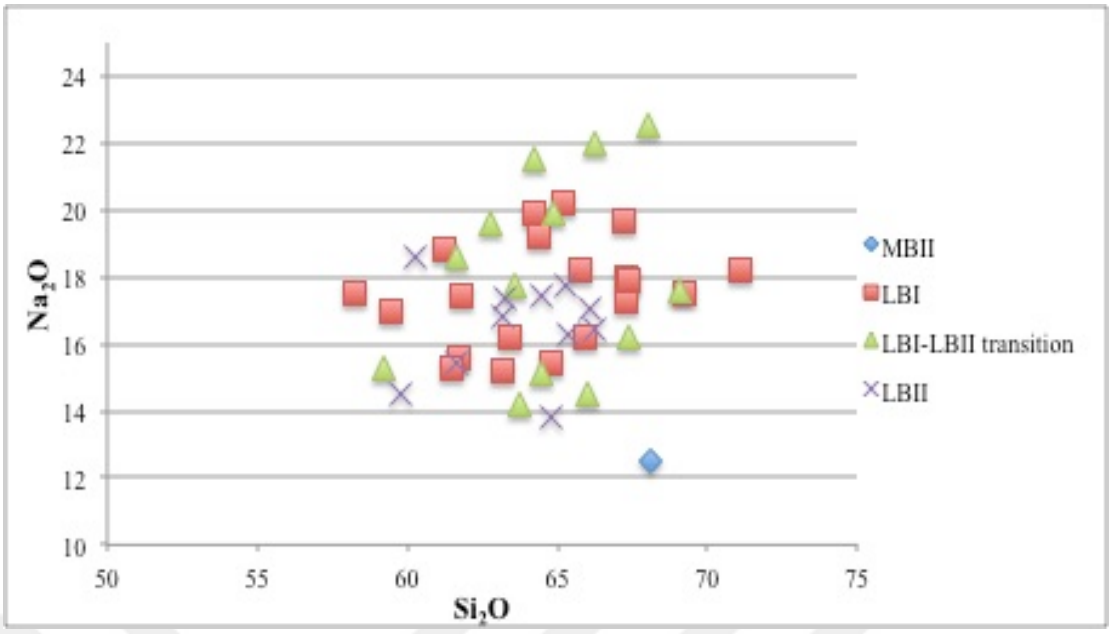


Fig. 7. 18: Soda and silica levels of all samples distributed by period.

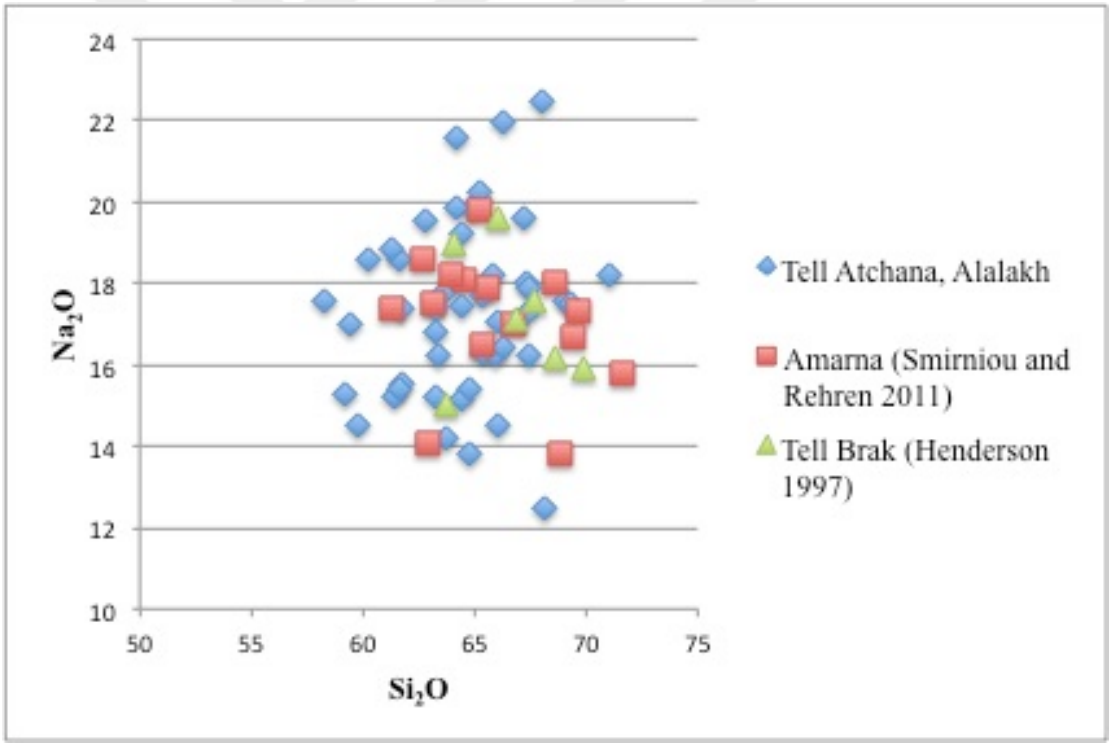


Fig. 7. 19: Soda and silica levels of all samples distributed among other glass compositions as known from the literature (Smirniou and Rehren 2011; Henderson 1997). The Tell Atchana, ancient Alalakh, corpus was evaluated regardless of chronological attributions.

Lime levels average 6–8% where LBII glasses cluster within a narrower group (Table 7.1–7.3; fig. 7. 20). Magnesia values average around 3%, indicating

that plant ash was used for all the analyzed samples. The LBI and LBII glasses have higher levels of lime, whereas the composition of LBI–LBII transitional period glasses have a broader range in lime concentrations. Most of the LBI glasses have magnesia levels between 2.5–4%, which is slightly lower than the LBI–LBII transitional period glasses, for which 2.5–3.5% appears as the dominant range.

Alalakh glasses have lower magnesia levels than Mesopotamian and Egyptian glasses in the LBI and LBI–LBII periods, whereas the LBII magnesia levels are more similar to the LBA comparatives of Tell Brak and Amarna. Lime levels tend to be higher at Tell Atchana, ancient Alalakh, than Tell Brak, though magnesia levels are found to be mostly lower than Tell Brak (fig. 7. 21).

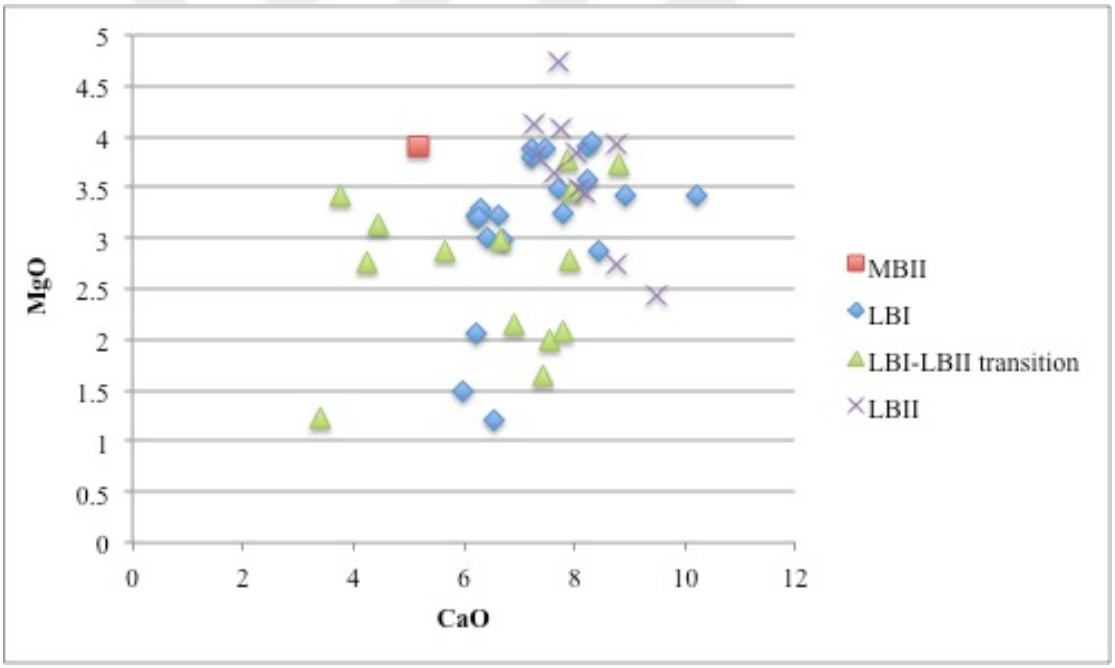


Fig. 7. 20: Lime and magnesia levels of all samples distributed by period.

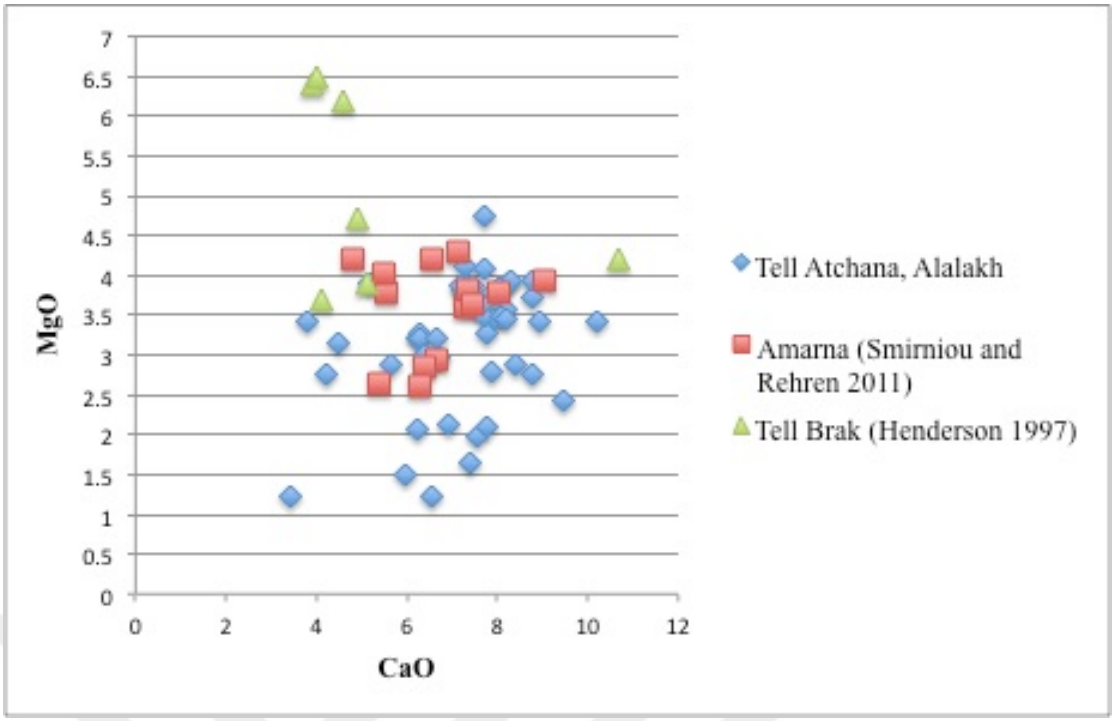


Fig. 7. 21: Lime and magnesia levels of all samples distributed among other glass compositions as known from the literature (Smirniou and Rehren 2011; Henderson 1997). The Tell Atchana, ancient Alalakh, corpus was evaluated regardless of chronological attributions.

The identification of low potash was reported for the LBA glasses (Liyquist and Brill 1993: 42; Smirniou and Rehren 2011: 68). A similar pattern is observed for MBII, LBI–LBII, and partially for LBI glasses. This might indicate the use of plant ashes of different plants or use of a plant with different potash ratio (Lilyquist and Brill 1993: 42). However, a significant number of the LBI glasses and the LBII glasses do not fit into the low-potash group (fig. 7.22). They have higher potash with lower than 1% alumina; this might indicate a selective use of plant ashes.

Low potash values in ancient glasses were mostly — but not entirely — related to cobalt coloring (Lilyquist and Brill 1993; Shortland and Eremin 2006; Smirniou and Rehren 2011). However, the low potash glasses of Tell Atchana, ancient Alalakh, were from the MBII and LBI–LBII levels, where copper dominated cobalt ppm values (fig. 7.23). There are two exceptions from the LBI–LBII context

where the cobalt levels are detected at approximately 60 ppm. These two dark blue-colored glass bead fragments with inventory numbers AT 16306 and AT 16333 are most probably imports from Egypt. I suggest that these beads are imports because the majority of the Alalakh glass artifacts, especially the ones found in the workshop debris (Square 64.72), contain copper as colorant for blue. Cobalt is generally rare in the local assemblage, thus supporting the fact that cobalt-bearing artifacts could have been related to Egypt.

Smirniou and Rehren (2011: 70) associate some low potash glasses with Amarna based on the identification of low potash semi-finished glasses found at the site. The low potash glasses of Alalakh, especially the ones from the LBI–LBII with high cobalt values, might be related to Amarna though generalizing such a suggestion would be dangerous for the rest of the LBI–LBII corpus. Furthermore, the MBII glasses, which are represented by the analysis of a single bead in the Alalakh corpus, does not allow further elaboration on low potash glass at the site.

Lower alumina levels indicate use of purer silica source during glassmaking (Henderson 2009). The alumina levels of Alalakh glasses vary between ca. 0.2–2%. The LBI and LBII have a narrower band for alumina, mostly clustered between ca. 0.2–1% (fig. 7.22). This suggests use of a purer silica source during LBI and LBII periods. However, the alumina levels of the LBI–LBII transitional period glasses are more diverse; compared to Amarna (Smirniou and Rehren 2011) and Tell Brak (Henderson 1997), alumina levels are elevated at Alalakh during this time period, with one exception from Tell Brak (fig. 7.23) which might be a sign of experimentation with the raw materials i.e. silica sources during the transitional period.

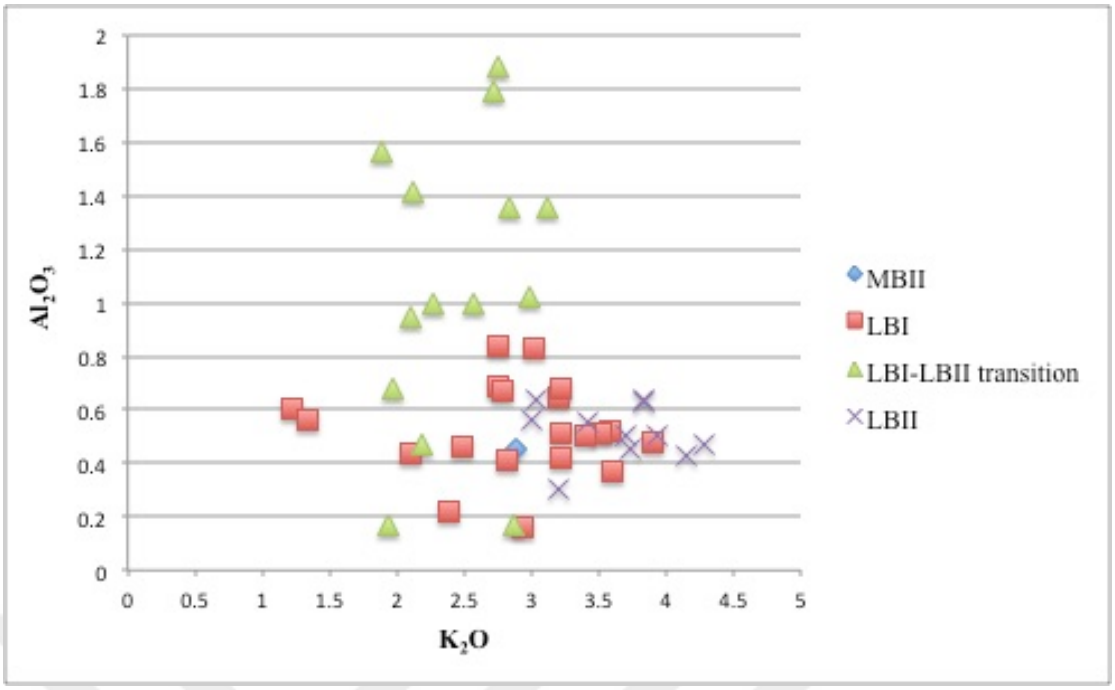


Fig. 7. 22: Potash and alumina levels of all samples distributed by period.

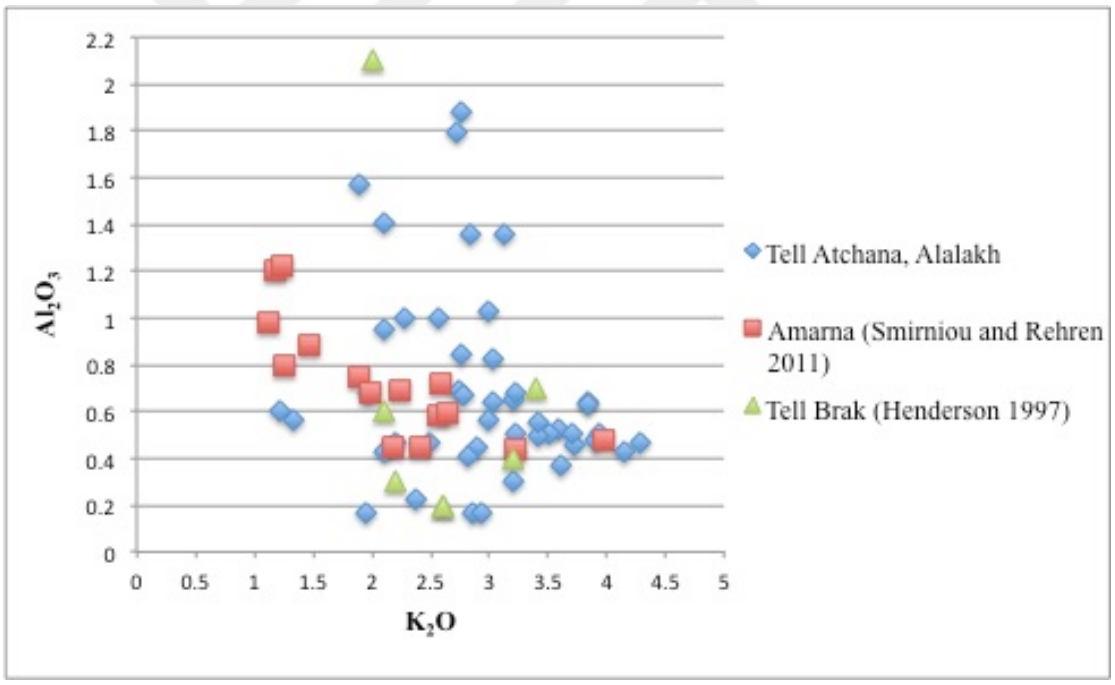


Fig. 7. 23: Potash and alumina levels of all samples distributed among other glass compositions as known from the literature (Smirniou and Rehren 2011; Henderson 1997). The Tell Atchana, ancient Alalakh, corpus was evaluated regardless of chronological attributions.

The alumina and iron levels of the Alalakh glasses have greater variation in the LBI and LBI–LBII transitional periods, whereas LBII glasses demonstrate a

narrower cluster (fig. 7.24). Compared to the literature, the whole of the LBII artifacts and some of the LBI objects have parallel results mostly with Amarna glasses, though the glasses with elevated levels of alumina and iron dated to the LBI–LBII transitional period demonstrate a noticeable difference within the existing evidence (fig. 7.25).

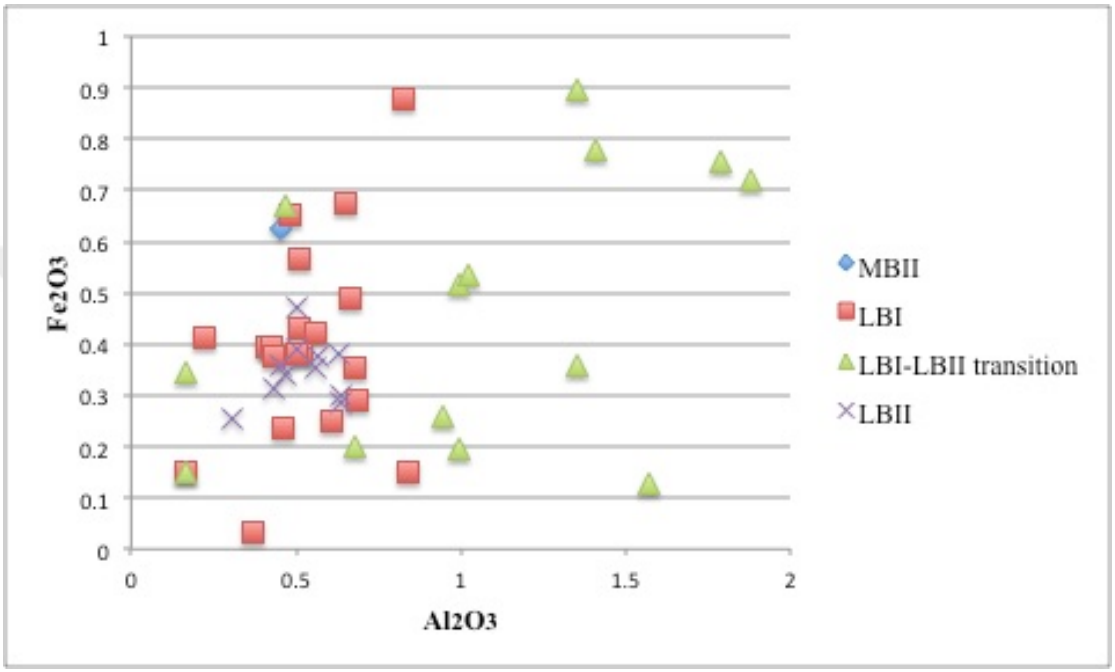


Fig. 7. 24: Alumina and iron levels of all samples distributed by period.

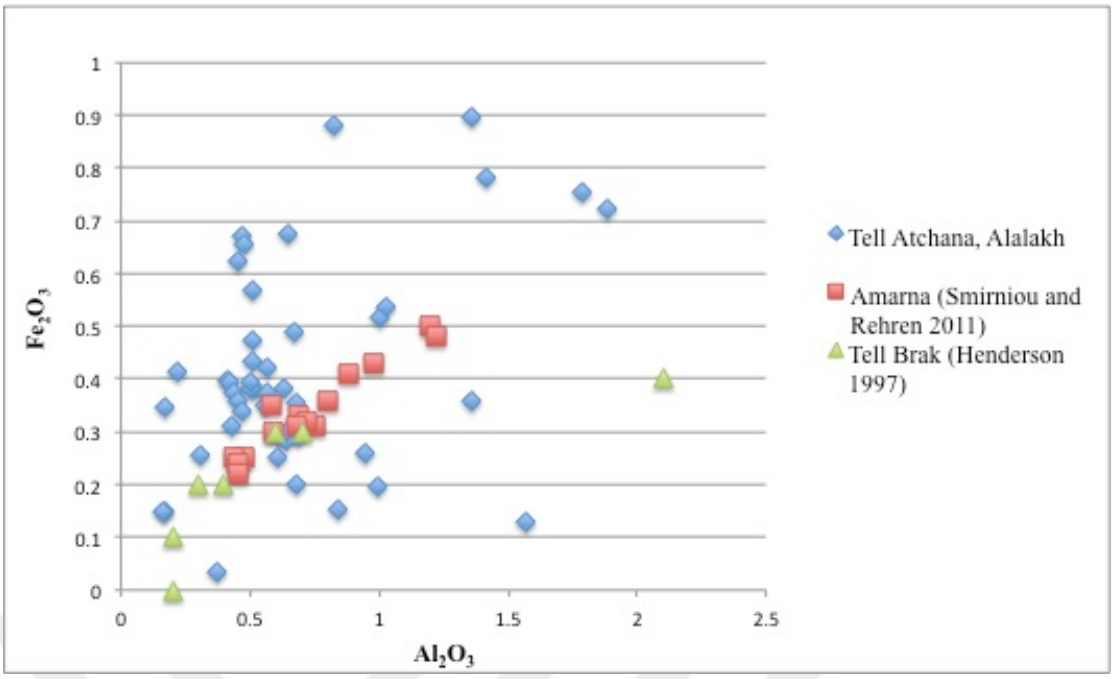


Fig. 7. 25: Alumina and iron levels of all samples distributed among other glass compositions as known from the literature (Smirniou and Rehren 2011; Henderson 1997). The Tell Atchana, ancient Alalakh, corpus was evaluated regardless of chronological attributions.

The glass samples analyzed from the LBI–LBII transitional period of Tell Atchana, ancient Alalakh, demonstrate unique characteristics with elevated and diverse major element compositions when compared to the rest of the assemblage. Furthermore, when compared to other Mesopotamian and Egyptian glasses, the diversities observed in the alumina and iron compositions within the assemblage for the LBI–LBII transitional period indicates ongoing experimentation for glassmaking. This idea is supported also with the trace element compositions.

7.5.2 Trace Element Compositions

In this study, 30 trace elements were measured with ICP–MS. The results are given in Appendix IV, Table 1. Three elements out of 30 — zinc (Zn), zirconium (Zr) and tungsten (W) — are not listed in Appendix IV since all these elements were found to be below the detection limits for all of the glass samples.

Zirconium is important for the trace element characterization of LBA glass, since Shortland et al. (2007) successfully used zirconium–titanium covariation to differentiate between the colored and colorless glasses from Tell Brak, Nuzi, Amarna, and Malkata. However, a variation using zirconium was not possible for Tell Atchana, ancient Alalakh, glasses with the data produced with ICP–MS.

Even though variations among zirconium together with titanium, lanthanide, and chromium have succeeded in differentiating Mesopotamian and Egyptian colored and colorless glasses (Shortland et al. 2007), this dissertation provides other possible compositional fingerprints to distinguish the Alalakh glasses from the published second millennium B.C. glasses. For comparison, data published by Shortland et al. (2007) is used as the reference collection, since analyses provided in this publication were done with LA–ICP–MS, thus allowing a suitable comparative method for this dissertation.

In the first attempt for comparison, the successful method of trace elements based on manganese (Mn)–yttrium (Y), chromium (Cr)–lanthanide (La), and titanium (Ti)–lanthanide (La) are plotted on graphs.

In the first Mn–Y graph (fig. 7.26), two samples were eliminated in order to format the x–axis of the graph at maximum of 2000 ppm. These two samples are from Malkata with literature numbers UPP38 and UPP23, containing 7576 ppm and 4146 ppm Mn, respectively. These two samples were also eliminated in the Mn–Y graph in the literature (Shortland et al. 2007: 786, fig. 2). The Malkata cobalt blue glasses contain high levels of Mn; the Y levels of glass (between ca. 200–750 ppm) from the LBI levels of Tell Atchana, ancient Alalakh, are higher than the rest of the Alalakh corpus as well as Nuzi, Tell Brak, Amarna, and Malkata Late Bronze Age glasses combined (fig. 7.27).

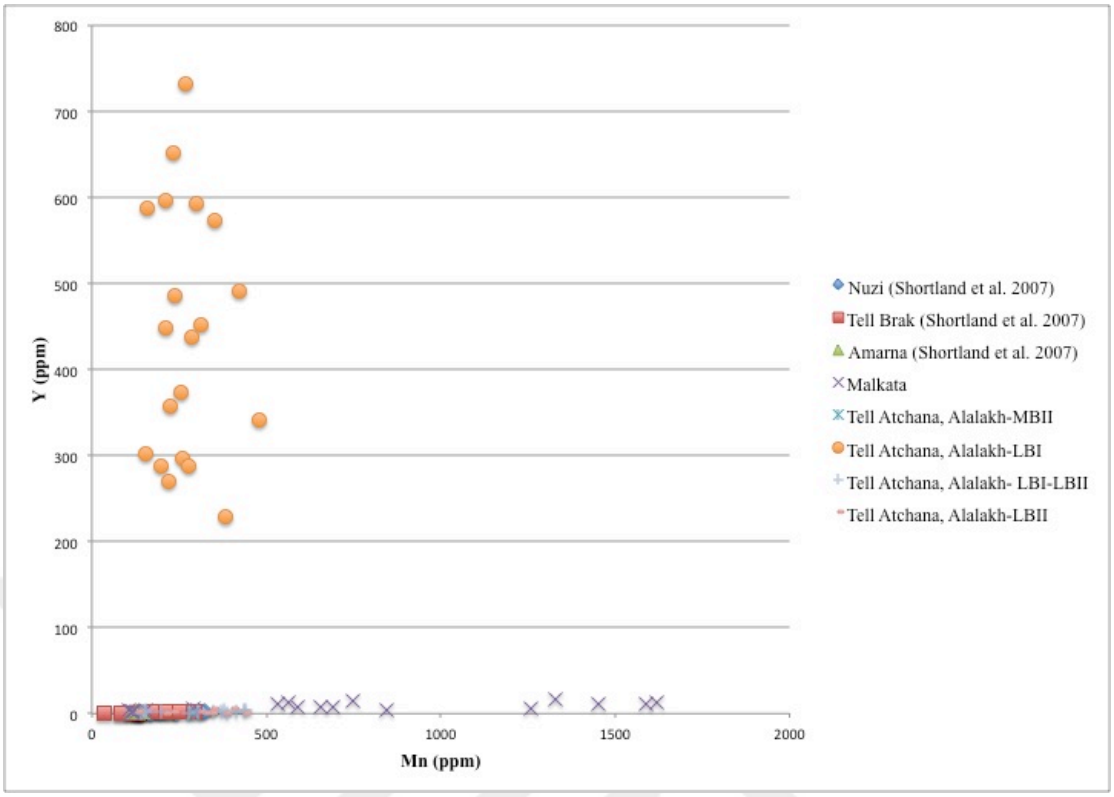


Fig. 7. 26: Covariation of Mn and Y levels of all samples distributed among other glass compositions as known from the literature (Shortland et al. 2007).

Such a clustering (fig. 7.26) disables the visibility of the Mn–Y covariation for the rest of the analyzed glasses. Thus, two more graphs are plotted excluding the LBI Alalakh glasses and the Malkata glasses. According to figure 7.26, Nuzi, Tell Brak, and the LBI–LBII glasses of Tell Atchana, ancient Alalakh, overlap, whereas Amarna clusters separately. Furthermore, the LBII group has a broader range with most of the Mn values higher than the rest of the glasses known from the literature.

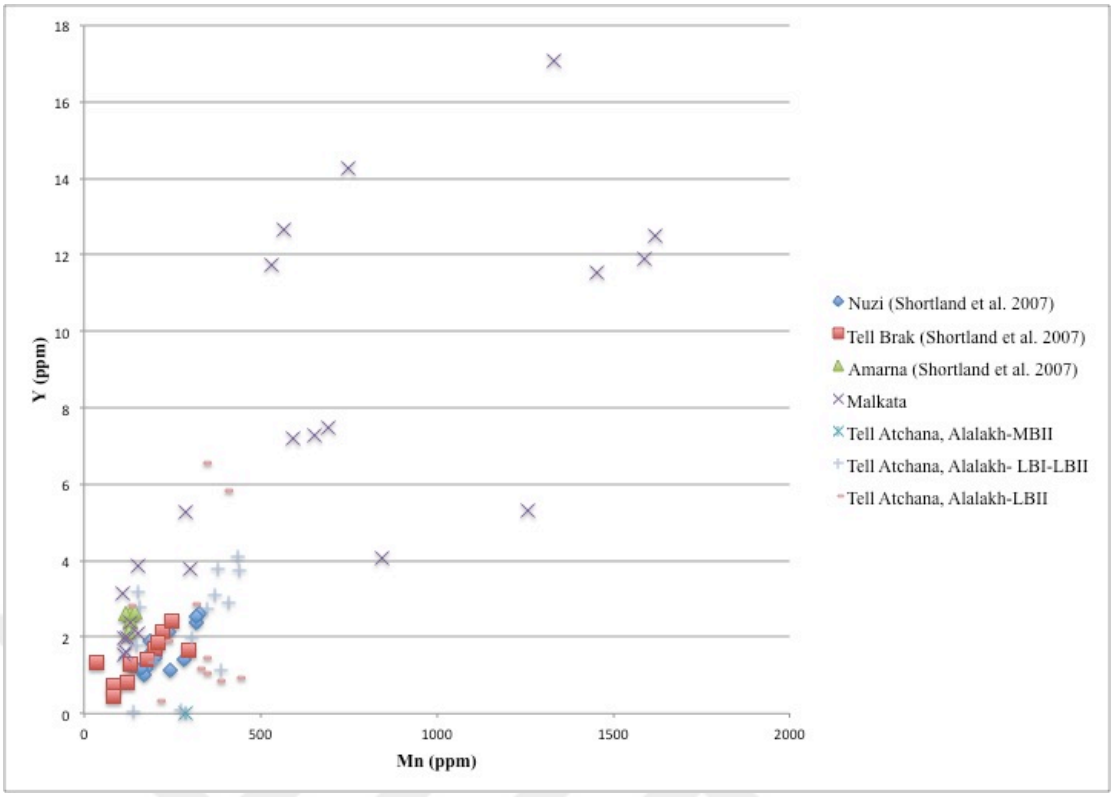


Fig. 7. 27: Covariation of Mn and Y levels of samples excluding LBI Tell Atchana, ancient Alalakh, glass distributed among other glass compositions as known from the literature (Shortland et al. 2007).

According to figure 7.28, the LBI–LBII and LBII Alalakh glasses contain higher levels of Mn and Y. Two samples from the LBI–LBII levels and one sample from the LBII period show a close relationship with Amarna. Two other samples dated to the LBI–LBII and one LBII sample cluster tightly with the Tell Brak and Nuzi groups. As a result, this binary plot does not allow a definitive separation of Alalakh glass from the other second millennium B.C. glasses unless it was dated to the LBI period. Only LBI glasses have Y levels higher than 200 ppm, thereby providing a unique characteristic for that group.

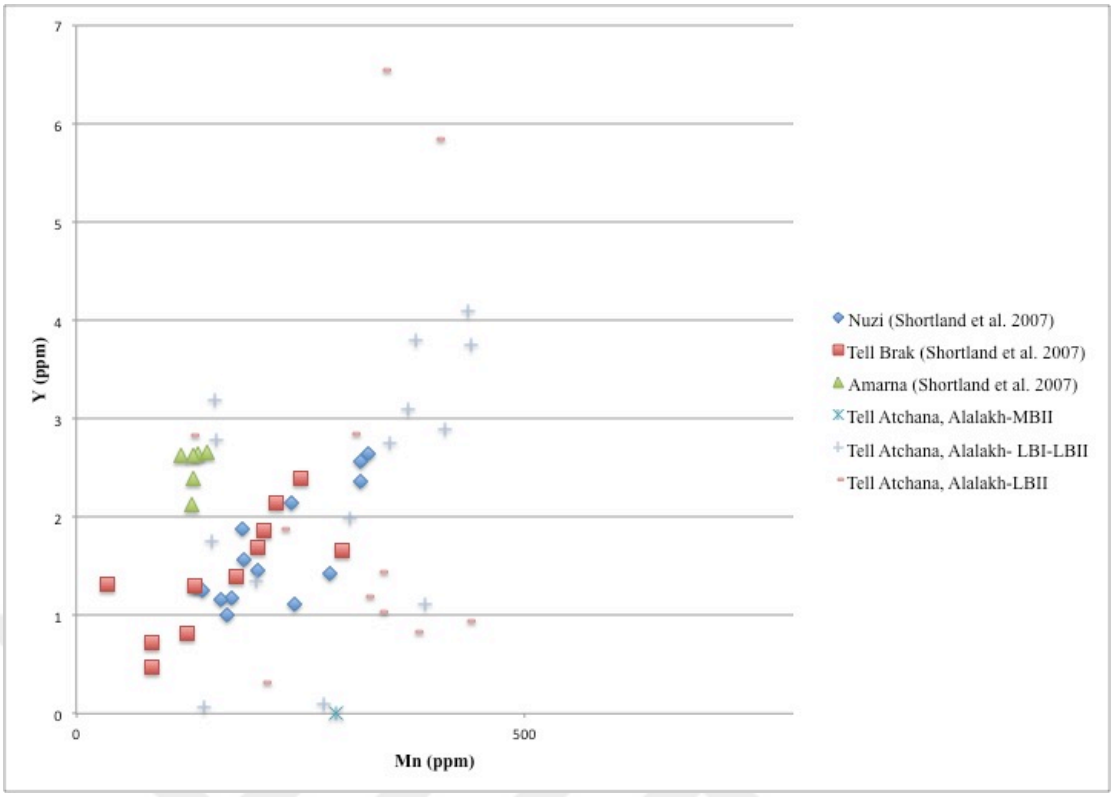


Fig. 7. 28: Covariation of Mn and Y levels of samples excluding LBI Tell Atchana, ancient Alalakh, and Malkata glasses distributed among other glass compositions as known from the literature (Shortland et al. 2007).

Trace elemental levels of lanthanide in Tell Atchana, ancient Alalakh, can be questioned, since most of the lanthanide levels are below the detection limits and thus plotting them on a graph is not as useful as other LBA glasses known from the literature. The values are given as zero for the samples having lanthanide levels below the detection level in order to plot the Cr–La binary diagram (fig. 7.29).

The Cr–La binary diagram shows that lanthanide levels are zero for most of the LBI glasses. Thus, like the yttrium, lanthanide is also characteristic for LBI glasses from Tell Atchana, ancient Alalakh. The samples dated to the LBI–LBII and LBII periods are separated from Mesopotamian and Egyptian glasses with comparative lanthanide and elevated chromium contents.

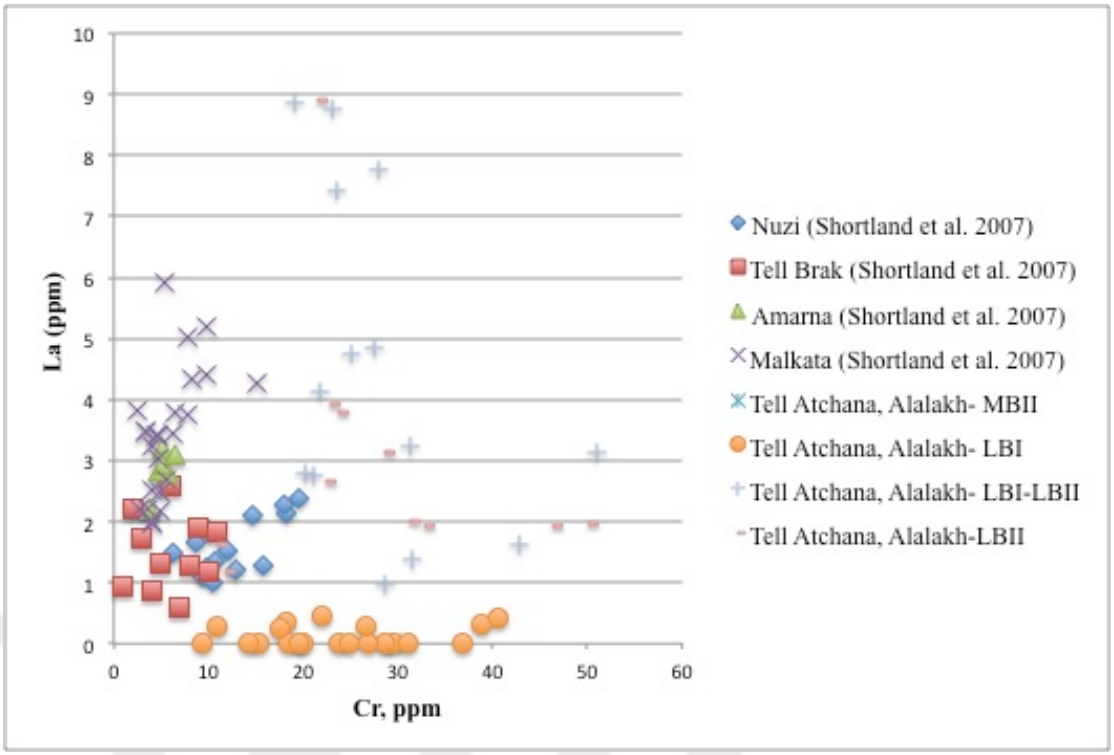


Fig. 7.29: Covariation of Cr and La levels of samples distributed among other glass compositions as known from the literature (Shortland et al. 2007).

The graph in figure 7.30 presents the comparison of titanium (Ti) and lanthanide (La) with the published literature. The binary graph shows that Alalakh has lower titanium levels than any other glass (fig. 7.30). Regardless of any chronological divisions, all analyzed glasses from Alalakh are distinguished from the Nuzi, Tell Brak, Amarna, and Malkata glasses with their low titanium concentrations.

The so-far plotted binary diagrams and their comparative applications in the literature (Shortland et al. 2007; Walton et al. 2009) are partially successful in allowing us to observe a fingerprint of Alalakh glasses. Therefore, new sets of covariation diagrams are plotted to visualize the data in detail.

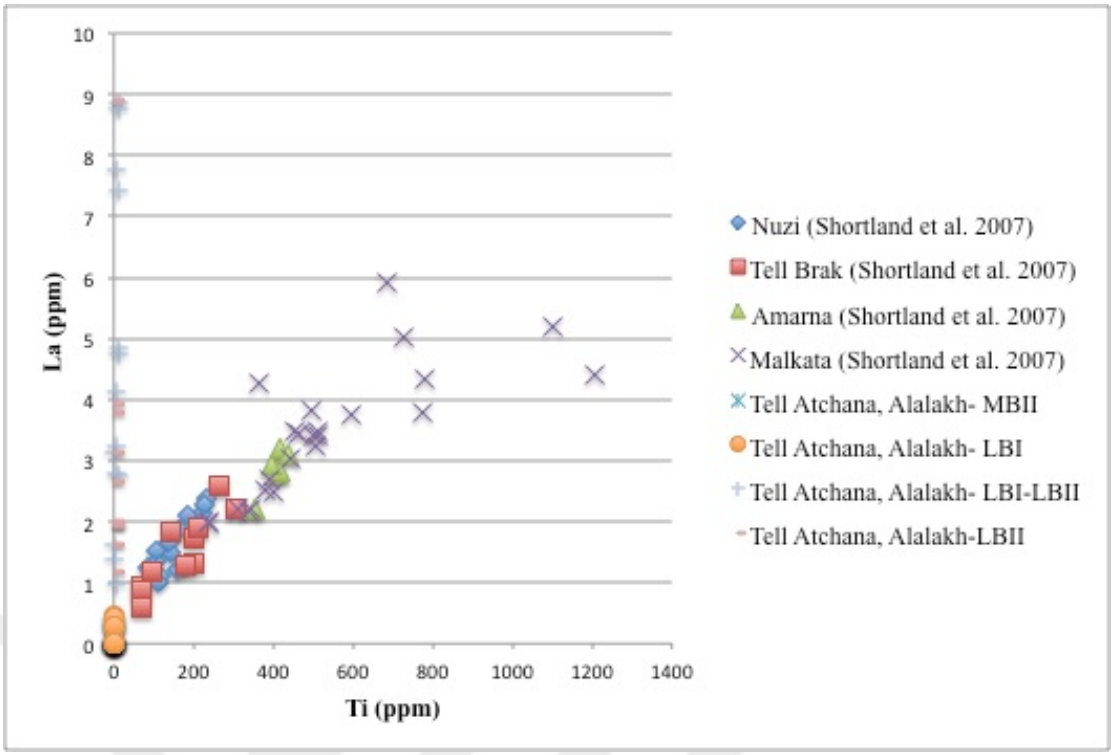


Fig. 7.30: Covariation of Ti and La levels of samples distributed among other glass compositions as known from the literature (Shortland et al. 2007).

For the detailed sets, the vanadium (V)–chromium (Cr), chromium (Cr)–nickel (Ni), and nickel (Ni)–arsenic (As) binaries were selected. The selections for these specific trace elements were based on the observations of the analytical data, which established its dissimilarity from the known examples in the literature.

The V–Cr graph demonstrates a separation of the Alalakh glasses from the Nuzi, Tell Brak, Amarna, and Malkata examples as the Alalakh glasses have higher vanadium and chromium levels (fig. 7.31). The separation is more visible when I plot the graph without considering the chronological attributions for Alalakh glasses (fig. 7.32). It is noteworthy that three Nuzi and two Tell Brak samples cluster within the Alalakh group. One sample from Malkata falls close to the Alalakh and Mesopotamian groups; otherwise, all Egyptian glass clusters separately due to their low chromium levels. Based on this trace element coupling, I argue that V–Cr is a fingerprint for Alalakh glasses.

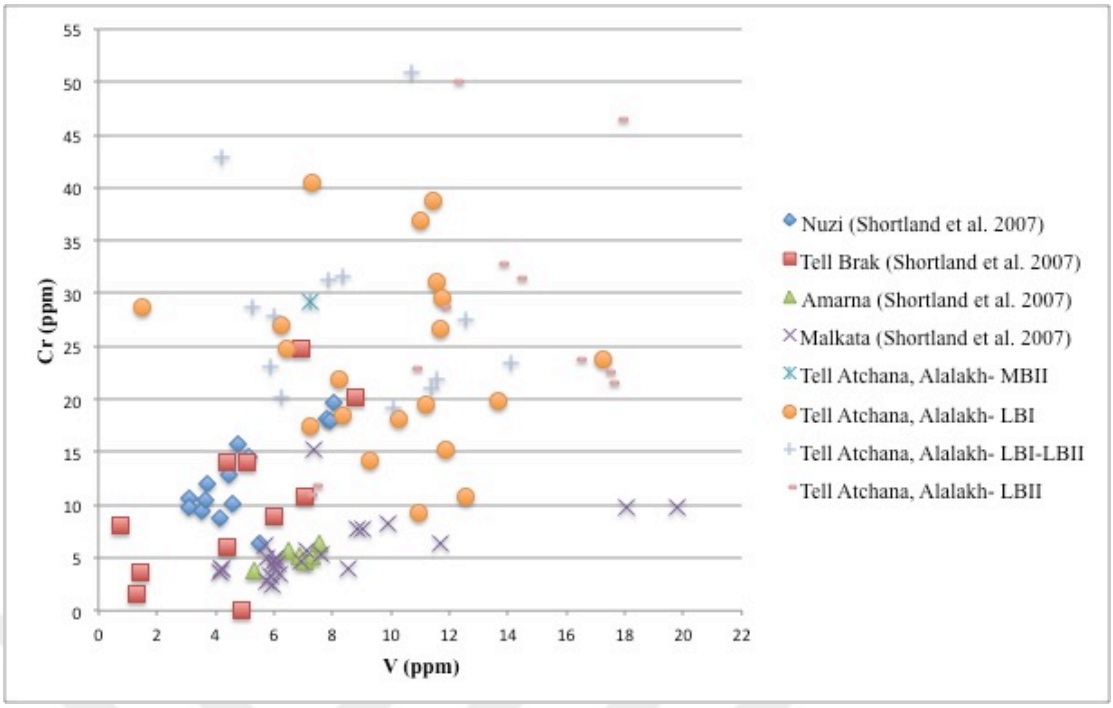


Fig. 7.31: Covariation of V and Cr levels of Tell Atchana, ancient Alalakh, glasses distributed along the periods and among other glass compositions as known from the literature (Shortland et al. 2007).

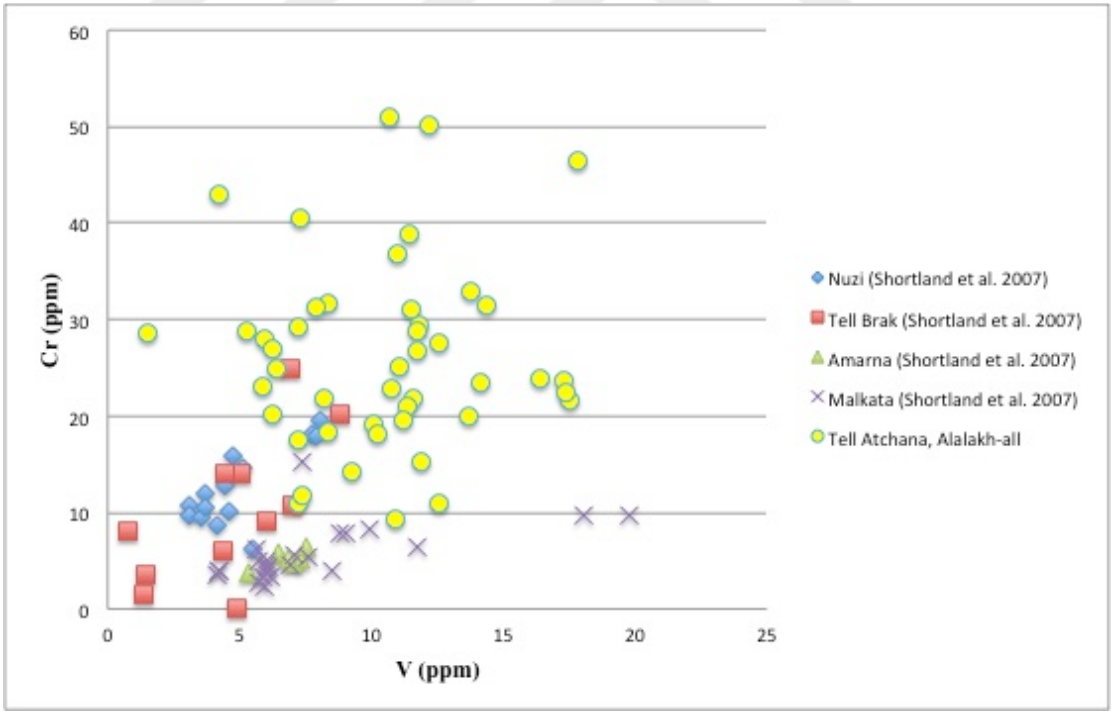


Fig. 7.32: Covariation of V and Cr levels of Tell Atchana, ancient Alalakh, glasses distributed among other glass compositions as known from the literature (Shortland et al. 2007). In this graph, Tell Atchana, ancient Alalakh, glasses are examined as a group regardless of their chronological attributions. The elevated V–Cr levels provide a distinctive clustering of Tell Atchana, ancient Alalakh glasses.

Similar to V–Cr, the Ni–Cr graph also demonstrates a separation of the Alalakh glasses from the Nuzi, Tell Brak, Amarna, and Malkata examples mostly based on their higher chromium levels (fig. 7.33–34). It is also visible that the LBI–LBII transition period and LBII glasses have similar nickel contents to Nuzi and Tell Brak, whereas glasses dated to the LBI strata have greater variation in the nickel contents.

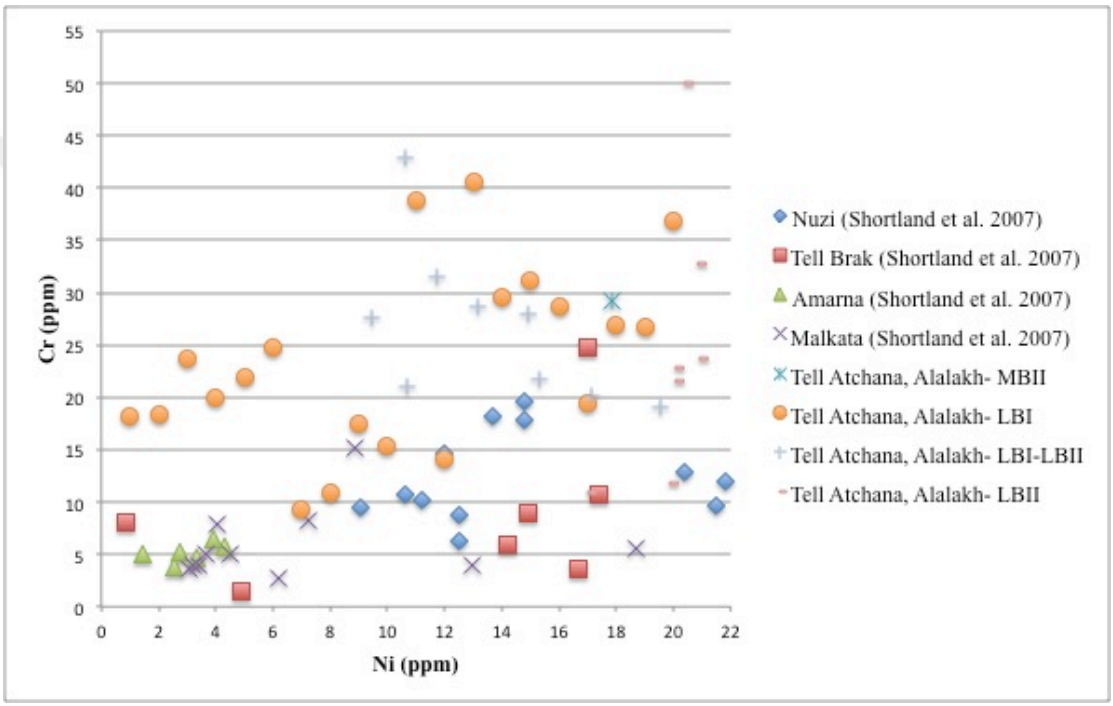


Fig. 7.33: Covariation of Ni and Cr levels of Tell Atchana, ancient Alalakh, glasses distributed along the periods and among other glass compositions as known from the literature (Shortland et al. 2007).

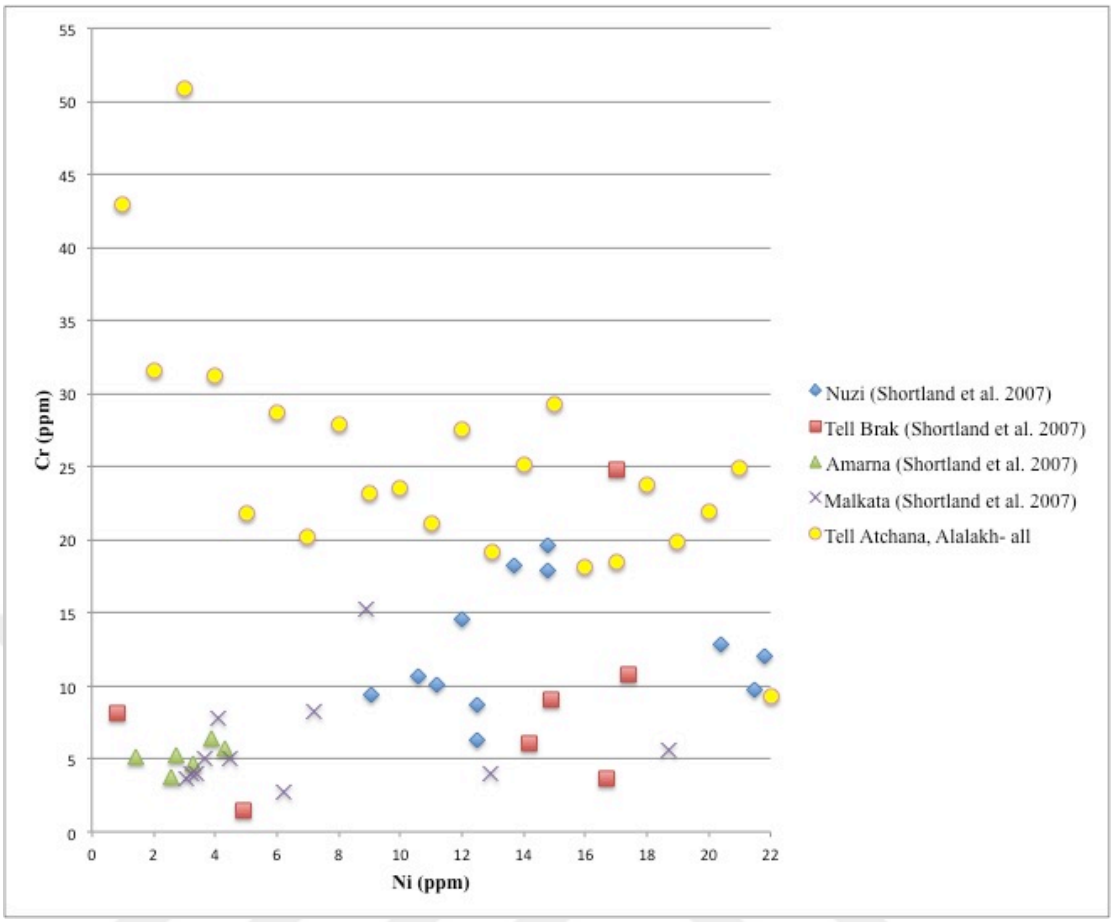


Fig. 7.34: Covariation of Ni and Cr levels of Tell Atchana, ancient Alalakh, glasses distributed among other glass compositions as known from the literature (Shortland et al. 2007). In this graph, Tell Atchana, ancient Alalakh, glasses are examined as a group regardless of their chronological attributions.

When nickel (Ni) was plotted against arsenic (As) on a graph (fig. 7.35), the elevated nickel values from the Malkata glasses caused the graph to squeeze close to the y–axis, thus inhibiting the observation of any features related to arsenic. Another diagram was graphed that excluded Malkata glasses as well as the Alalakh glasses that have an arsenic content below the detection limits. I also excluded AT 17883 (catalogue number: 421), which has 1554 ppm nickel, in order to scale the x–axis maximum to 70 ppm. With these parameters, figure 7.36 was created where Alalakh glasses were separated from the Amarna example, but partially superimpose over the Nuzi and Tell Brak examples. According to these graphs, the glass from Amarna (with depressed nickel content) and Malkata (with elevated nickel content) are

distinguished from Alalakh. Furthermore, arsenic levels higher than 200 ppm seem to be unique to Alalakh and thus could be used as a parameter to evaluate blue-colored glasses of the second millennium B.C.

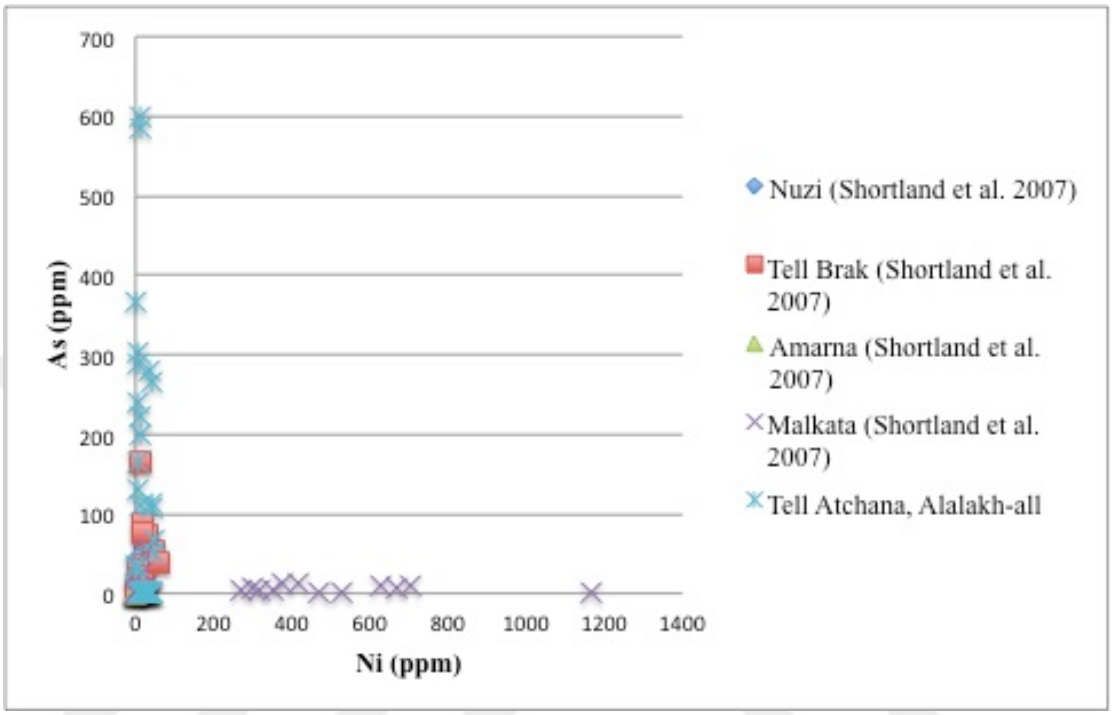


Fig. 7.35: Covariation of Ni and As levels of Tell Atchana, ancient Alalakh, glasses distributed among other glass compositions as known from the literature (Shortland et al. 2007). In this graph, Tell Atchana, ancient Alalakh, glasses are examined as a group regardless of their chronological attributions.

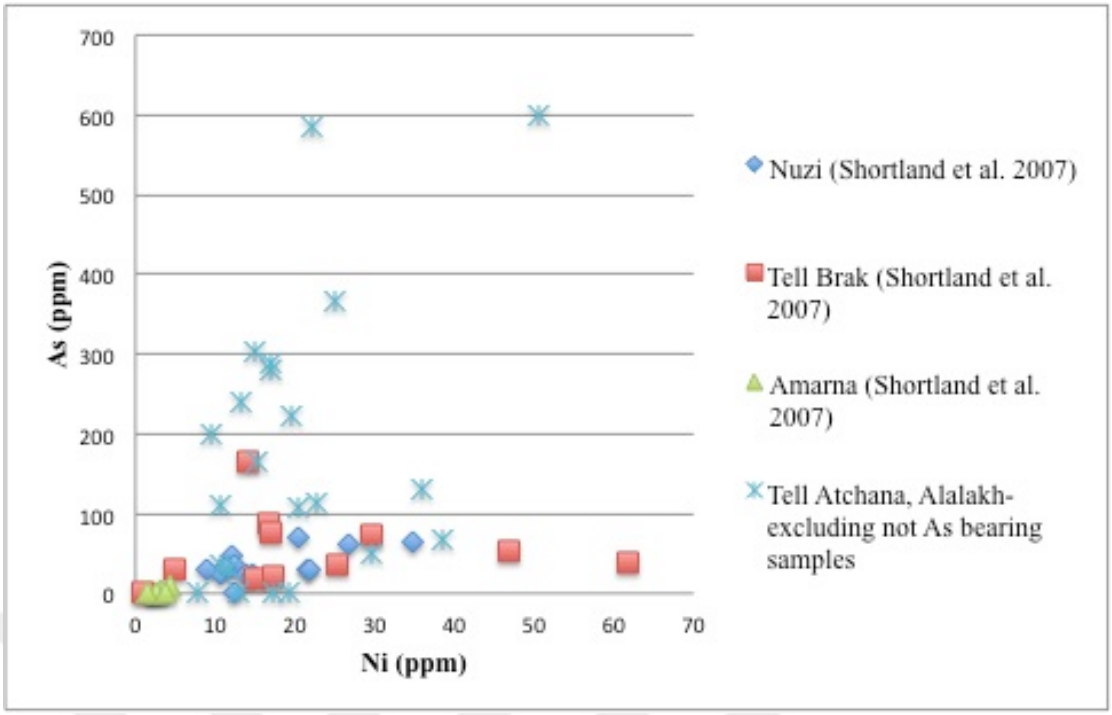


Fig. 7.36: Covariation of Ni and As levels of Tell Atchana, ancient Alalakh, glasses distributed among other glass compositions as known from the literature excluding Malkata glasses (Shortland et al. 2007). In this graph, Tell Atchana, ancient Alalakh, glasses are examined as a group regardless of their chronological attributions and glasses with arsenic levels below the detection limit are excluded.

7.5 Isotopic Research

The trace elemental results of Alalakh glass demonstrate variations from the comparative Mesopotamian (Nuzi and Tell Brak) and Egyptian sites (Amarna and Malkata). The trace elemental values indicate the use of different sources and the manipulation of diverse raw materials for the Alalakh assemblage.

Strontium (Sr) and neodymium (Nd) isotopes have been heavily used in recent years for provenance studies of glass since these elements are reflectors of local geology. As discussed in detail in chapter VI, Sr isotopes provide information on plants. The salt-bearing plant family *salsola kali*, which was used as flux in glassmaking, carries traces of local geology, which could be tracked through isotopic work. Similarly, Nd isotopes offer information on silica, which is the major raw

material in glassmaking, by distinguishing young and old geological formations (see references cited in chapter V).

In order to identify the local geology, only two glass fragments were analyzed isotopically. These analyses were conducted by the British Geological Survey, Natural Environment Research Council, Isotope Geosciences Laboratory in 2014. This study was supported with a grant from Suna–Inan Kıraç Research Institute on Mediterranean Civilizations (AKMED) in 2013.

The grant made isotopic work possible on two artifacts. Therefore, glass objects that were at least 1.0 gr, unweathered, and unearthed from secure contexts were selected. Both of these fragments were recovered from the LBI–LBII context of Square 64.72. The first sample is the fragment of the blue glass ingot (AT 16968, catalogue number: 291) that was unearthed from inside the kiln. The second sample is the amber-colored vase fragment (AT 15065, catalogue number: 260). Two different colors were specifically selected in order to observe possible variations in the different colored glasses.

The results are plotted in figure 7.37. According to the isotopic research, the values for the blue ingot fragment were found to be close to the Tell Brak isotopic range. The blue ingot fragment values are also close to one sample from Athens, which was posited to have originated from Mesopotamia (Henderson et al. 2010). It is visible on the graph that the Tell Brak isotopic results are very scattered and not clustered (Degryse et al. 2010; Henderson et al. 2010); one of the samples was also clustered within the range of Nuzi glass.

The scattering of Tell Brak isotope ratios might indicate the use of different sources for glass found at the site or Tell Brak might be importing glass as a need for specific colors and/or quality. Glassmaking debris has not been recovered yet but

some glassworking debris was found at the settlement (Henderson 1997, 2013). Even if glassmaking was practiced at Tell Brak, it is important to note that having local production does not prevent the possibility of importing the same material.

The existence of the Tell Brak glass isotope values and the analytic results of the Alalakh blue glass ingot fragment in close proximity have the potential to provide further information on glass material-based relations between Alalakh and Tell Brak. However, the data set of Alalakh is very limited; thus this research cannot elaborate further on glass production and trade relations regarding glass among these settlements.

The isotopic values of the amber-colored vase fragment is more intriguing since the values were found in a distinctive zone among the other isotopically characterized second millennium B.C. glasses.

These isotopic ratios demonstrate two major conclusions: 1) In Alalakh, there should be an idiosyncratic raw material usage; and 2) in the general frame of the second millennium B.C., there must have been at least two or more glassmaking centers, including Alalakh.

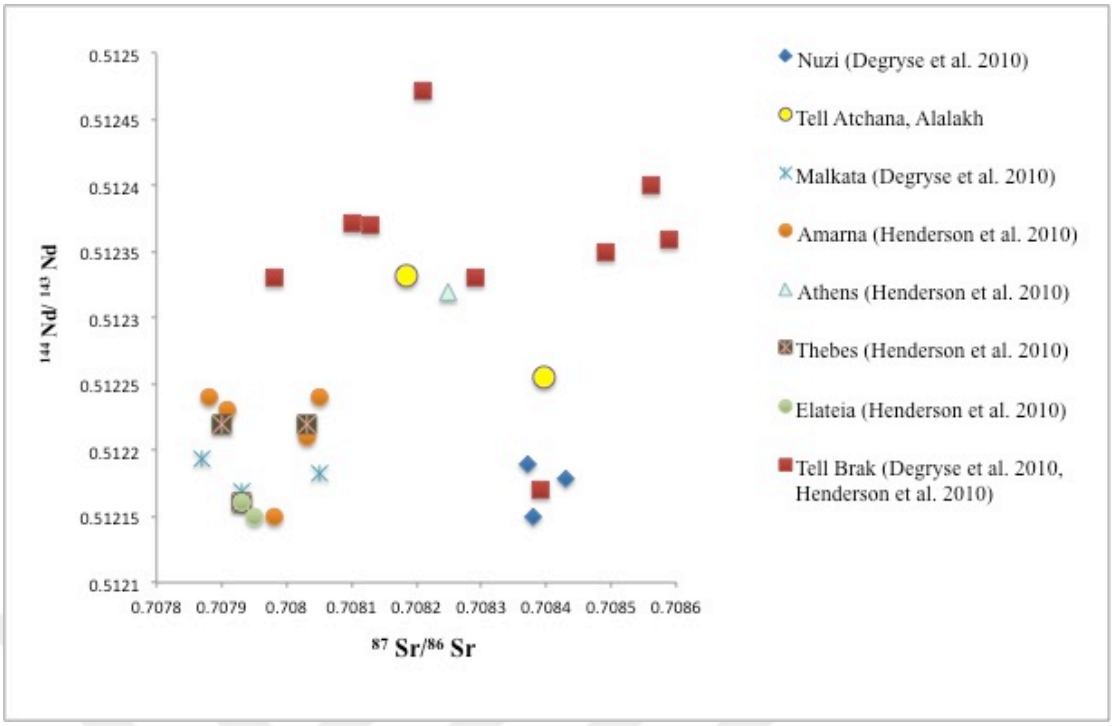


Fig. 7.37: Sr–Nd isotope values of two glass fragments. AT 16968 (blue ingot fragment) and AT 15065 (dark amber vase fragment) are prepared for Sr and Nd isotopes at BGS.

7.6 Concluding Remarks on Scientific Results

The ICP–MS analysis of glass artifacts from Tell Atchana, ancient Alalakh, with different chronological attributions demonstrate new interpretations to the literature of the second millennium B.C. glass data. First of all, all of them are soda–silica–lime glasses with copper used for blue colorant and antimony as the opacifier. The potash levels are important to consider. The low potash levels detected in the MBII, LBI–LBII, and partially LBI glasses designate use of different plant ashes or same plant ash with varying levels of potash; however, a noteworthy number of the LBI glasses and the LBII glasses with higher potash and lower than 1% alumina indicate a selective use of plant ashes, since plant ashes themselves could also contribute to alumina into the glasses (Henderson 2013: 65). The soda (salt)-bearing plant family *salsola jardonicola* still grows on the mound Atchana and this species may have been the most likely candidate for the plant ash source. Furthermore, in the

summer of 2014 and 2015, while examining the field I realized that this species is seasonal around the mound (fig. 7.38). It appears in late May and disappears at the end of August. This seasonal plant shows that some stages in glassmaking — at least plant ash collecting — must have been a seasonal activity. The effect of being a seasonal activity is discussed in chapter VIII.

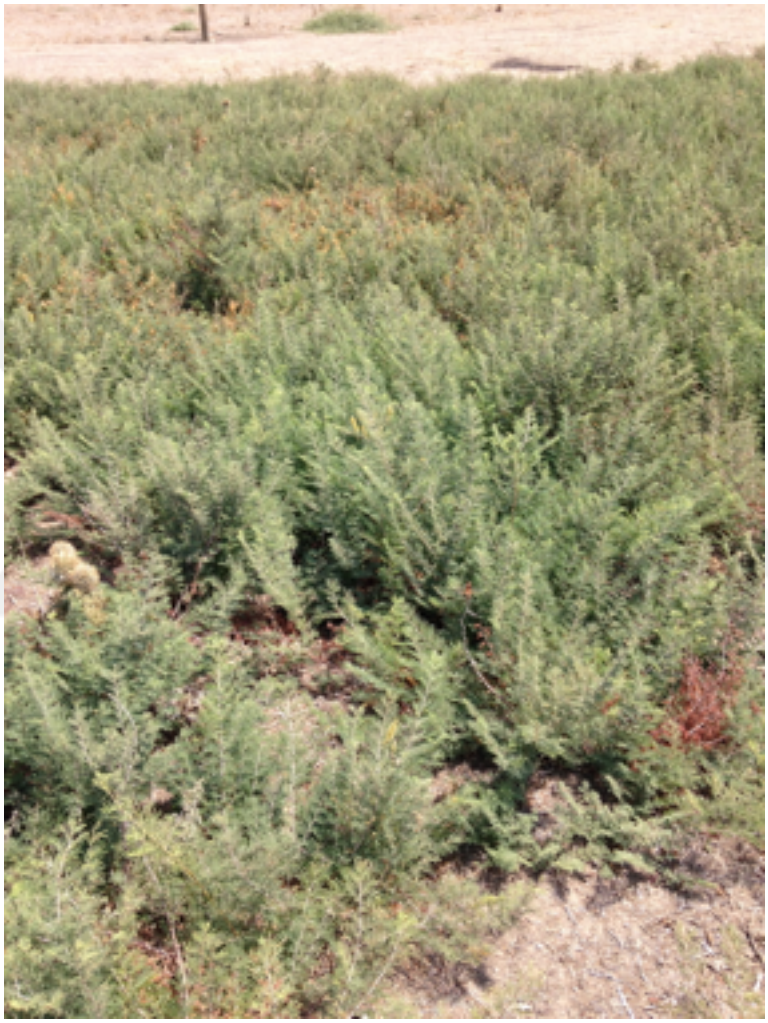


Fig. 7.38: *Salsola jordanicola*, a type of salt-rich plant used in the second millennium B.C. glass production as flux, is still growing on the mound Atchana (photo taken in July 2014).

These analyses show that the trace elements, especially the binary plots of Cr–V, can be used to distinguish Alalakh glass. Furthermore, the existence of arsenic and the lack of tin in blue-colored glasses is a significant characteristic to distinguish them from the copper-colored glass of Egypt that often bears tin (Shortland et al.

2007: 786). Arsenic does not only differentiate Alalakh glass, but also provides information on the metal oxide-based colorants. It appears that rather than tin bronzes, arsenical bronzes were preferred by the glassmakers of Alalakh. It is important to underline the fact that none of the glass analyzed from the Tell Atchana, ancient Alalakh, corpus is colorless. Therefore, it is not be possible to distinguish elements added during the coloration process.

I suggest chromium as one of the fingerprints of Alalakh glasses. This raises the question of a source for the chromium. There are chromium reserves 40–50 km away from the location of Tell Atchana (fig. 7.39). A possible riverbed flowing from the reserves to a closer proximity to the site could have been carried the minerals deposited/form apart of the clays near the settlement or Reyhanlı. The ancient riverbeds in Amuq Valley have not been studied in detail, but Derek Ryter from the United States Geological Survey (USGS) conducted geophysical surveys and sedimentary borings around Tell Atchana. According to his research, the river Orontes was running below Tell Atchana during the Middle and Late Bronze Ages (Yener 2013).

Low lanthanide and low titanium levels are observed in the whole corpus. When specifically evaluated according to period, the LBI–LBII glass of Alalakh can be distinguished from both the rest of the assemblage and the general second millennium B.C. glass with high levels of yttrium.

As demonstrated in figure 7.24, Alalakh glass has a slightly higher iron and aluminum content. The variation in Fe–Al is noticeable, especially in the LBI and LBI–LBII periods. Higher iron and alumna levels at Alalakh are known from the literature (Erb-Satullo et al. 2011; Yener 2010b; Dardeniz 2013).

The Orontes River, which ran just below the site in the Middle Bronze and Late

Bronze Ages, has up to 25% iron content in the form of magnetite (Erb-Satullo et al. 2011; Yener 2010b; Dardeniz 2013). Geological research conducted by the Turkish General Directorate of Mineral Research and Exploration (MTA) at Antakya (Hatay) documents aluminum sources with high levels of iron in the Kırkhan region,[189] which is located almost 10 km away from Alalakh. The existence of such ores around the region supports the possibility of local raw material usage.

Furthermore, high levels of alumina and iron in glass are indicators of the use of sand instead of quartz as a silica source. Modern glassmaking uses pure sand whereas ancient sand was not purified and contained alumina, iron, titanium, and calcium together with other minor elements whereas quartzite pebbles are pure (Brill 1999; Shortland 2002; 2012: 99). The high levels of alumina and iron in Alalakh glass also support the hypothesis that sand from the Orontes was used systematically throughout production.

The isotopic research conducted in this dissertation is not sufficient for a detailed statistical assessment. Bearing that in mind, the strontium and neodimyum isotopic values demonstrate the possibility of the trade of glass between Mesopotamian glass production centers. In ancient glass studies, the focus is more on the trade of glass between the known centers of Egypt, Mesopotamia, and Mycenae; however, the possibility of trade within the same region is less discussed due to the lack of information. With the emerging evidence from Alalakh, I suggest that

[189] As written on the MTA webpage: "Dörtyol yöresindeki alüminyum sahalarında %15-25 Al2O3 ve %30-40 Fe2O3 tenörlü 70.000.000 ton görünür+muhtemel rezerv bulunmaktadır. Yöredeki demirli boksit yatakları rezervleri yüksek olmakla birlikte, teknolojik sorunlar nedeniyle işletilememektedir. ... Kırıkhan-Kostal demir yatağında, tenörü % 33.76 Fe, % 19.30 SiO2 ve % 11.76 Al2O3 olan 1.742.437 ton görünür+muhtemel, tenörü % 15-20 Fe, % 25-40 SiO2 ve % 9-12 Al2O3 olan 1.293.650 ton görünür+muhtemel ve tenörü % 25-35 Fe olan 2.970.800 ton mümkün rezervler tespit edilmiştir."
www.mta.gov.tr

regional trade between the northern Mesopotamian centers and the northern Levant/southern Anatolia might also include glass.

One of the lacunae in the glass research is determining the firing temperature of semi-finished glasses. Theoretical calculations as well as archaeometric and experimental investigations indicate lower lime levels in the semi-finished glasses (Rehren 2000; Shugar and Rehren 2002; Tanimoto and Rehren 2008). However, such estimations could not be applied to the existing evidence to the Alalakh glass corpus.

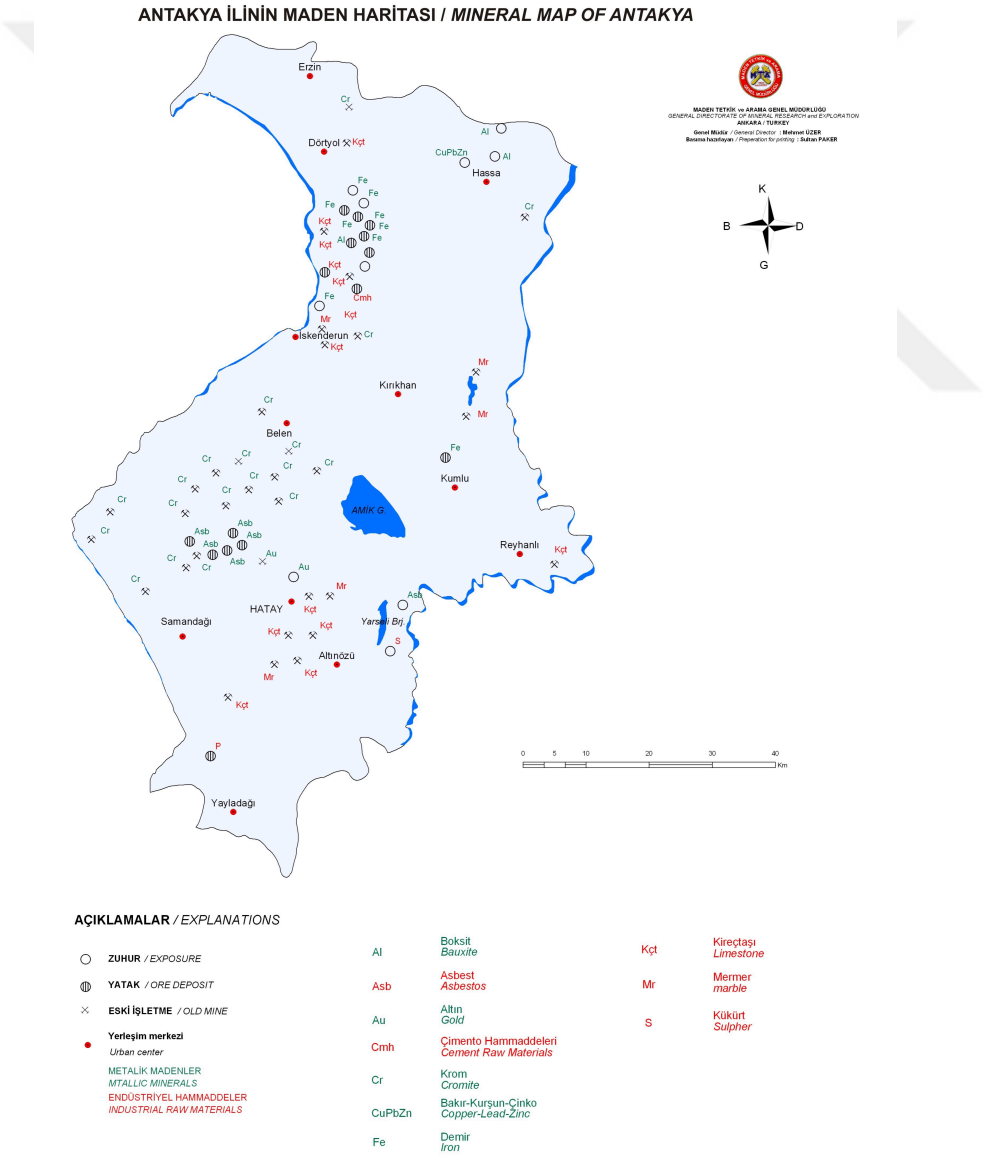


Fig. 7.39: Mining deposits of chromite around Tell Atchana, ancient Alalakh, which are located close to Reyhanlı. The chromite reserves are approximately 40–50 km away from Reyhanlı (map, ©MTA).[190]

Regarding faience artifacts, the SEM–EDX analysis shows most of the objects — including the ones unearthed from the workshop debris of the LBI–LBII transition period — were manufactured with the cementation technique. Nicholson (2008) documented the factory evidence from Amarna and Lisht (ca. 1570–1070 B.C.) and suggested that efflorescence and direct application techniques were used in these Egyptian sites. Nicholson (2008) also listed the addition of finely powdered glass to the glazing process in order to extend the color range. Within the analytical results obtained in this dissertation, I argue that the production technique of faience is a distinguishing feature of Alalakh, differentiating it from Egypt at least. The preference for the cementation technique must have been related to the other ongoing activities in the multifunctional working debris recovered from Square 64.72 at Alalakh. The integrated activities are discussed in the next chapter (chapter VIII) in relation to relevant craft theories.

[190] http://www.mta.gov.tr/v2.0/turkiye_maden/il_maden/pdf_2010/Antakya.pdf

CHAPTER VIII:

INTEGRATED CRAFTS AND RETHINKING VITRIFIED MATERIAL INDUSTRIES IN THE SOCIAL CONTEXT OF THE SECOND MILLENNIUM B.C.: THE CASE OF ALALAKH

This chapter discusses the relevant theoretical aspects on craft specialization and prestigious technologies within the limits of existing evidence of the second millennium B.C. and proposes a hypothesis on how vitreous material crafting could have been practiced at Tell Atchana, ancient Alalakh.

Vitreous material production was an important part of the creation of prestige items. This prestigious technology was practiced in Mesopotamia (still an unknown location probably in northern Mesopotamia) and Egypt (Amarna and Qantir) in the second millennium B.C.; the previous chapter of this dissertation (chapter VII) introduced new archaeometric evidence for vitreous material production (glassmaking and faience production) from Tell Atchana, ancient Alalakh.

This chapter attempts to answer the following questions, which are related to the agents of manufacture:

- Who controlled the production?
- Who were the artisans doing the work?

- Were artisans specialized solely in the vitreous materials or were they practicing together with other artisans? How were they integrated with other artisans?
- Were the artisans part-time or full-time specialists?
- What was the relationship of craftspeople to the supervisors/owners of the prestigious objects? Were they attached or independent from any possible governor of the production?

8.1 Prestige Items and Patronage over the Vitreous Material Crafting

The production of glass, faience, and frit require specialized artisanship. The relationship between specialized artisanship, their industries, and social status in the Bronze Age is multifaceted. In order to be recognized as a person of higher status, the ownership of extra property was necessary, which includes material goods that were not available to the masses. This triggers the involvement of rare materials and complex technologies to manipulate them (Wilkinson 1999: 28–59).

Glass, faience, and frit were considered as prestige goods in the second millennium B.C. along with other status items such as precious metals (gold, silver, bronze, iron), precious and semiprecious stones, ivory, or specially produced ceramics (such as Nuzi Ware). This consideration necessitates a definition for a prestige good. Stein and Blackman (1993: 50) use the following criteria:

> "(1) the presence of the appropriate craft specialist in the texts as a dependent of a 'great institution,'
> (2) textual evidence for state procurement of the necessary raw materials,
> (3) a high price/value equivalent for the raw materials or finished products, and
> (4) records indicating that these particular items were presented as gifts to high-status individuals of known social rank."

The production of vitreous materials, especially glass, was carried out within

the control of the palace, elites, or an equally effective central institution. The necessary raw materials, especially metal oxides for coloring vitreous items and fuel for kilns, would have been acquired by the people who were in charge of controlling the manufacture of the prestige goods. Glass was used as a commodity of tribute (see chapters II and III) and thus was most probably subjected to gift exchange among courts (Brumfiel and Earle 1987: 5).

At Tell Atchana, ancient Alalakh, except for the area which itself was associated with production, most of the glass, faience, and frit artifacts were recovered from palatial, temple, and grave contexts (chapters IV and V). The artifacts from the palatial and temple contexts together with some noteworthy objects, such as the significant number of cylinder seals made out vitreous materials found at different strata and parts of the mound, figurines, the eyes of the statue of Idrimi made out of blue glass, and couple of eye models made out of frit, were obviously for elite consumption. On the other hand, the extensive number of beads collected from non-palatial/non-elite archaeological contexts such as pits, streets, and graves also indicate a utilitarian consumption of vitreous materials, at least for beads.

8.2 Artisans Involved in Production

"Production" is defined as turning raw materials into goods, and "specialization" as an organized method of this production (Costin 1991: 3). Both production and specialization are subsets of the socioeconomic and sociopolitical systems and should be considered key factors in the political economy of complex societies (Brumfiel and Earle 1987).

Vitreous materials are considered for elite production and consumption, but Alalakh also demonstrates utilitarian consumption, though there is no evidence to

elaborate on the utilitarian production of vitreous materials. Even though there is material evidence, information on the artisans is inadequate to create strong ties between the materials and producers; thus I will make use of craft theories to assess to the question: who were the artisans doing the work?

Through examining craft specialization and the sociopolitical organization of production, linkages between artisans and their specializations, and hierarchically higher status elites could be better understood. To study the organization of production in more detail, this dissertation will use Costin's model where the context of production is divided into two groups — "attached" and "independent" — depending on the degree of organizational and economic control exhibited by society's elites.

"Attached production" describes the control of the elite over production, especially for high-status goods, which were usually highly valued and had restricted access (Earle 1981; Costin 1991: 7, 11). Elites or states try to control the production of goods and especially luxury items, including vitreous materials, which are important to reinforce their social status and to display their power (Helms 1993; Peregrine 1991; Stein 2001). Textual records listing professions evidence this maintenance of production and elite control over crafts (Archi 1982; Hauptmann 1988; for Alalakh, see von Dassow 2008 and chapter II). Such sponsorship by elites emphasized their social and political position in the society and made the attached specialist producers economically and socially dependent on their patrons. For "independent production," the control over production is in the hands of the artisans themselves. Manufacturers produce according to demand and distribute products mainly to a public market of customers (Costin 1991: 11).

Vitreous material production as a prestigious technology and the production

of luxury items for elite consumption suggests an attached production at Alalakh; the rich assemblage of the Level IV palace puts forward a palace-centered production. Artifacts like cylinder seals or statue eyes must have been controlled by elites or the state. On the other hand, artifacts – such as beads – have clear utilitarian consumption and thus independent craftsmen might have been involved in production of such artifacts.

Based on the archaeological evidence, it would be logical to consider the existence of both types of artisans at the site: the attached artisans, who were producing vitreous artifacts for the palace and elites; and the independent artisans, who were supplying the ordinary community. It is also possible that the attached artisans were producing for the elites and the general population. Shortland et al. (2001: 153, fig. 8.2, 157, fig. 8.3) suggested that glass and faience workshops were supplying the royal court in Egypt with glass vases or high quality faience objects, whereas glass beads and secondary quality faience artifacts were given to the general population (figs. 8.1 and 8.2). This theory seems also valid for Alalakh where both high status individuals and the general population could have been supplied by luxury items.

It is also possible that luxury vitreous items were used as a type of payment from elites to the lower classes or as gifts.[191] Eventhough solid evidence does not exist at Alalakh for such payment systems, it has been documented in ethnoarchaeological literature (Earle 1997; Rappaport 1968) that rare items (i.e., sea-shells) even communal feaasting have been used to initiate debt-relations among the individuals of a society. These debt relations might have contributed to the emergence of social and economic inequalities in the long-term.

[191] I would like to thank Professor Carolyn Aslan for reminding me this aspect of political economy.

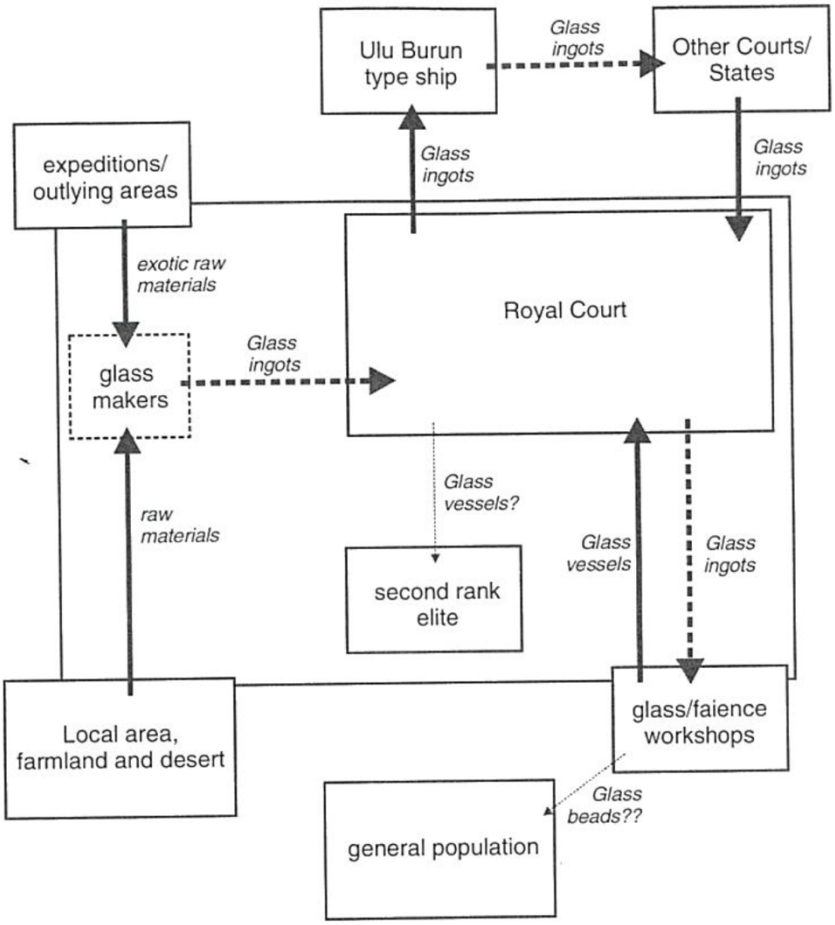


Fig. 8.1: Glass distribution (after Shortland et al. 2001: 153, fig. 8.2).

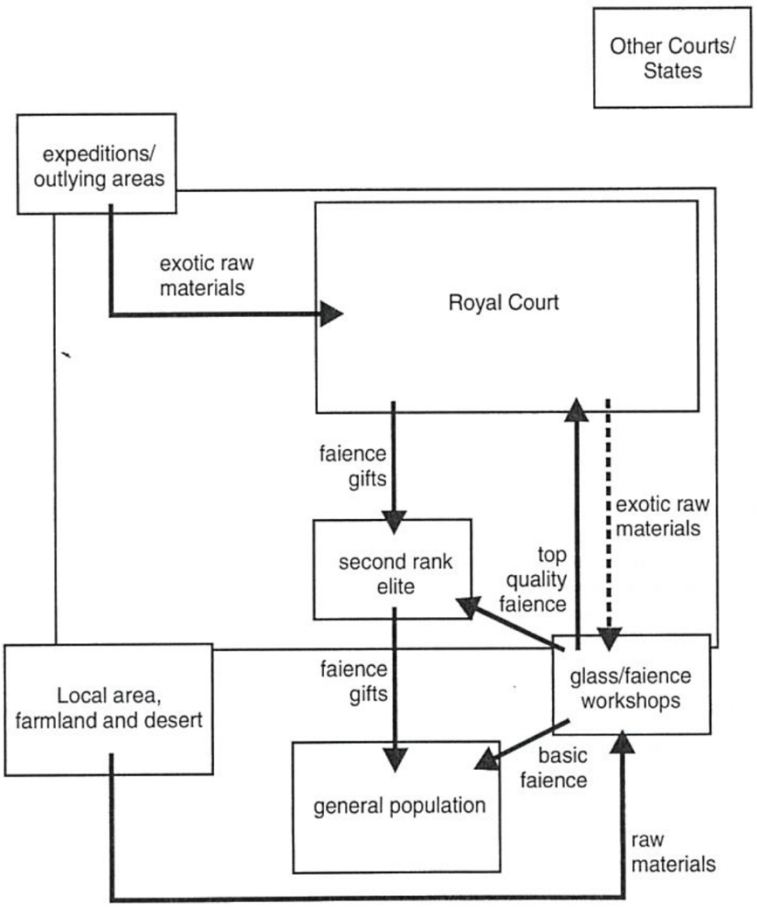


Fig. 8.2: Faience distribution (after Shortland et al. 2001: 157, fig. 8.3).

This dissertation mostly relies on glass, so I will put particular attention on glassmakers. Terminologically, two groups of artisans can be related to glass: glassmakers and glassworkers. As noted at several points in this dissertation, glassmakers were the artisans who produce glass from its raw materials — sand, plant ash, and colorants — whereas glassworkers were the people who worked glass mainly as ingots into final items, such as beads, amulets, vessels, or figurines. Even though they might co-exist at the same workshop, research on Roman glass vessels show that these two groups of artisans worked separately (Freestone et al. 2002). A similar line of evidence exists in Amarna and Qantir, where Qantir yields glassmaking evidence and the site Amarna of is mainly loaded with rods and

working pieces of glass indicative of glassworking. Such evidence led Shortland (2007: 263) to argue for distinctive localities for making and working activities. Having glassmaking and glassworking done at different places must involve different artisans (Shortland 2007: 263). However, if making and working activities were practiced in the same area, then the same artisans could have been involved in both making and working.

Evidence on the status of vitreous materials' artisans shows that glassmaking, at least in the 15th century B.C., was under royal control (Nicholson 1993: 47). At Amarna, the possible houses of glassmakers/workers were found to be small and indicative of low status, thereby indicating a non-prestigious identity of the glass artisans (Peet and Woolley 1923; Shortland 2000b). However, it is hard to identify them archaeologically. Egypt provides textual evidence for glass/faience workers and makers, which was summarized by Shortland (2007: 264, table 1; here table 8.3). According to textual references, there was a hierarchy among the artisans; for example, titles like "chief of works" or "overseer" are known (Shortland 2007: 265–66 with references cited). But most important for the Egyptian artisans, at least, was that the artists signified a link between god and the spiritual world by manipulating materials.

TABLE 1
Names and titles of glass/faience makers/workers known in the archaeological record

	title	period	type of object
Overseer			
Debeheni	*ỉmy-r ṯḥntyw*	13th Dynasty, King Hor	coffin inscripton
Qennou	*ỉmy-r ỉrw ḫsbḏ*	19th Dynasty	papyrus
Chief			
Hatiay	*ḥry ỉrw ḫsbḏ n nb t3wy*	New Kingdom	funerary stelae
Ptahmose	*ḥry jrw ḫsbḏ n nb t3wy*	New Kingdom	papyrus
Maker/worker			
Rekhamun	*jrw ḫsbḏ n Jmn*	19th Dynasty, Ramesses II	faience funerary stelae

Fig. 8.3: Glass/faience workers and makers from Egyptian records (after Shortland 2007: 264; table 1).

Mobile craftspeople are also a phenomenon that needs to be touched upon. It is known from the textual records that artisans have been considered as a part of the royal gift exchange (Zaccagnini 1983). Interaction among the empires (Egypt, Syria, Anatolia, Mesopotamia, and Mycenae) accelerated/triggered the mobility of skilled artisans, who were attached to or dependent on a royal court; this interaction resulted in the transfer of new ideas and the exchange of elite technologies at a court level (Moorey 2001). Evidence for independent mobile craftspeople has not been found (Moorey 2001: 4). Oppenheim suggested that migrating artisans may have triggered the essential prestigious technologies like glassmaking or perfume making (Oppenheim 1973: 266). On the other hand, there is no clear evidence for mobile glassmakers/workers or frit and faience producers, and thus it is hard to claim the existence of mobile vitreous material artisans.

According to the level IV tablets from Alalakh, a class might be related to specialized craftsmen. The class named as *eḫelle* refers to a high-ranking status.[192] The term *eḫelle* (*eḫelena*) describes "released – or freed-men" (Dietrich and Loretz 1969: 92). It is not clear what they were released from (von Dassow 2008: 98), though this might symbolize an independence from the royal service. It is also possible that they were exempt from the *corvée*[193] requirement due to their special skills, such as technological knowledge, which was worth more than physical labor. Furthermore, the *eḫelle* class had an occupation and, according to the tablets, the king and/or the place or elites like the *maryanni* class employed these people (von Dassow 2008: 315–16). As briefly mentioned in chapter II section 2.5, various crafts

[192] For details of social classes at Alalakh, see chapter II footnote 14.
[193] Corvée: (1) unpaid labor (as toward constructing roads) due from a feudal vassal to his lord; (2) labor exacted in lieu of taxes by public authorities especially for highway construction or repair (http://www.merriam-webster.com/dictionary/corvée).

like the potter (*paḫāru*), smith (*nappāḫu*), carpenter (*naggāru*), stone-cutter (*zadimmu*), leather-worker (*aškāpu*), reedworker (*atkuppu*), weaver (*išparu*), seal-cutter (*parkullu* [*ḫuli*]), bow-maker (*sasinnu*[?]), and scribe (*ṭupšarru*) were listed in the Alalakh texts, among which one scribe, one cupbearer, and one major were listed as *eḫelle* (von Dassow 2008: 319). Furthermore, the text AIT 197 supports the idea of *eḫelle* as a class of specialized crafts. The text recorded some *eḫelle* from the town Laşşi as smith, seal-cutter, and *liluḫuli* (von Dassow 2008: 317). Furthermore, another list identified the members of this class as specialized stonecutters, seal-cutters, smiths, leather-workers, carpenters, and managers of livestock and horses (von Dassow 2008: 319). Eva von Dassow (2008: 319) wrote:

> "From the standpoint of the administration, the reason for creating the *eḫelle* class, and determining who would belong to it; would have been to obtain the skilled labor of persons whose services or occupational specializations were highly valued."

In that sense, this class with skills and specialized labor, and possibly with particular technical knowledge, might have included vitreous material or luxury item artisans; yet a clear identification for glassmakers/workers and frit and faience producers is not possible like it is for Egyptian records. However, it is also probable that glassmakers/workers and frit and faience producers have been partially/completely classified within another group of artisans such as stoneworkers. There might also be a group of artisans rather than one person (excluding any master artisan, if any) involved in the vitreous material production; thus, pointing to a specific artisan might have not been as easy as, for example, defining a scribe.

Considering all these probabilities and parameters for whom the artisans might have been, I would argue that the vitreous material artisans at Alalakh could have been classified within the system of interlinked crafts such as stonecutters, stoneworkers, and/or smiths. The bases of my argumentation are discussed below.

8.3 Integrated Crafts

Another question seeking an answer is whether the artisans were specialized solely in vitreous materials or whether they were practicing together with other artisans. This section discusses the relationship of vitrified material producers (glassmakers/workers and other vitreous material producers) to other crafts, mainly metal- and stoneworkers.

It is discernible that the production of glass, faience, and frit requires specialized skills and knowledge; the refinement of these skills may have taken a long time. Artisans may have practiced extensively on recipes found by trial and error, and worked on techniques and tools to improve the production process. Vitreous artifacts were not only products of creativity and innovation, but they also required a broad knowledge of technology and application in incorporated fields (Barag 1985: 29), which must have necessitated close collaboration and integration among the crafts.

8.3.1 Glaze, Faience, Glass and Their Relationship to Stones

It is assumed that the initial impulse for glazing happened when siliceous stones like steatite were exposed to heat with some soda-rich ashes and some copper in or around a fire-related installation, like a fire-pit or kiln (Moorey 1985: 136). Beck (1934) places the beginning of glazed quartz and steatite sometime around 4000 B.C. and even as early as the Badarian period (5500–4000 B.C.).[194]

It is obvious that since the Upper Paleolithic period, people have used fire to treat stones (for example, for flaking), which led them observe the vitreous features of silica-rich stones. Treating siliceous stones in the presence of soda-rich plant ashes

[194] See chapter III on the glazed beads of the Badarian period.

and metal oxides (mostly copper) could be thought of as a step towards glazing and faience.

Moorey suggested that faience was substituted for glazed stones after the early third millennium B.C. He argued that bead-makers were experimenting with glazing dark-colored stones to a blue color, and when they achieved the same blue color with faience, craftspeople abandoned the glazing of stones (Moorey 1985: 141). However, Moorey's suggestion does not explain existence of glazed stones and faience at the same time. I think it is not necessarily correct that achieving one technological stage led to the abandonment of the prior accomplishments in related crafts.

Another point of interest is the selection of the blue color, which is still debated. The blue color is known/accepted as an imitation of the stone lapis lazuli. Georgina Hermann (1968: 21) suggested that the early blue color was an imitation of turquoise rather than lapis lazuli based on the fact that blue glazed objects appeared in Mesopotamia before the trade of lapis lazuli began. Keeping that in mind, glass and, to a lesser extent, faience were referred to as imitations of semiprecious stones like lapis lazuli, turquoise, and even green feldspar. Nicholson (2012: 11) argued that rather than mimicking semiprecious stones, colored glasses themselves used to be accepted as types of stones. If so, glassworking must have been considered as a type of stoneworking. He suggests that stoneworkers may have been the originators of faience and his argument mainly depends on Egyptian evidence. For example, faience beads, figurines, and vessels have stone-made counterparts. Furthermore, objects too big to manufacture out of semiprecious stones like turquoise or lapis lazuli became possible with faience (Nicholson 2012: 15). For the organization of

production of faience, not much is known except some uncovered tombs belonging to the tombs of overseer of faience workers or faience worker.[195]

The relationship between stone and faience is also visible between stone and glass. The earliest glass vessels were cold-worked, which points out a link with stone. Among a group of vessels dated to the reign of Tuthmose III, rather than hot-worked glass, a cast and drilled kohl-pot was identified (BM object number EA24391) (Nicholson 2012: 20, Table 1). The well-known lotus chalice found in Wadi Qirud was also cast and cold-worked (Metropolitan Museum of Art number 23.9). The similarities of the types of glass and stone vessels support the relationship between glass and stoneworking (Duckworth 2012: 319). If glassworkers were not cooperating with stoneworkers, then they must have been also specialized as lapidaries since carving cold-worked glass necessitates serious skills and cutting methods.

Nicholson argued that rather than ceramic and metal, the most suitable link to glass is in faience technology. He noted that when Tuthmosis III brought this new technology from the Mitanni to Egypt,[196] he needed to locate the crafts somewhere where artisans could teach the Egyptians their skills, especially working with this new hot pyrotechnology. Thus, it could be faience workers who could also make imitation stone (Nicholson 2012: 19). It must be also considered that the influence on rather than linking glassmaking with a single craft such as stone or faience or metal, the influence could be multi factorial.

In Egypt, glass was known as "stone of the kind that flows," which provides a linguistic exemplar for the relationship between glass and stone. The distinction in

[195] See chapter III.

[196] I argued in chapter II that Alalakh might be also one of the candidates for introducing glass to Tuthmosis III during his campaigns in northern Syria.

language between lapis lazuli from the mountain (genuine) and lapis lazuli from the kiln appears in the first millennium B.C. Naming glass as an imitation stone rather than a new synthesized material indicates that people perceived glass as a natural stone (Beretta 2009: 3–4).

Besides linguistic links between glass and stone, and faience and stone, the excavations of Nicholson (2007) and Petrie (1894) at Amarna and campaigns at Qantir (Hamza 1930; Rehren and Pusch 1999) show that glass and faience were worked in close proximity. Amarna O45.1 provides evidence for the existence of faience workers and glassmakers working alongside each other, though Nicholson could not argue for the presence of glassworkers (Nicholson 2012: 21). The archaeological evidence obtained from Square 64.72 at Tell Atchana, ancient Alalakh, indicates that glass and faience production as well as stoneworking were practiced in close proximity as discussed in section 8.5.

8.3.2 Glass and Glazing

Glaze was known long before glass (chapter III) and glazes were associated with metalworking due to the fact that vitreous materials were obtained during hot processing.

In terms of glazing and glass vessel making, Peltenburg suggested that both of these technologies appeared instantly and fully developed without prior experimentation. This led Peltenburg to further argue that individual craftsmen improved the techniques to an advanced stage (Peltenburg 1971: 10). He specifically pointed to glass vessel making as evidence of advanced stages since vessel making requires a fully developed glass industry. For glass vessels and glazed pottery, Peltenburg pointed to the Nuzi- and Mitannian-influenced sphere as the foundation

of innovation (Peltenburg 1971: 10). Glazed clay objects and glass vessels appear almost at the same time in the archaeological record and thus a typological similarity of glass vessels and glazed clay is visible for the vessels of the 14th century B.C. (Peltenburg 1987).

It is obvious that both glazing and glass items became the products of an organized industry, which could not have been supported only with individual artisans. It might be possible that individual craftsmen achieved technological breakthroughs, but they must have collaborated with other artisans to improve their techniques. The typological similarities could be interpreted as evidence of their integration rather than an independent emergence of both technologies. Furthermore, the lack of evidence for any prior experimentation does not indicate that there were not trial-and-error phases during the refinement of the techniques of glazing and glass (vessel) making.

Glassmaking and the demand for glass vessels might have been triggered by the demand for glazed objects (Paynter 2009: 10). Clay vessels were generally glazed on the outside to obtain a glassy surface, and thus were considered to be luxury items, like glass. Sarah Paynter (2009) investigated the relationship between ancient alkali glazes and glasses. She found out that alkali glazes and glasses are very similar with only slight variations; thus, there must have been a close relationship between glass and glazing clay. Both technologies used similar raw materials, but processing the raw materials might have differed and glazing fired clay objects necessitated additional skill (Paynter 2009: 10). But Paynter's argument also favored a linked artisanship/technical skill rather than independently appearing technological stages. There is not any solid evidence from Alalakh to confirm or disregard the relationship between glazing and glassmaking.

Another subject of discussion is that clay-based ceramic glazing appears in the mid-second millennium B.C. Mesopotamia but not Egypt, which is unusual considering the technological achievements that Egypt had accomplished at that time. Various explanations have been made as to why glazing was not possible in Egypt but possible in Mesopotamia. One of the explanations is dependent on the difference in thermal expansion between the glaze and the clay, which is a measure of the shrinkage of the glaze while it cools down after firing. A fault in the glazing, known as "crazing," which is defined by the formation of a network of cracks, can happen. The thermal expansion coefficient of glaze depends on its composition. The alkali glazes have a higher thermal expansion coefficient and thus are easier to craze. Furthermore, thinner glazes are easier to craze than thick ones and gas bubbles also decrease the homogeneity of glazes and increase the chances for crazing. Additionally, the mineralogy of clay affects thermal expansion. For example, the addition of quartz decreases the potential of crazing. The interaction between the glaze and clay also depends on the chemical composition and thus the viscosity of the glaze (Paynter 2009: 11).

This problem was partially solved in the Near East; however, in Egypt, it could not be overcome either because of the lack of raw materials or expertise (Lucas and Harris 1962; Hedges 1982; Vandiver 1982). In her research, Paynter explained how this problem was solved by analyzing four examples from Nuzi from the Peabody Museum, Boston collections, with SEM–EDS and WDS techniques. She identified augite and diopsite crystals between the glaze and the clay, but between these layers not much observation could be made (Paynter 2009: 5). She argued that

the thick glazes might have been fritted before application (Paynter 2009: 6).[197] The alkali glazes contain generally slightly higher potash, alumina, and iron than the glasses. Thus, Paynter argued that the plant ashes with higher potash than magnesia (Brill 1970) may have been selected for glazing, whereas another type of plant ash was used for glass production (Paynter 2009: 9). This argument is hard to confirm archaeologically, but it might be reasonable to think that there was a classification of the plants and plant ashes according to their use. For vitreous materials, plant ashes must have been selected based on their color, porosity, smell, and taste (Rye and Evans 1976), which was also documented in the ethno-archaeological video of Herat glassmakers.[198]

Another option to overcome this problem was the available raw materials in Mesopotamia and Egypt. Paynter experimentally compared Egyptian Nile silt, Egyptian marl clay, and Mesopotamian alluvial clay and found that crazing in the Mesopotamian clay is the least severe, whereas the Egyptian Nile was the most crazed. Even though Egyptian marl clay and Mesopotamian alluvial clay have similar thermal expansion coefficients, the interaction zone between magnesia and calcium-rich clay and glaze is more substantial. High magnesia and lime levels provided an advantage to Mesopotamian alluvial clay for alkali-based glazing (Paynter 2009: 12–13). The characteristic of raw materials might have been caused the use of stone, which is available on a large scale in Egypt. Furthermore, in Egypt, faience was preferred for colored decorative purposes, whereas in Mesopotamia, where clay and limestone is available on a large scale but stone is a rare commodity, glazed clay objects were favored for votive and decorative purposes (Paynter 2009).

[197] The alumina and iron concentrations were found as higher than typical (Paynter 2009: 7, table 3) and the alumina around the region increases weathering resistance. She concluded that the early glazes of Nuzi had comparable compositions to later glazes.

[198] The video is available online: http://www.cmog.org/video/glassmakers-herat. See chapter III, footnote 43, for the details.

At Alalakh, glazing clay and glazed pottery was a subject of debate due to its very early existence in the 17th century B.C. (see chapter IV, section 4.2). According to an unpublished analysis by Peltenburg,[199] he proposed that the glazes of Alalakh were alkaline, like the common glazes of its period, and the vessels were slightly more silica rich than clay vessels (Peltenburg 1969: 80, n. 33; Paynter 2009). In light of the new research from Nuzi and based on the results presented in the previous chapter, I can argue that the availability of proper clay resources at and around Tell Atchana, ancient Alalakh, might have helped the artisans of Alalakh to achieve this technological stage. Furthermore, the number of glazed stone objects in the Alalakh assemblage is limited even though there were fewer limitations with stone in the region than for Mesopotamia. Nevertheless, at Alalakh, glazed clay objects were favored over glazed stones.

8.3.3 Glass and Faience

Faience and glass are generally discussed together, but the extent of their relationship during production is not fully understood. Peltenburg (1987) linked the innovation of glass with the socio-political influence of Hurri-Mitannian dominancy in the region of Syria and Iraq and he did not promote the relation of glass production with faience working. He related glass to metal rather than faience due to the involvement of hot working both in metal and glass technologies (see section 8.3.4).

[199] While I was writing and discussing the arguments of Peltenburg on Alalakh, I drafted an email to consult him as to whether he still had the data. At that particular moment, I got a message from the email group Agade announcing the loss of Edgar Peltenburg on August 14, 2016. I would like to commemorate him here with respect for all his scholarly work on the vitreous materials and his cautious arguments on Alalakh.

Hodges (1992: 125) proposed that overfired faience might have resulted in true glass. If the temperatures achieved in faience production were not carefully controlled, then the same raw materials (silica and alkali) might lead to the production of glass (Henderson 2013: 12). Henderson mentioned that faience and glass production have common preparatory steps, like crushing the quartz pebbles or ashing plants, though he also pointed out crucial differences in the production of these materials; one is the temperature achieved in the processes. Glassmaking necessitates higher temperatures than faience and thus necessitates a furnace rather than a small kiln. The other is the number of steps involved in production. Faience production is a single-step process whereas glass needs two steps: (1) the production of raw glass, and (2) the working of glass to its final shape by reheating, molding, marvering, and so forth. (Henderson 2013: 12).

An example about the relationship between glass and faience can be given from Egypt, where polychrome faience with inlaid glazed fragments appeared (von Bissing 1902: 80) during the reign of Amenhotep III.[200] This method was suggested as inspired by glassworking where polychrome glass sticks were heated and used to decorate glass (Peltenburg 1971: 9). Polychrome faience with glazed inlay could be interpreted as the response of faience workers to glass, though it does not explain to what extent these two crafts were integrated. Nevertheless, faience production must have provided a background or a basic set of training/knowledge, thus faience production was an attempt towards glass (Peltenburg 1987: 18).

[200] Polychrome faience was known in Minoan Crete sometime before. Polychrome in the glazed pottery industry is a later achievement since different colored glazes do not fuse easily when they tried to mix them, they ended up with blurry designs, which were an unwanted effect. This technique was mastered in Assyrian times with glazed bricks and panels, which are beyond the subject of this dissertation (Reade 1963: 38). Syria, not Egypt, was argued as the innovator for faience production in Crete in the late third millennium B.C. when Minoan metalworking was also influenced by this region (Foster 1979: 56). However, Moorey (1985: 147) disagreed with that based on the limitations of the material evidence.

Based on the available evidence in 2013, Henderson proposed the following (Henderson 2013: 14–15):

> "Some of the earliest glass vessels have been found at Alalakh, in modern-day Turkey (see Chapter 5). They are stratified with faience vessels, so in theory it ought possible to see whether the faience industry there reacted to the introduction of glass (Peltenburg 1987, 14). Although the number of artifacts is small there is no clear technological 'anticipation' in 16th century B.C. faience technology and the emergence of faience vessels."

This dissertation demonstrates that faience and glassmaking were practiced in the same working area (Square 64.72) at Alalakh, though evidence does not extend to the 16th century B.C. material. Archaeometric research confirms cementation as the production technique for faience (chapter VII). Cyril S. Smith (1981: 202, 248) suggested that the cementation method triggered the manufacture of core-formed glass vessels; this theory finds archaeological-archaeometric evidence with the results of this research. Even though Vandiver (1983) suggested that the application of glazing delayed core-formed glass production, Roger Moorey (1994: 195) pointed out the simultaneous appearance of glass vessels and glazed terracotta at Alalakh at the end of the MBA, which supports Smith's argument and the results of this dissertation.

Peltenburg has another study on Alalakh faience and glaze that is worth discussing here. Peltenburg stated that in Alalakh the glazes for faience were directly applied to the cores or applied to one another in an on-glazing fashion. He identified this as a conservative method, and considered it as an adaptation towards brown/black glaze on the blue background. In his 1971 article, Peltenburg recorded that his observations and the relevant analysis were unpublished (Peltenburg 1971: 9). Thus, I could not review the results of this analysis in any of Peltenburg's publications, so I will accept this argument as unconfirmed. Further, it is important to note that the archaeometric research on Woolley's vitreous materials is missing. The

existence of the direct application method of faience could not be confirmed through the analysis of the 2004–2014 material assemblage covered in this dissertation. Nonetheless, some examples from 2015, which were excluded from this dissertation, show signs of direct application though this is not scientifically confirmed.[201]

Based on the similarities in typology of faience and glass amulets and female figurines in the early phases of glass production, Moorey (1994: 194) argued for workshops that were "producing objects of faience for the courts and temples of Turkey and Syro-Palestine towards the end of the Middle Bronze Age." He proposed the possible relationship of three crafts: faience manufacture, metalworking, and glassmaking. His theory now finds its evidence at Tell Atchana, ancient Alalakh.

8.3.4 Glass and Metal

It is obvious that the production of any type of material involved a great deal of integrated activities. In the case of vitreous materials, one needed to select and carry the proper raw materials, collect enough quality fuel, and construct the proper installations (Henderson 2013: 2). The relationship between metalsmiths and vitreous material artisans must stem from the raw materials, hot-working skills, and probably technological knowledge.

Copper-rich minerals provided the necessary colorants for early faience and glassmakers to obtain the colors blue, green, and turquoise. The use of metal oxides was a crucial link between metal and vitreous material artisans. Henderson suggested that copper-based minerals led early glassmakers to imitate turquoise, which was a ritually loaded stone associated with healing properties (Henderson 2013: 7).

[201] These samples have drops of glaze on the surface. I also observed an uneven thicknesses of glaze that was thinner on one side and thicker on the opposite side, like the glaze flew from one side to the other while drying, which is indicative of a direct application technique in faience production (chapter III).

There are two hypotheses relating metalsmiths and glassworkers. Lambert proposed glass as a colored silicate slag collected and processed by metalsmiths of the second millennium B.C. (Lambert 1997). Peltenburg argued for a relationship between metal and glassworkers since both of them were using similar skills while dealing with molten material; meanwhile, faience makers were dealing with cold-state materials (Peltenburg 1987). He noted that the hot working of glass for shaping and decoration is more closely related to metal than faience working, though he accepted the fact that there is paucity for a solid linkage (Peltenburg 1987: 21–22). Tite et al. (2002) suggested something similar to Peltenburg by noting that metalworking involved hot and viscous fluids and thus may have been related to glassworking.

Bronze by-products and corrosion products used as colorant for blue-opaque glasses and the potential use of silver refining litharge in yellow and green glasses supported Peltenburg's hypothesis (Mass et al. 2002). Since the firing temperature for Egyptian glassworking is accepted as 900–1000°C (Vandiver 1991; Stern and Schlick-Nolte 1994), smiths and glassworkers possibly shared related working conditions (Peltenburg 1987).

A less-discussed common ground for metal and glass technologies is annealing (Henderson 2013: 16). Metal production — especially the casting technique — necessitates the controlled cooling down of the final product in order to avoid cracking and deformation. The same applies for glassworking and I think also for faience production where slowly cooling is necessary in order to avoid fracturing. Controlling heating as well as cooling are key parts of metal and vitreous material technologies; therefore, following Henderson, I argue that at least the technological

information necessary to control heating/cooling must have been shared among these artisans, if the artisans were not practicing both crafts.

8.5 The Relationship of Crafts: The Case of Alalakh

Archaeological evidence for related crafts is rare. There are more theories than facts about the integration of crafts in compact, *in-situ* working debris. Beyond that, archaeological debris related to glassmaking in the second millennium B.C. was also rare and solid evidence was only found at the Egyptian sites of Amarna, Malqata, and Qantir-Pi-Ramesse.

Costin (1991) wrote that the study of glass debris is missing since it does not exist in the archaeological record. However, the application of pottery and metal workshop data allows her to list what should be found in a glass workshop.

Basically, raw materials that are quartz or sand, plant ash, and soda should be ground, mixed, melted, cooled, and ground again. The powder obtained at the end of second step should be melted and molded if necessary. According to this process flow, vitrified material remains, finished and semi-finished products, pyrotechnical installations, tools, and raw materials could be expected to be found in an archaeological context (Costin 1991).

The Alalakh craft area provided evidence of vitrified material remains, finished and semi-finished products, pyrotechnical installations, and tools, but not raw materials. This may indicate three options: 1) raw materials are still somewhere around the mound — like in a storage area for raw materials — but have not been found yet; 2) plant ashes might weather out of existence and sand could not have

been recognized during excavations; or 3) the area had been abandoned so all raw material had been carried away before abandonment.

Archaeometric analysis (chapter VII) together with the LBI–LBII transition period archaeological contexts of the working areas at Alalakh (chapter V, section 5.4) identifies for the first time a glassmaking area contemporary to Egypt in northern Syria/southern Anatolia. These new finds re-fuel debates about the existing glassmaking locales in Mesopotamia and shift attention to northern Syria and Anatolia to identify not only glassmaking areas, but also a new set of information on the crafting areas, types of technologies and production, as well as organization of production.

Evaluating the architectural alignment of the Egyptian glassmaking area at Amarna (Nicholson 1993) and comparing it to Alalakh provides noteworthy parallels between these sites (fig. 8.4). At both sites, the kilns are located in an apsidal structure. The reason behind the preference for an apsidal structure is beyond the subject of this dissertation, but it is relevant here to note the similarities of the apsidal architecture at both Amarna and Alalakh. At Amarna, the kiln has a pit located just outside the kiln where lots of glass fragments were collected. The same alignment is visible at Alalakh. As discussed in detail in chapter V, the area near the kiln turned out to be full of glass vase fragments along with other vitreous remnants, like faience fragments. Additionally, Nicholson (1993) suggested a possible pottery kiln in the southwestern part of the trench due to the high accumulation of pottery sherds and the remnants of an installation. Even though such an installation was not excavated at Alalakh, pottery recovered from this area suggests a pottery kiln in the southwestern part, in the possible room of Square 64.72. In 2015, the floor level of this area was reached and burnt mud bricks and highly burnt pottery sherds were found. The

installation was found to be cutting another pyrotechnical installation, indicating continuous production activities at this part of the mound.

At both Amarna and Alalakh the working debris have yielded similar architectural features that were interesting to observe. Does architectural arrangement also indicate the relationship between craft organizations at Alalakh and Egypt? This is a question for further research, but such a relationship could be regarded as a transfer of technological knowledge among the regions, at least for the architectural basis of how to align working areas. Such a similarity in plans, both architecturally and organizationally, could have been reflecting also relation of crafts and chains of operations though verification with further evidence is necessary.

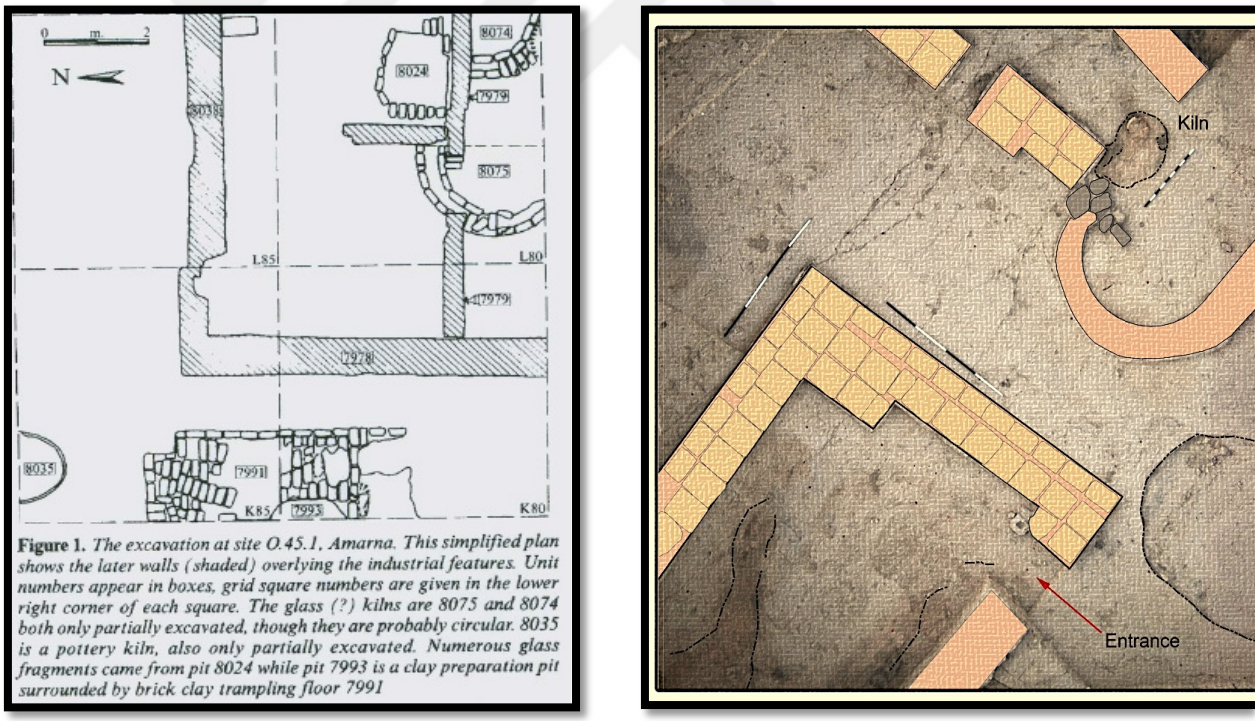


Figure 1. *The excavation at site O.45.1, Amarna. This simplified plan shows the later walls (shaded) overlying the industrial features. Unit numbers appear in boxes, grid square numbers are given in the lower right corner of each square. The glass (?) kilns are 8075 and 8074 both only partially excavated, though they are probably circular. 8035 is a pottery kiln, also only partially excavated. Numerous glass fragments came from pit 8024 while pit 7993 is a clay preparation pit surrounded by brick clay trampling floor 7991*

Fig. 8.4: Architectural plan of O.45.1 at Amarna (right, after Nicholson 1993); Architectural plan of Square 64.72 (left, The Alalakh Excavations archive).

Besides glass, the production of faience must have been a part of the vitreous material production activities. The existence of glass and faience artifacts together with frit and metal objects, fragments, and wasters point towards the multifunctional nature of Alalakh's workspaces. In order to obtain a basic understanding of the activities in the area, distribution maps for glass, faience, frit, and metal were created with geographical information systems (GIS; fig. 8.5). For the GIS map the spatial interpolation with regularized spline with tension method of Grass GIS is used since the data is limited.[202] The maps show that glass and faience artifacts were concentrated around the kiln, whereas frit and metal accumulations were visible in a different corner. Such a distribution suggests a division of work in the area. According to the artifacts analyzed thus far, copper was used as a colorant to obtain blue and turquoise. Since metal and frit artifacts had accumulated in the same corner and were not found or rarely found in the rest of the working zone, it suggests that metal and frit were associated during the production. A possibility for their linkage could be the sequence of colorant addition into the glass and/or glazing batch. It is not clarified yet (at least outside Egypt) whether colorant was added when the glass was molten or while the frit was powdered for the second of a multistage process. Figure 8.5 demonstrates that the addition of metal colorant was linked with frit, which supports multistage production and thus bolsters the evidence derived from the glass texts (chapter III). According to the distribution patterns, the preliminary and/or intermediate preparation for vitreous batches were processed in the lower right part of the craft area, whereas glass and faience were processed around the hot zone, in other words, in the upper right part of the square where the kiln was situated. It is necessary to note at this stage that the analysis on the faience from the same area

[202] I would like to thank Dr. Bülent Arıkan for his contribution while creating the GIS maps in fig. 8.5.

(chapter VII) indicates the application of a cementation technique, which requires the highest temperatures among the various faience production techniques, and thus fits well with the picture of existing faience remnants in the hot zone.

Such a division in the area proposes multiple-stage production. A similar pattern was proposed for Amarna, including glass, faience, and pottery production (Nicholson 1998), and the existence of frit was shown as an indicator of such a pattern (Shortland 2008). Additionally, the similarity recorded between the layouts of the Alalakh 64.72 and Amarna O45.1 workspaces hint at a shift of technological knowledge within the regions; this is supported by this new line of evidence (Dardeniz forthcoming (b)).

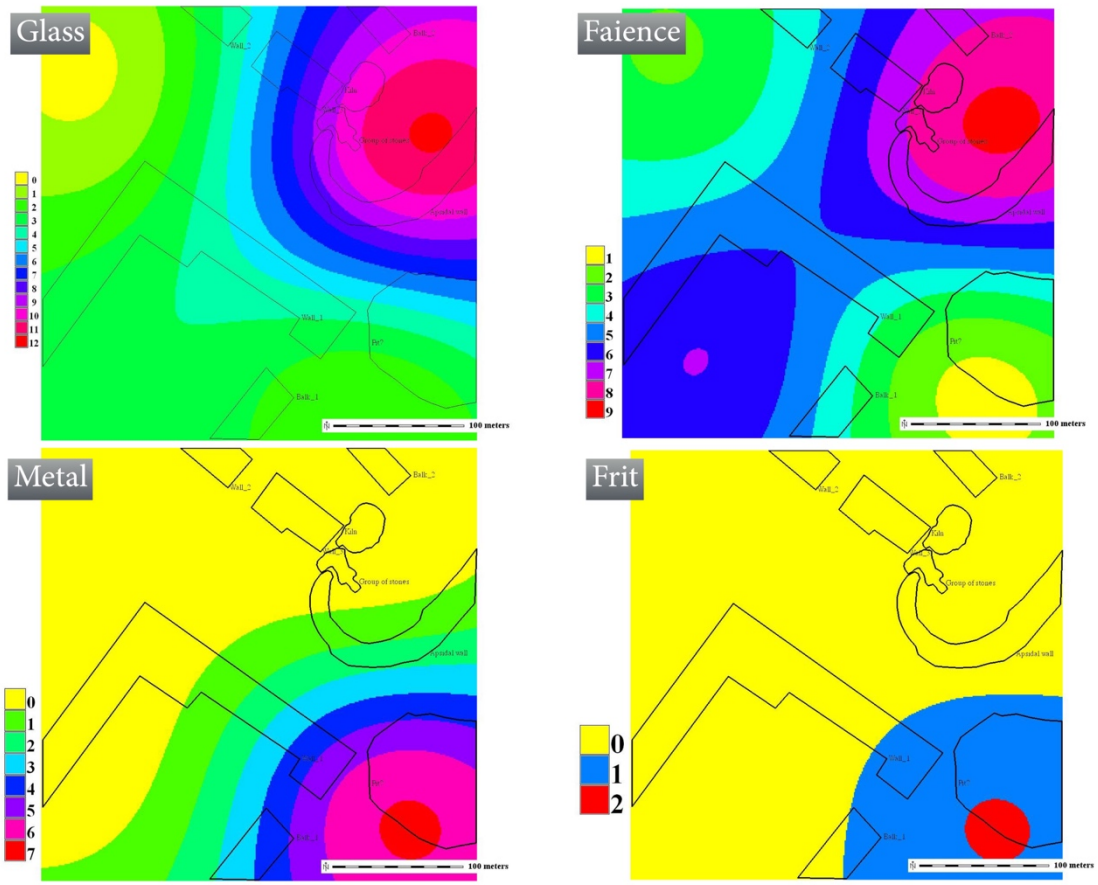


Fig. 8.5: Distribution maps of glass, faience, frit, and metal artifacts in the period 3 local phase 4 context of Square 64.72.

Scientific evidence together with the archaeological context and its associated assemblage confirm that both glass and faience were produced in LBA Alalakh. Besides experimentation with production, possible combinations of glass and faience would have also been explored in this LBI–LBII transition period context of Alalakh.

The emergence of glass technology and the relationship of glass production to other specialized crafts are other aspects of the relationship of technology to socio-economic structure. Vandiver relates faience production to glass manufacture (Vandiver 1983). On the contrary, Peltenburg (1987) suggests faience production only as a background, but not a real trigger, for glass production due to the rapid emergence of glass technology around 1500 B.C. Nicholson and Henderson suggest that glass production in Egypt was driven by foreign crafts since it is not possible for an internally developed craft to have begun at an advanced stage (Nicholson and Henderson 2000). For the emergence of a glass industry, Mesopotamia was generally thought of as an earlier producer than Egypt. With the aid of scientific and archaeological evidence, Alalakh now shows us a nonlinear development pattern, meaning that one technology or craft does not specifically follow the development of another technology, but instead they could have been experimented with and emerged/evolved at the same time.

The related assemblage of the context also yielded valuable information relevant to the archaeological theories reviewed above. In addition to the unique glass corpus, the debris of Square 64.72 yielded an elevated number of metals. Evaluating metals in the debris bring up further questions about the interpretation of the context. Metals can be used as tools for glassworking, while metal ores and/or scrap metal fragments could have been used as colorants for glass. Furthermore,

glassmaking is related to metal production since both of them are hot-fire-related technologies.

In Square 64.72, there were several metal fragments and artifacts identified as projectile points, though they may have been mislabeled.[203] They could be tools for drilling, which could have been used during glass, faience, metal, and stone manufacture. Lots of metal fragments from the context look very much like scrap metals, which could have been used as colorants during glass and faience manufacture.

There were also two flat stones that were recorded as having been found in Square 64.72. Even though the pictures of the stones are not available, they were defined as oval-shaped, dark-colored stones with flat surfaces.[204] They could have been used as a marver to work with hot glass by rolling beads on it or rolling vessels on the surface. Another feature in this context is the accumulation of stone artifacts. The same type of melon shaped and spherical beads made out of metal, stone, frit, and faience were excavated in Area 4. Ring beads made out of stone and glass were among the corpus of the zone. The existence of artifacts with similar typologies but made of different media certainly points toward the integration in crafts.[205]

[203] The one that was identified as a projectile point in the excavation records may have another use. This idea was inspired from our class discussion with Aslıhan Yener who said these possibly could be drills. The original inspiration comes from Magda S. Pieniazek during her lecture about stone tools at Koç University in 2013.

[204] The definition was made by trench supervisor Sim Belik in 2011. I personally saw the artifacts in the same year and they were suitable to use as marvering stones. However, their exact location was not recorded in the field book. Furthermore, the information on the artifacts are not available in the database. In 2014, I visited the Alalakh dig house depot for a second round of observations, but it was not possible to reinvestigate the artifacts.

[205] The metal and stone artifacts of the area will be the subject of further research by Michael Johnson (metals) and Magda Pieniazek (stones); they could not be covered within the limits of this dissertation.

While adding the possibility of metal tools used for glass production, I do not want to disregard the probability of metal and glass being worked in the same area. To answer these questions and establish a link between metal, glass, and faience workers, slag found in this context should be analyzed as well as the architectural features, like the wall linings of the pyrotechnological installation, which could give us information on the working temperature in the area.

There are two significant examples from Alalakh that also confirm the tight relationship of stone and vitreous material crafts. The light blue statue eye made out of frit and inserted in a white stone (AT/39/33, catalogue number: 518) found in the Hatay Archaeology Museum (see Appendix II) shows how frit was worked as an inlay in stone. Inlaying frit in stone in the shape of the statue eye necessities advanced and experienced carving skills of stone artisans. Similar work must have been done for the blue glass eyes of the statue of Idrimi. The second artifact is a bead (catalogue number: 549; AT Number: unknown), which is currently in the British Museum collections. This quartz bead was carved professionally like a dome and blue dots, which were made of glass, were applied on the surface. These blue decorations must have been made by touching a blue glass rod on the surface when the glass was hot. This artifact is a perfect example of the close relationship between stoneworkers and glassworkers.

Following Costin's theoretical approach on the organization of crafts, it is important to evaluate whether the artisans of Square 64.72 were attached or independent craftspeople. Without any solid evidence, it seems like they were attached because in the LBI–LBII period, glass and faience would have been luxury goods that could have been produced under the control of the palace, temple, elites, or any high-ranking society member. The depot rooms of the Level IV palace

contained unprocessed raw materials (chapter IV), which also shows state control over production; this could have continued for the later time periods of the settlement. To further validate this point, a Mitannian style faience seal was found in 2015, possibly indicating an elite governance or control over the area.[206] On the other hand, I cannot simply disregard the existence of any seal-cutter practicing in the same area with the faience workers. Even though the cartouche-like cylinder beads made out of mostly frit and faience might be unworked pieces of cylinder seals, the existence of only one faience cylinder seal is not enough to confirm any seal-cutting activity in the earlier levels of Square 64.72.

While being speculative, I would also like to point out the Egyptian blue pigment chunk (AT18864) found in the temple sounding in 2012 as evidence for temple control over production. If the context is proved to be part of the temple, finding raw materials in the temple area will illuminate linkages between temple–production and temple–crafts. Considering the fact that early examples of glass, such as female figurines, were found in the temple contexts at Alalakh, the involvement of the temple in vitreous material production seems reasonable.

Vitreous material production, especially glassmaking, needs high-level specialization and great attention to the process, so it is reasonable to think that vitreous material artisans were full-time workers. However, it is hard to make any suggestions as to how much of their time had been dedicated solely to vitreous materials in the case of integrated crafting zones. Furthermore, even though the artisans were full-time workers, the production itself might be seasonal. There is indeed some seasonal activity involved in vitreous material production. For example, the *salsola jardanicola*, which is a type of salt-bearing plant, still grows on the

[206] The 2015 artifacts are beyond the subject of this dissertation.

Atchana mound (fig. 7.38). This species might have been harvested in the second millennium B.C. (though not much is known about the climate and vegetation of Alalakh in the second millennium B.C.) and thus is a strong candidate as the source of plant-ash flux at the site. I observed the species in the summers of both 2014 and 2015 and realized that it appears in late May and disappears at the end of August. If this plant was used, then at least the harvesting of the plant and processing it into plant ash must have been seasonal, and thus could be considered part-time.

The level of the technological knowledge of the craftspeople is debatable since it was obvious that they knew how to manipulate their environmental resources to produce luxury goods, but whether they had already mastered or were mastering it through experimentation still needs to be answered. There are more questions to be solved reflecting the socioeconomic significance of the vitreous materials. If glass and faience were luxury materials of this time period, what was the volume of the daily/monthly/yearly production? What was the demand for such material? Was it really necessary to control them? How much of the production was controlled and how much of the production was consumed by the general population?

Once demand is clarified by careful evaluation of archaeological materials from secure contexts and textual records, we should also ask about the economic value of glass. What was the price of glass in the Late Bronze Age? In the modern day, glass is a cheap and common material, which is contradictory to its meaning in the second millennium B.C. economy. It was rare and restricted to the use of elites. This is best exemplified by its appearance after gold and silver in the Temple of Karnak depictions, and the appearance of horizontal dark blue glass inlays in gold in the funerary mask of Tutankhamen (Cairo Museum number: JE 60672). It is obvious that glass was a prestigious and high-status material in the second millennium B.C.

and thus must have been highly valuable (Shortland 2007). Schick-Nolte (1968) suggested that glass was as valuable as gold, though textual records are essential to prove this idea.

8.6 Concluding Remarks: The Context of Inventions and Artisanship and Vitreous Economies at Alalakh

This section reviewed the archaeological theories on craft specialization and the relationship among crafts by putting the Alalakh vitreous material assemblage and the workshop area as the center of focus. Hopefully, these results will shed new light on the glass and faience production traditions of the second millennium B.C. and their relationship to craft specialization by providing evidence from the key site Tell Atchana, ancient Alalakh.

In its broad history and during its occupation in the Bronze Age, Alalakh did not play a dominant role in the overall political setting of the Near East (chapter II). Nevertheless, the strategic location of the site made Alalakh a part of international trade networks, especially in the Late Bronze Age (Yener 2007; Akar 2012b). The ability to trade while having access to raw materials provided an advantageous situation for Alalakh as a manufacturer of daily and luxury materials.

Trade has political as well as symbolic value; thus luxury goods had a special role in the preferences and consumption of highly ranked members of society. Trade not only set commercial and political relations, but it also led to the transfer of technological knowledge, ideas, and innovation (Sinopoli 1994; Sherratt and Sherratt 1991). According to Carlo Zaccagnini (1983), not only caravans with goods were traded, but skilled artisans also were transferred among the courts (see the paragraph on mobile crafts in section 8.2).

Inventions were not only facilitated by trade, but also by military conflict, which Moorey called "captured technologies" (Moorey 1989: 281). According to him, for the improvement of technology and inventions, international contacts in military and diplomatic basis are necessary. In other words, for the spread of inventions, a social and economical link among the ruling classes is necessary (Moorey 1989, 2001). This might be true for the relationship of Alalakh and Egypt, especially during the military campaigns of Tuthmosis III, where he mentioned Alalakh in his lists. Still, the tribute lists did not specifically attribute glass ingots to a city. As I discussed in chapter II, Alalakh with its invention abilities and production capacity of luxury items might well be a candidate as the source of the glass that served tribute, and thus might have helped the spread of this glass technology.

In the second millennium B.C., glass — compared to faience and frit — was a new innovation. This provides a basic understanding for the economic capacity or structure of the settlement based on the fact that:

> "only a society sufficiently centralized and organized on a large enough scale can find the effort and capital for major innovations, and the success of these innovations is likely in its turn to enhance the status of the investors" (Spratt 1982: 84).

With the available archaeological evidence, it is not possible to argue that Alalakh invented glass, but I would like to suggest that Alalakh must have had a well-established and organized system and enough capital to support production and new technologies. The Mitanni Empire, which Alalakh served as a vassal (chapter II), might have prompted/promoted the new inventions through its vassal states thus vassal states might have been practicing new technologies in order to enhance their status.

I specifically pointed out the Mitanni Empire; based on textual records, scholars were associating Hurrian-speaking people with new technological

innovations like horse-drawn chariots, composite bows, and scale-armor for men and horses (de Vaux 1967; Klengel 1978; Moorey 1986), as well as core-formed glass vessel production and vitreous material industries (Peltenburg 1971, 1987).

Oppenheim (1973) argued that glass as a new technology was introduced to the Near East during the time of Mitanni Empire, around the 15th and 14th centuries B.C. Oppenheim (1966: 35) interpreted the literary evidence including the production of glass and glazed materials, the manufacture of perfumes, or the dyeing of wool as a "new technology of alien origin." However, since perfumes or dyes have not survived well in the archaeological record, glass vases were interpreted as the only surviving witnesses of this technological change (Moorey 1989: 274).

The practice of vitreous material crafting at Alalakh necessitated technological knowledge along with the potential for innovation. Barag (1985: 29) noted the following idea for glass, which I think is valid for all types of high-quality crafting:

> "The ancient glassmaker prepared his glass batches according to prescriptions and formulae developed by trial and error in different areas and places over a long time. Similarly the development of techniques and tools for producing large scale and ever growing variety of glass and the use of glass in many very different ways required creative and inventive minds as well as broad knowledge of the technology of many related fields. Again, one may assume that this took a long time, generation of artisans refining and elaborating techniques and tools handed down from previous generations."

Vitreous material craftspeople, especially glassmakers,[207] were manipulating and turning low-cost silica, soda, and lime into highly prized materials (Shortland 2012: 271).[208] By creating esteemed items out of materials with no value, crafting

[207] Shortland's idea is for glassmakers and does not cover all the vitreous material crafts.

[208] The only high cost additive of vitreous materials must be the colorants (metal oxides) such as the copper and lead used.

must have been a magical activity deeply imbedded in secrets. Artisans must have guarded the technological knowledge behind their work (Barag 1985: 29). Archaeological records will not divulge these secrets unless the textual records speak of them (chapter III).

Why did vitreous material technologies emerge and develop? Was it just a new line of luxury items and a desire for prestige? Or did it stem from the excitement of artisans who were playing with new materials? Smith (1981: 347) proposed the discoveries as a form of art rather than something intended to serve a utilitarian purpose.

I presume there is no way to clearly identify the intention(s) behind the production of vitreous material crafting. It could have been for prestige, a way to emphasize power, a fashion, or the excitement of artisans for new materials; it is clear that the demand for colorful, lustrous, and luxury items was continuous.

The archaeological context unearthed at Alalakh is just one case to examine and test various theoretical approaches centered on the linkage of different crafts. The results created a new platform to rethink the relationships of artisans and the context of innovation in the second millennium B.C., though there is no limit to further the archaeological and philological research that could help us bring the pieces of the puzzle together to reconstruct cross-cultural and intercultural links between crafts and artisans' wisdom.

CHAPTER IX:

CONCLUSIONS

From glazed stones to the production of frit and faience, glazing clay, and the emergence of a fully developed glass industry, vitreous material crafts made advances in manipulating and transforming raw materials into artifacts and luxury goods. This dissertation investigated the second millennium B.C. vitreous material industries by focusing on the vitreous corpora of Tell Atchana, ancient Alalakh, uncovered during the Woolley and 2004–2014 Yener excavations.

By archaeologically re-investigating the collections of the site, a comprehensive study has been completed, which is among one of the aims of this dissertation (see chapter I). The vitreous collections are evaluated as a whole (except the UCL collections; see appendix III) so that new interpretations of the corpus have become possible. The gaps and selection in the information presented by Woolley in his publication reports (1936, 1939, 1947, 1950, 1953) and his final publication (1955) had led scholars such as Barag, Peltenburg, and Lilyquist to base their interpretations on selected artifacts rather than having the chance to investigate the complete corpora. This led to the misidentification or lack of documentation of several artifacts, which is well exemplified by the case of three glass female figurines from Levels VI, V, and II. Among those, glass scholars had paid little attention to Level II (AT/39/66, catalogue number: 446) due to Woolley's vague terminology, such as

"glass paste." Chapter IV is mostly dedicated to clarifying Woolley's terminological confusion so as to identify the original character of the vitreous artifacts and to understand Woolley's recognition/confusion of glass, faience, frit, glass paste, lapis lazuli paste, and glazed pottery.

One of the archaeological problems relevant to vitreous materials is where the production areas might be located. Rather than frit and faience, my research is centered on second millennium B.C. glass because glass was considered the high-tech industry of the period. Archaeological, archaeometric, and textual evidence address Egypt and Mesopotamia as the zones for glassmaking. Even though Amarna, Malkata, and Qantir were identified as production sites for glass in Egypt, locales for Mesopotamia could not be identified. Settlements in northern Mesopotamia like Nuzi, Tell Brak, and Tell el-Rimah have yielded rich assemblages, but production-related debris have not been identified yet.

The evaluation of archaeological contexts (chapter V) from the 2004–2014 excavations demonstrates a drastic increase in the number and type of vitreous artifacts in the LBI (dated to 1500–1400 B.C.), which links to the emergence of glass technology in the region. For the first time, the archaeological context dated to the LBI–LBII transition period locates a multimedia craftsmanship area, where glassmaking was also practiced. This new set of information extends the region of possible glassmaking areas to northern Syria, which has been less discussed for the glass industry, perhaps due to the relatively rich material evidence from the northern Mesopotamian sites.

This new line of evidence necessitates further examination of the materials themselves in order to characterize the technology, manufacturing techniques, and the manipulation of raw materials. The archaeometric methods summarized in

chapter VI were applied to characterize the Tell Atchana, ancient Alalakh corpora and to detect possible methods or parameters to distinguish the corpus from the other settlements' assemblage.

The ICP–MS analysis of 46 glass artifacts from the settlement demonstrated that all of them are soda–silica–lime glasses with copper used for blue colorant and antimony as the opacifier. These major element compositions are in accordance with Brill's previous research (chapter IV). The low potash concentrations detected in the MBII, some of the LBI, and the LBI–LBII glasses indicate the use of different sources of plant ash or the same plant with varying levels of potash which might be due to climatic conditions or water levels on the earth at the period. The rest of the LBI glasses and the LBII glasses have higher potash with lower than 1% alumina indicating a selective use of plant ashes. The variations in the practice of plant ash selection according to chronological period suggests a stage of experimentation in glassmaking, especially between the MBII and the LBI–LBII. The glass recovered *in situ* in the multipurpose craft (LBI–LBII) area demonstrates the use of different plant ashes, which supports the hypothesis of experimentation together with integrated crafting in that part of the mound. However, in the LBI and LBII, plant ash selection for glass seems more specialized. The existence of LBI objects mostly in temple- and palace-related contexts might signify a more controlled production, most probably following strict and strictly guarded recipes with ritual elements. During this period, glass was a luxury product and was managed by high status individuals; thus keeping production recipes secret and involving rigorous rules must have been the default way of manufacture. In the LBII, the selection of plant ashes might be due to either strict rules of production or improved technological practices. I favor improved technological practices over ritually loaded production practices for the LBII period

because in the LBII, craftspeople must have already learned which plant ashes were working the best for making glass after a long period of trial and error. They must have been experimenting for quite a long time to obtain supreme efficiency in the manufacture of glass. Additionally, they must have known how to integrate different production practices, such as metalworking and faience production, so that they acquired maximum effectiveness with fewer mistakes and less waste.

Detecting any evidence of experimentation of ancient technologies is not an easy task; and for the second millennium B.C. glass and vitreous technologies a complete data is not known at the time of this dissertation. For identifying any evidence for ancient experimentation, either excavator should have a trained eye or investigations at craft related areas need to be conducted by scholars who are specialized on the subject. Otherwise, the evidence could be easily unnoticed. From the scientific point of view, more major and trace elemental data of the artifacts especially from northern Syria and Levant is necessary. Besides archaeological data, environmental reserves and possible raw material sources need to be investigated scientifically, which need an archaeological reevaluation later.

The second millennium B.C. glassmakers, glassworkers, and their rulers left no records regarding their activities. As the later textual records on glassmaking mention (see chapter III), several steps in glassmaking follow seasonal schedules. The selection of plant ashes must have been in accordance with this. *Salsola jardonicola*, which still grows on Tell Atchana, ancient Alalakh, is available between June and August, thereby restricting the harvest of this plant to the summer period. It is not possible to project modern climate and vegetation onto the second millennium B.C., but modern observations on this plant represents a seasonal pattern.

The seasonal availability of one ingredient or the seasonal collection of any ingredients, such as silica, lime, or metal oxides, do not necessarily designate the production of vitreous materials — especially glass — as a seasonal activity. It might be possible that production was practiced year round. On the other hand, any kind of pyrotechnological activity necessitates installations, which consume fuel and produce poisonous gases. Locating kilns in open courts and activity areas is advantageous in two ways: 1) removing undesired by-products easily; and 2) benefiting from fresh air and wind, which are two key factors to helping pyrotechnical installations function more efficiently. Therefore, I argue that glassmaking at Alalakh must have been restricted to a season (chapter VIII) when the climate conditions were more convenient for achieving higher temperatures in kilns, such as seasons with less rain and more stable wind.

One can feel a strong daytime wind blowing from west to east at the Atchana mound. This wind is caused by an atmospheric temperature gradient due to the geography of the Amuq Valley and the Amanus Mountains. This continuous wind even caused the local border crossing in Syrian to be named *Bab al-Hawa*, "gate of the winds." Given that the workshop in Square 64.72 as well the associated workshop debris recovered in Area 4 is located along the southern part of the mound, this directional wind (likely not different in the Late Bronze Age) would have helped to carry the smoke and toxic gases away from the city rather than into the settlement itself. This wind is not only helpful for the disposal of smoke, but it also helps the pyrotechnological installations obtain higher temperatures as is necessary for glassmaking. Air circulation created by the west–east wind would have worked as a catalyst and helped craftspeople to reach higher firing temperatures with ease, rather than relying solely on bellows or tubes. This strong wind would have helped

craftspeople to reach higher temperatures with less labor and therefore would have caused a decrease in fuel consumption, which is the major cost of craftspeople.

Since I proposed glassmaking as a seasonal activity, I hesitate to propose glassworking as also seasonal. Fragments of glass vases, beads, and small number of rods indicate that glassworking had also been practiced at Alalakh to a certain extent, but there is not solid evidence for assigning this activity to a season. Glassworking requires lower temperatures and the manipulation of already manufactured glass ingots into final shapes. It did not require direct access to raw materials. Similar to glassworking, the interlinked activities — namely faience production, stoneworking, and metal working(?) — might have continued throughout the entire year. Faience production requires low temperatures, just as glassworking does. Stoneworking depends on the availability of labor, if the stone to be processed was readily available. Some of the seasonal aspects are: access to stone as raw materials, metals that would be used as colorant (and other for other metallurgical activities that are not the subject of this dissertation), plant ashes that would be added as flux, and wood for fuel. Storing raw materials could have allowed artisans to continue working on these materials for the whole year. Since storing valuable raw materials was a crucial part of state-controlled production, this idea is supported unless a special climate condition was mandatory for production.

The characterization of vitreous materials aimed in this study also covers distinguishing the Alalakh glass from the other sites, which was achieved by using minor elements like chromium, vanadium, and arsenic (chapter VII). The binary plots of chromium–vanadium (Cr–V) distinguished Alalakh glass from Nuzi, Tell Brak, Amarna, and Malkata, all of which have comparable archaeometric data. This shows that Alalakh has fingerprint trace elements to distinguish it from Egypt and

northern Mesopotamian sites. The available chromium reserves (fig. 7.34) within 50 km from the site supports the idea of local raw material exploitation for production.

The existence of arsenic and the lack of tin in blue-colored glasses is yet another characteristic to distinguish between the copper-colored glass of Alalakh and Egypt. The blue glass of Egypt, which is colored with copper, often includes tin, which was also linked to the use of tin bronze scraps as colorant in Egypt (Shortland et al. 2007: 786). According to the results of this dissertation, in the case of scrap metal usage as colorant, arsenical bronzes were preferred at Alalakh. At this stage, it is hard to determine whether tin bronzes were specifically avoided as colorant. The characterization of the LBI and LBI–LBII period metals of Tell Atchana, ancient Alalakh, will shed further light on the use of scrap metals in the corpora of the site. But within the existing evidence, I would propose a reason why arsenical bronzes were preferred over tin bronzes as colorants: Recycling arsenical bronzes must have allowed for less control over the arsenic content due to the volatile nature of this element. Thus, rather than using recycled arsenical bronzes for the production of utilitarian tools or weapons, manipulating arsenical bronzes for side production, like colorants for vitreous materials, seems logical. Tin bronzes might have been more suitable for recycling. At the end of the second millennium B.C., ternary alloys (tin-arsenic-copper) also appeared, probably the result of recycling arsenical and tin bronzes together (Yener 2000, 2010c).

The high iron (5–6 w%) and aluminum (10–12 w%) concentrations in Alalakh artifacts were the subject of other studies, mostly on locally produced Nuzi type (Alalakh ware) ceramics and mud brick architectural fragments (Erb-Satullo et al. 2011; Yener 2010a, b; Dardeniz 2013). This local feature now also includes the vitreous corpora. Aluminum sources with high levels of iron located in the Kırkhan

region (almost 10 km away from Alalakh) might have been served as a local raw material source.

High levels of alumina and iron in glass are also indicative of the use of sand instead of quartz as a silica source. Sand is more contaminated with elements including alumina, iron, titanium, and calcium whereas quartz is pure. Thus, I proposed in chapter VII that the sand that was used as a raw material possibly came from the Orontes River. Further research, including the isotopic characterization of not only the river both also the region, will present a more solid background on this subject.

The strontium and neodimyum isotopic results on the glass are not sufficient for statistical analysis. On the other hand, the primary archaeological context of two isotopically characterized glass fragments present new information on glassmaking and trade. The amber-colored (AT 15065, catalogue number: 260) glass vase fragment shows idiosyncratic values that support local production. The blue ingot fragment (AT 16968, catalogue number: 291) recovered from inside the installation demonstrates a close value to Tell Brak isotopic values. However, the scattering of Tell Brak isotopic values signify that the site might either use different sources for glass or Tell Brak might be importing glass of specific colors and/or quality. Since industrial debris was not recovered at Tell Brak, I propose that Alalakh might have been in contact with Tell Brak — if not also with other northern Mesopotamian sites — for glass.

Based on isotopic research, blue-colored glass fragments from Athens were proposed as having originated from Tell Brak (Henderson et al. 2010). The isotope values of the Athens fragments are now also in concordance with Alalakh, which potentially adds a new route to the trade relations between northern Syria and

Mycenae. Alalakh could have been trading glass through Ugarit or an unknown port from Hatay to Mycenae. Thus the glass from Mycenae might have not originated only from Egypt or northern Mesopotamia, but also from northern Syria. Further, it is not possible to extrapolate this argument from the Uluburun shipwreck, which occurred in the late 14th century B.C., because the Alalakh glassmaking area dates to the early 14th century B.C. There was continuous production at Alalakh, though it has not been confirmed yet for glass. Therefore, the question of whether the glass from the Uluburun shipwreck characterized as northern Mesopotamian could actually be linked to Alalakh is left for future research.

The chronology of the production debris (period 3, local phase 4) of Alalakh is not completed yet and research related to the stratigraphy and chronology of the settlement is currently under study. But at this point, research related to Alalakh chronologies suggests the dating of the Alalakh production debris as earlier than Amarna (ca. 1353–1336 B.C.). Within this dissertation, I specifically avoid the origin of glass theories. Nevertheless, the existing chronologies point towards the fact that Alalakh was a glassmaker earlier than Egypt, which also confirms theories based on textual records suggesting (northern) Mesopotamia as the origin of glassmaking (see chapters III and VIII). The results of this dissertation present northern Syria/southern Anatolia to have been a potential production zone of glass.

Besides glass, the faience of Alalakh comes in various colors. The artifacts from the production debris that were analyzed demonstrate the cementation technique, which requires the highest temperatures compared to the other methods for faience production. The evidence of faience from Amarna and Lisht show efflorescence and direct application (Nicholson 2008), which differentiates Alalakh from the production patterns of New Kingdom Egypt (ca. 1570–1070 B.C.). Alalakh does not

have evidence for faience produced with efflorescence and direct application methods. However, the analysis of Nuzi faience demonstrated that all techniques were used and thus it is not possible to differentiate between Alalakh and northern Mesopotamia. At Alalakh, I suggest that the practice of the cementation technique is deliberate due to the interrelated activities in the same workshop area. Since glass was also manufactured in the same workshop, the high temperatures achieved in the kiln could have also facilitated faience production.

Archaeology and archaeometry are two pillars of information to uncover the organization of ancient crafts and to illuminate the possible transfer(s) of ideas, innovations, and technological knowledge. The geographical location of Alalakh provided an advantageous setting to connect it to international trading networks as well as give it access to the raw material resources, which stimulated the emergence of a hybrid culture and the establishment of several industries including the production of luxury goods. Even though the site benefited from its strategic setting, during its life span Alalakh stood in the center of political and military struggles among the superpowers of the region (the Hittites, Egypt, and Mitanni). While being destructive, these military campaigns must have also triggered the movement of ideas including exchange of innovations among the regions to a certain extent.

Square 64.72 yielded a multi-purpose crafting area where glassmaking, glassworking, faience production, stoneworking, and metal working(?) took place. During the time when this craft area was busy with the production of these luxury items, Alalakh was under the political dominance of the Mitanni Empire. The Mitannian supremacy was not restricted to political power; it also had an effect upon the material culture and production technologies of Alalakh for a long time. Even though the site politically shifted to Hittite dominance after the Mitanni, the vitreous

material assemblage of Alalakh continued to demonstrate Mitannian influence. It is also important to note that the association of Hittites with glass was not completely understood. As Ayşe Baykal-Seeher and Jürgen Seeher (2003: 108–09) recorded, between the 1978 and 2003 excavation campaigns at Boğazköy, only 25 objects of glass, faience, and frit were recovered; most of these were beads. Based on the existing material evidence, the interest of the Hittites in vitreous materials appears to have been limited. Yet, textual records speak of various colors of glass, but this requires further investigation.

The production of any artifacts and the manipulation of raw materials into valuable goods necessitates organization, specialization, and definite technological knowledge. The access to certain raw materials, such as metals or fuel, was under state control; thus I argue that artisans related to vitreous material production must be attached (chapter VIII). Even though the archives from Alalakh did not provide evidence that vitreous material artisans were under palatial governance, the household and personnel lists demonstrated various kinds of artisans, like smiths and potters, as attached to the palace. I also propose that vitreous material artisans — at least glassmakers — were full-time workers due to palatial control, the necessity of high levels of specialization, and great attention to the process. Since I proposed glassmaking as a seasonal activity, glassmakers must have worked full time during the appropriate season, though they might have been occupied for the rest of the year with interlinked manufacturing activities.

Crafting and the emergence of new technologies required new ideas and an accumulation of technological knowledge. Such innovations were facilitated by trade and political relations, contacts among courts (such as gift exchange), and military conflicts. The new invention of the second millennium B.C. was glass, which

entailed well-established and organized political systems to accumulate enough capital to support the practice of new technologies. The architectural similarities at Alalakh Square 64.72 and Amarna O45.1 (chapter VIII) demonstrate that the transfer of technology did not only include the final products but also encompassed the operational chains and architectural settings. The finished items themselves were the carriers of innovation; they also served as luxury goods, as in the case of vitreous materials.

The idea of multimedia workshops is favorable, since it was hard to think as many craftsmen and workshop areas for each material type (Laffineur 1995: 199). Vitreous material manufacturers were transforming low-cost raw materials (silica, plant ash, and lime) into valuable items; thus the technological knowledge embedded in production was probably guarded. Their integration with other crafts, such as metal, faience, or stone, must have been based on the use of certain technological knowledge that would have been necessary for different stages of production. Glass artisans could have cooperated with smiths during hot working (the making of glass and annealing) and collaborated with stoneworkers and faience workers. It might be the same artisans doing all the work, or there could have been a group of artisans, such as a master and apprentices, who were responsible for different stages of production. Furthermore, use of respectively high-cost raw materials (metal oxides) and fuel for pyrotechnical installations makes it reasonable to use the same workshop area for different purposes. When you fire a kiln or a pyrotechnological installation, it would take a long time to achieve a certain temperature and stabilize the kiln/installation in that required temperature for a long-term. Therefore, using the same kiln/installation at the same time for different purposes would have been more fuel efficient.

Vitreous materials were “symbols of excellence” desired by the growing class of elites (Aruz 2008: 6). In the general setting of the second millennium B.C., vitreous materials did not consist of more than maybe 1–2% of the material corpus. Even though the vitreous materials could be considered rare, they carry a significant capacity to elucidate ancient technologies and their role in the economic and social setting of the ancient settlements; they also present new ideas on trade, the shift of technologies, creativity, and innovation. Vitreous exotica are a media that can help illustrate the knowledge and ideas of the second millennium B.C., which are intangible treasures of the archaeological record. Without including archaeology, the information obtained from archaeometry is inconclusive. This dissertation hopefully presents the integrated data to illuminate new pieces of the big jigsaw puzzle of ancient technologies.

SONUÇLAR

Taşların sırlanmasından başlayarak frit ve fayans üretimine, kilin sırlanmasına ve gelişkin bir cam endüstrisinin ortaya çıkmasına kadar geçen süreçte, vitrifiye malzemeler ile uğraşan zanaatkarlar ham maddeleri işleyip dönüştürerek eserler imal etme ve lüks mallar üretme konusunda geliştirler. Bu doktora tezinde, M.Ö. İkinci Binyıl vitrifiye malzeme endüstrisi açısından Açana Höyük, eski adıyla Alalah kenti buluntuları esas alınmıştır. Yerleşimde Sir Leonard Woolley'nin 1936–1939, 1946–1949 yapmış olduğu arkeolojik kazılar ve Prof. Dr. K. Aslıhan Yener'in 2004–2014 senelerine ait arkeolojik kazı çalışmalarında ortaya çıkarılan vitrifiye eserler[209] bu araştırmanın temel malzemesini oluşturmaktadır. [210]

Açana Höyük, Alalah yerleşiminin koleksiyonlarının yeniden değerlendirilmesi ile yerleşimin vitrifiye malzemelerinin daha bütüncül ve kapsamlı bir biçimde ele alınması sağlanmıştır (bknz: chapter I). Bu çalışmada Hatay Arkeoloji Müzesi ve The British Museum'un depolarında ve sergi alanlarında yer alan eserlerin yanı sıra, Açana Kazı Evi deposunda bulunan ve 2004–2014 kazı sezonlarına ait tüm eserler incelenmiştir. Bununla birlikte The Ashmolean

[209] Vitrifiye eserlerin tamamını kapsamak üzere 'külliyat' kelimesi de kullanılabilirdi. Prof. Dr. Tayfun Yıldırım'ın önerisi üzerine külliyat kelimesi yerine 'malzeme', 'malzeme topluluğu', 'eser topluluğu' veya 'korpus' tanımları kullanılmıştır.

[210] Bu kısım Koç Üniversitesi Sosyal Bilimler Enstitüsü ve Arkeoloji ve Sanat Tarihi Bölümü'nün tez yazım önerileri kapsamında eklenmiştir. İngilizce ana metindeki "chapter IX: conclusions" kısmının birebir çevirisi olmayıp, daha geniş kapsamlı bir özeti ve sonuçları içerir.

Museum'un yalnızca sergi alanlarındaki eserler incelenebilmiş, University College London (UCL)'de yer alan koleksiyonlar (bknz: appendix III) ise bu çalışma ile eşzamanlı olarak farklı akademisyenlerin çalışması altında olduğu için bu koleksiyondaki eserler hakkında kısıtlı olarak bilgi sahibi olunabilmiştir. Yerleşimin vitrifiye malzemeler koleksiyonun omurgasını oluşturan ve Hatay Arkeoloji Müzesi ve The British Museum'da bulunan eserlerin yanı sıra, Yener kazıları döneminde ortaya çıkarılan eserler ve arkeolojik bağlamları, yerleşimin vitrifiye korpusunun yeniden yorumlanmasına imkan sağlamıştır.

Yerleşimde ilk çalışmaları yapan Woolley'nin kazı raporlarında (1936, 1939, 1947, 1950, 1953) ve yerleşim ile ilgili son yayınında (1955) ortaya koyduğu bilgilerdeki bazı eksiklikler, bir takım verilerin seçilerek yayınlanması ve bazılarının yayınlanmaması gibi sorunlar Dan Barag, Edgar Peltenburg ve Christine Lilyquist gibi cam üzerine çalışmalar yapan araştırmacıların Alalah'ın vitrifiye korpusunu seçmece eserler üzerinden değerlendirmelerine ve tüm eser topluluğu yerine Woolley tarafından seçilen eserler üzerinden yorumlamalar yapmalarına sebep olmuştur. Bu durum pek çok eserin yanlış tanımlanmasına ve eksik raporlanmasına sebep olmuştur ki, VI., V. ve II. Tabaka'da bulunan ve zaman zaman Astarte'ye atfedilen cam kadın/tanrıça figürinlerinin tanımlanmasındaki anlaşmazlık ve karışıklık bu duruma iyi bir örnektir. II. Tabaka (AT/39/66)'da bulunan cam figürin, Woolley'nin vitrifiye malzeme terminolojisinde yaptığı muğlak ve yanlış tanımlamalar sebebiyle cam hamuru olarak tanımlanmış; bu sebeple özellikle cam üzerine çalışmalar yapan uzmanlarca, rağbet görmeyen bir eser halini almıştır. Woolley'nin bu muğlak terminolojisi ve cam, fayans, frit, cam hamuru, lapis lazuli hamuru ve sırlı seramik tanımlamaları bu tezin IV. Bölümünde (chapter IV) detaylı olarak irdelenmiş, yeni tanımlama ve doğru terminoloji aktarılmıştır.

Vitrifiye malzemeler ile alakadar bir arkeolojik problem de üretim merkezlerinin nerede bulunabileceği (lokalizasyon) sorunudur. Bu doktora çalışması, frit ve fayans malzemeyi kapsamakla birlikte, M.Ö. İkinci Binyıl'ın ileri teknoloji malzemesi sayılan cam üzerinde daha çok yoğunlaşmıştır. Arkeolojik ve arkeometrik çalışmalar ve yazılı kaynaklar cam üretim/yapım (glassmaking) merkezleri olarak Mısır ve Mezopotamya'yı adres göstermektedir. Her ne kadar Mısır'da yer alan Amarna, Malkata, ve Qantir gibi yerleşimlerde üretim merkezleri tespit edilmiş olsa da, Mezopotamya'da henüz benzer bir saptama yapılamamıştır. Kuzey Mezopotamya'da yer alan Nuzi, Tell Brak ve Tell el-Rimah gibi yerleşimler zengin vitrifiye buluntulara sahip olmakla birlikte, üretimle ilgili bir arkeolojik birikinti (debris) henüz ortaya çıkarılamamıştır.

Açana Höyük, Alalah'ta 2004–2014 kazı dönemlerinde ortaya çıkarılan arkeolojik bağlamların incelenmesi Geç Tunç Çağı I (GTÇI) (M.Ö. 1500–1400) döneminde, vitrifiye malzemelerin çeşitliliği ve sayısında önemli bir artış olduğunu göstermiştir ki, aslında bu dönem cam teknolojisinin bölgede ortaya çıkması ile eş zamanlıdır. Geç Tunç Çağı I–Geç Tunç Çağı II (GTÇI–GTÇII) dönemine tarihlenen arkeolojik bağlamda ise ilk kez cam üretiminin de yapıldığı çok amaçlı bir atölye/işlik alan ortaya çıkarılmıştır. Yerleşimde tespit edilen bu yeni veriler sayesinde muhtemel cam üretim alanları Kuzey Suriye'ye kadar yayılmıştır. Zira bu yeni bilgilerin evvelinde Kuzey Mezopotamya'da zengin buluntuları sebebiyle cam üretim merkezi olarak ön plana çıkmış; Kuzey Suriye ise cam üretim merkezi olabilirliği açısından göz ardı edilmiştir.

Bu yeni bulgular, malzemelerin teknolojisi, üretim tekniği, ham maddelerin işlenme yöntemler ve kullanımları ile ilgili sorunların da cevaplanmasını gerektirmiştir. Bölüm VI (chapter VI)'da sunulan arkeometrik yöntemlerin tamamı,

Açana Höyük, Alalah kentinin vitrifiye malzemelerinin kimyasal karakterizasyonunu ve malzemelerin teknolojisini çözümlemek amacıyla uygulanmıştır. Bu yöntemler ile aynı zamanda yerleşimin buluntularının, çağdaşı olan diğer yerleşimlerden ayrılabilirliği için kullanılabilecek muhtemel metotlara ve parametreler de incelenmiştir.

Yerleşimin buluntuları içerisinden uygunluklarına ve arkeolojik bağlamlarına göre seçilerek ICP–MS yöntemi ile analiz edilen 46 adet cam eserin tamamının soda–silika–kireç camı olduğu bulunmuş, mavi renk için renklendirici olarak bakırın (Cu), opaklaştırıcı madde olarak antimonun (Sb) eklendiği tespit edilmiştir. Bu ana element içerikleri Robert H. Brill'in (bknz: chapter IV) yerleşimin camları üzerine daha evvel yaptığı çalışmalar ile tutarlılık göstermektedir. Tüm Orta Tunç Çağı II (OTÇII), bazı GTÇI ve tüm GTÇI–GTÇII dönemi eserlerinde düşük potas seviyeleri tespit edilmiştir ki, bu durum soda kaynağı olarak kullanılan bitki külünün farklı kaynaklardan, bitkide bir seçicilik gözetmeden elde edildiğine işaret etmektedir. GTÇI'de düşük potaş elde edilmeyen örnekler ve tüm GTÇII örneklerinde ise alum miktarları %1'in altındadır. Bu veri bitki külü kullanımında bir seçicilik olduğunu göstermektedir. Dönemlere göre bitki külü kullanımındaki seçicilik, özellikle OTÇII ve GTÇI–GTÇII geçiş dönemlerinde cam üretimi esnasında bir deneme-yanılma sürecinin varlığına işaret etmektedir. GTÇI–GTÇII geçiş dönemine tarihlenen ve *in situ* cam buluntuların ortaya çıkarıldığı 64.72 plan kare kapsamındaki arkeolojik bağlamda farklı bitki küllerinin kullanıldığının tespit edilmesi, GTÇI–GTÇII işlik alanında üretimde deneme-yanılma sürecinin (deneyselliğin) sürdüğü hipotezini desteklemektedir. Buna rağmen GTÇI ve GTÇII dönemlerinde gözlemlenen bitki küllerindeki seçicilik ise daha itina gösterilen ve/veya uzmanlaşılmış bir üretime yorumlanabilir.

Açana Höyük, Alalah'ta GTÇI dönemine tarihlenen vitrifiye eserlerin tapınak ve sarayla ilişkili alanlarda bulunmuş olması bu lüks mal grubunun muhtemel kati ve kontrollü bir şekilde ritüelleri de içeren reçetelere uygun olarak, gözetim altında üretimine işaret etmesi muhtemeldir. Bu dönemde, camın lüks bir mamul olduğu ve yalnızca yüksek statü sahibi kişilerce kullandığı göz önüne alındığında, üretim reçetelerinin gizli tutulması ve katı bir kontrol altında üretiliyor olması olağan karşılanmalıdır. Bu bağlamda bitki küllerindeki seçicilik de anlamlı hale gelmiş olur. GTÇII döneminde ise bitki küllerindeki seçiciliğin nedeni üretimde uygulanan katı kurallar ve/veya artık daha gelişkin bir hal almış teknolojik uygulamalar (üretim teknikleri) olabilir. Kanımca GTÇII'de bu seçiciliğin sebebi üretimindeki ritüellerden çok teknolojik uygulamaların gelişimidir, zira bu dönem içerisinde cam üreten zanaatkarlar deneme-yanılma ile geçen uzun bir süreç sonunda hangi bitkilerin küllerinin daha uygun olduğunun ayırdına varabiliyor olmalıdırlar. Zanaatkarlar, GTÇI'den GTÇII'ye kadar geçen süre boyunca deneyerek cam üretiminde yüksek verimliliği olan bir imalat yolunu benimsemiş olmalıdırlar. Bunlara ek olarak, zanaatkarlar fayans üretimi, metal işleme gibi farklı malzemelerin üretimlerini de azami verimlilik, asgari hata ve sarfiyat ile birbirleriyle nasıl bütünleştirebileceklerini (entegrasyon) de keşfetmiş olmalıdırlar.

M.Ö. İkinci Binyıl cam üreticileri (glassmakers), cam işleyicileri (glassworkers) ve zanaatkarları kontrol eden ve gözeten yönetici sınıf ve/veya hamilere dair yazılı kayıtlar ne yazık ki mevcut değildir. M.Ö. Birinci Binyıl'da cam üretimine ait yazılı kaynaklar (bknz: chapter III) cam üretiminde mevsime dayanan bir takvimin varlığından bahsetmektedir. Külleri üretimde kullanılan bitkilerin seçimi de bu takvim ile bağlantılı olmalıdır. Açana Höyük üzerinde günümüzde hala yetişen ve cam üretimde soda kaynağı olarak kullanıldığı bilinen *Salsola jardonicola*

bitkisi, höyükte haziran ve ağustos ayları arasında bulunmaktadır. Bu durum bu bitkinin hasatının ancak bu aylarda yapılabileceğini göstermektedir. Elbette ki günümüzün şartlarında bölgede gözlemlenen iklim koşullarını ve bitki örtüsü ile M.Ö. İkinci Binyıl'ın şartlarını değerlendirmek yetersizdir ve kesin bir kanı bildirmeyecektir. Ayrıca, bitkinin hasat sürecinin de aynı aylarda gerçekleştiğini iddia etmek de yine muhtemel iklimsel farklılıklar da göz önüne alındığında gerçeği yansıtmayabilir, ancak kullanılan bu bitkinin günümüzde de mevsimlik olduğunun gözlemlenmesi arkeolojik yorumlamaların bu minvalde yapılması açısından önem taşır.

Vitrifiye malzemelerin ve özellikle camın üretiminde kullanılan kum, kireç ve metal oksitlerin mevsimlik olarak toplanması veyahut sezonlara bağlı olarak elde edilebilirliği, üretimin de sezonluk bir aktivite olduğunu şeklinde yorumlanmamalıdır. Üretimin tüm yıl boyunca sürüyor olması muhtemeldir. Buna rağmen, piroteknik aktivitelerin hepsinde yakıtın kullanıldığı ve zehirli gazlar çıkaran fırın ve/veya ocak gibi enstalasyonlara ihtiyaç vardır. Bu tip fırın ve/veya ocakların açık avlularda veya işlik alanlarda yer almasının iki önemli üstünlüğü vardır: 1) istenmeyen yan ürünleri kolaylıkla uzaklaştırmak, 2) piroteknik enstalasyonların daha verimli çalışabilmesini sağlayacak taze hava ve rüzgardan faydalanmak. İklim koşullarının daha uygun olması, daha az yağmurun yağması ve sabit bir esintinin varlığı fırın ve/veya fırınlarda daha az maliyetle ve emekle daha uzun süreli olarak yüksek sıcaklıklara çıkılabilmesini sağlayacağından, kanımca Alalah'ta cam üretiminin mevsimlik bir uygulama olması (bknz: chapter VIII) daha makuldür.

Günümüzde Amik Ovası ile Amanos Dağları'nın coğrafi konumunun yarattığı atmosferik basınç ve sıcaklık farkından kaynaklı rüzgarın batıdan doğu

yönüne doğru estiği gün boyu hissedilebilmektedir. Bu rüzgar sebebiyle Suriye-Türkiye sınır kapısının Suriye tarafının adı *Bab al-Hawa* yani Hava Kapısı'dır. Bu doktora tezine konu olmuş 64.72 plan karede (Square 64.72) yer alan işlik alan ve 64.72 plan karenin de içerisinde bulunduğu Alan 4 (Area 4) olarak tanımlanan işlik alanlar bölgesi Açana Höyük'ün güney kısmında yer almaktadır. Geç Tunç Çağı'nda da aynı yönlü esmesi kuvvetle muhtemel olan yöreye özgü bu rüzgar, dumanın, isin ve toksik gazların yerleşimden uzaklaşmasını kolaylaştırmış olmalıdır. Bu rüzgar yalnızca dumanın ve gazın yerleşimin üzerine doğru ilerlemeden uzaklaştırılmasını sağlamakla kalmamış, aynı zamanda piroteknik enstalasyonların cam üretebilecek kadar yüksek sıcaklıklara çıkmasına da yardımcı olmuş olmalıdır. Batı-doğu yönünde esen bu hava akımı bir katalizör olarak işlev görmüş ve zanaatkarlara daha yüksek sıcaklıklara ulaşmak için körük ve tüyerin yanı sıra kolaylık sağlamış olmalıdır. Bu rüzgar, sadece yüksek sıcaklıklara çıkma aktivitesini daha az zahmetli yapmakla kalmamış, zanaatkarların en yüksek maliyeti olan yakıttan tasarrufu da kısmen sağlamış olmalıdır.

Bu çalışmada, cam üretiminin mevsimlik olduğunu önerisine rağmen, cam işlemeciliğinin de mevsimlik olduğu sonucu çıkarılmamıştır. Cam vazo, boncuk ve az miktarda cam çubuğun bulunması Alalah'ta belirli miktarda cam işlemeciliği olduğunu göstermiştir ancak, cam işlemeciliğinin belirli bir sezonda yapılmasını gerektirecek bir kanıt yoktur. Cam işlemeciliği, cam üretimine nazaran daha düşük sıcaklıklara ihtiyaç duyar; üretilmiş ve muhtemelen külçeler halinde hazırda bekleyen camların vazo, boncuk veya amulet gibi eşyalara dönüştürülmesini içerir. Cam işlemeciliği, camın üretimi için gerekli ham maddelere direkt olarak ulaşılmasını da gerektirmez. Cam işlemeciliği gibi, fayans üretimi, taş işlemeciliği veya metal işlemeciliği de tüm yıl boyunca sürekli olmalıdır. Fayans üretimi aynı

cam işlemeciliğinde olduğu gibi düşük sıcaklıklar gerektirir. Taş işlemeciliği, işlenmeye uygun taşların hazır olarak bulunması durumda iş gücünün varlığına bağlıdır. Bu tip imalatlarda mevsimlik olan işler, uygun taşların yataklarından ham olarak getirilmesi, renklendirici olarak kullanılacak (veya bu tez konusunun dışında olacak şekilde alet ve lüks mamullerin üretimi için kullanılmak üzere) metallerin taşınması, ergitme elemanı olarak kullanılacak bitki küllerinin eldesi için gerekli bitkilerin toplanması ve yakıt olarak gerekli odunun sağlanması olarak sayılabilir. Bu ham maddelerin hava şartlarının uygun olduğu dönemlerde toplanarak depolanması, zanaatkarların bütün bir sene çalışmalarını sürdürmelerini sağlayacaktır. Değerli ham maddelerin depo edilmesi tüm yıl üretimin yapılabilmesi için kritik önem arz etmektedir. Tunç Çağı'nda bu tip değerli ham maddelerin depolanmasının devlet/yönetici eliyle kontrol edildiği bilinmektedir. Dolayısıyla, değerli ve depolanması gereken ham maddelerin kullanıldığı üretimlerin tüm yıl boyunca sürmesi halinde devlet ve/veya yönetici sınıfın üretim üzerindeki kontrolünü de göz önünde bulundurulmalıdır.

Bu doktora çalışmasında, yalnızca Açana Höyük, Alalah'ta ele geçen vitrifiye malların karakterizasyonunun dışında, yerleşimde üretildiği savunulan cam mamullerin diğer yerleşimlerin cam malzeme gruplarından krom, vanadyum ve arsenik gibi minör elementleri kullanarak nasıl ayrılacağı konusuna da değinilmiştir. Krom–vanadyum (Cr–V) ikili (binary) diyagramı Alalah'ı Nuzi, Tell Brak, Amarna ve Malkata gibi benzer şekilde üretilmiş arkeometrik veriye sahip yerleşimlerin camlarından ayırabilmiştir. Bu durum, Alalah'ın üretimi olan camlarda yerleşimi Mısır ve Kuzey Mezopotamya'dan ayıran bir parmak izidir. Yerleşime yaklaşık 50 km uzaklıkta bulunan krom rezervleri (bknz: fig. 7.34), yerel ham madde kullanımı fikrini desteklemektedir.

Alalah'ta analiz edilen camlarda arsenik bulunması ve kalaya rastlanmaması yerleşimin camlarını, Mısır kaynaklı olan ve bakır kullanarak mavi renk verilmiş camlardan ayıran bir diğer parmak izidir. Mısır'da bulunan ve bakır ile mavi olarak renklendirildiği saptanan camlar genellikle kalay içermektedir. Bu durum, Mısır'da cam üretiminde kalaylı tunç hurdalarının renklendirici olarak kullanılması ile ilişkilendirilmiştir (Shortland vd. 2007: 786). Bu doktora çalışmasının sonuçlarına göre ise, renklendirici olarak hurda metal kullanılması durumunda, Alalah'ta arsenikli tuncun tercih edildiği ortaya çıkmaktadır. Bu noktada, kalaylı tuncun özellikle mi tercih edilmediğini ispatlamak oldukça zordur. Yerleşimin GTÇI ve GTÇI–GTÇII dönemine ait hurda metal korpusunun incelenmesi bu konuya açıklık getirebilecektir. Bununla beraber, ulaşılan kanıtlar ışığında neden renklendirici olarak kalaylı tuncun değil de arsenikli tuncun kullanılmış olabileceğine dair şu öneri sunulacaktır: Arsenikli tunçların geri dönüşümü esnasında özünde uçucu bir element olan arseniğin miktarını kontrol etmek zordur; bu da sertliğe ihtiyaç duyan bazı araç ve gereçlerin arsenikli tunçların geri dönüşümüyle eldesini güçleştirmiş olabilir. Bu sebeple, geri dönüştürülmüş arsenikli tunç ile günlük araç, gereç veya silah gibi malzemelerin üretilmesindense, arsenikli tuncu vitrifiye malların üretiminde renklendirici olma gibi yan dal sayılabilecek işlemlerde kullanmak mantıklı görünmektedir. Bununla beraber kalaylı tunç geri dönüşüme daha uygundur, zira içerisindeki kalayın arsenik gibi uçarak kaybolma gibi bir özelliği söz konusu değildir. Ancak, bu arsenikli bakırların geri dönüşüme hiç girmediği anlamına gelmemelidir. M.Ö. İkinci Binyıl'ın sonunda üçlü alaşımların (kalay-arsenik-bakır) ortaya çıkması, arsenikli ve kalaylı tunçların beraber tekrar kullanım için geri dönüştürülmesinden kaynaklanmış olabilir (Yener 2000, 2010c).

Açana Höyük, Alalah'te vitrifiye malzemelerde tespit edilen yüksek demir ve alüminyum miktarları, özellikle seramik ve mimari parçaları içeren farklı çalışmalara da konu olmuştur (Erb-Satullo et al. 2011; Yener 2010a, b; Dardeniz 2013). Yerleşimden yaklaşık 10 km uzaklıkta yer alan Kırkhan mevkiinde yüksek demir içeren alüminyum yataklarının bulunması aynı kromda saptandığı gibi yerel ham madde rezervlerinin kullanımına işaret etmektedir.

Alalah camlarında tespit edilen yüksek demir ve alüminyum aynı zamanda cam üretiminde silika kaynağı olarak kuvars değil kumun kullanıldığına da işaret etmektedir. Kum, alüminyum, demir, titanyum ve kalsiyum gibi safsızlıklar barındırmasına rağmen kuvars saf silikadır. Bu veriler göz önüne alınarak bu çalışmada (bknz: chapter VII), Asi Nehri'nin taşıdığı kum üretim için kullanılan muhtemel silika kaynağı olarak önerilmiştir. Bu konuda gelecekte yapılacak araştırmalar ile bölgenin ve nehrin taşıdığı kumların izotopik olarak incelenmesi bu konuda daha sağlam kanıtlara ulaşılmasını sağlayacaktır.

Bu çalışmada stronsiyum ve neodimyum izotop yöntemi de kullanılmıştır ancak bu analizlerin sayısı güvenilir bir istatistik verecek kadar çok değildir. Buna rağmen, birincil arkeolojik bağlamlardan seçilen ve izotopik olarak karakterize edilen iki cam parçası cam üretimi ve ticareti ile ilgili yeni veriler sunmaktadır. AT 15065 numaralı kehribar renkli cam vazo parçası şahsına münhasır izotopik parmak izi ile yerel üretim savını destekler sonuçlar vermiştir. AT 16968 kodlu ve fırının/piroteknik enstalasyonun içerisinden ele geçen mavi külçe parçasının ise Tell Brak ile yakın izotopik oranlar verdiği görülmüştür. Ancak, Tell Brak'ın izotop oranları incelendiğinde belirli bir kümeleşme göstermediği görülmektedir. Bu durumda, Tell Brak'ın cam üretimi için farklı kaynaklar kullanmış olabileceği gibi farklı yerleşimlerden belirli renklerde ve/veya kalitede cam da ithal etmiş de olabilir.

Tell Brak'ta şimdiye kadar arkeolojik olarak cam üretimine ait bir işlik alan ve üretim artığı bulunamadığı için, yakın izotop oranlarına dayanarak bu doktora tezinde, Alalah'ın Tell Brak ve belki diğer Kuzey Mezopotamyada'ki yerleşimler ile de cam malzeme üzerinden bir bağlantısının olabileceği önerilmiştir.

Stronsiyum ve neodimyum izotop verilerine dayanan daha önceki çalışmalarda, Atina'de bulunan mavi renkli cam parçalarının da Tell Brak kaynaklı olduğu tezi ortaya konulmuştur (Henderson et al. 2010). Bu doktora çalışmasında elde edilen veriler ışığında Atina camları için elde edilen sonuçların, Alalah ile de uyumlu olduğu ortaya çıkmıştır ki böylelikle Kuzey Suriye ve Miken bölgesi ile yeni bir ticari bağlantı rotası önermek mümkündür. Alalah, Ugarit üzerinden ve/veya Hatay'da henüz saptanamamış başka bir liman üzerinden Miken'e cam ihraç ediyor olabilir. Böylece, Miken camlarının kaynağı yalnızca Mısır ve Kuzey Mezopotamya değil, aynı zamanda Kuzey Suriye'de de olabilir. Bu rağmen, önerilen bu sav üzerinden, Uluburun gemisinin aktif olduğu geç 14. yy'da da benzer bir bağlantı olduğunu tahmin etmek şimdilik güçtür, zira Alalah'ta bulunan cam üretim işliği erken 14. yy'a tarihlenmektedir. Alalah'ta üretim sürekliği olan bir aktivite olmakla birlikte, cam üretiminin süreklilik arz edip etmediği henüz kanıtlanamamıştır. Dolayısıyla, Uluburun gemisinde bulunan ve Kuzey Mezopotamya'ya atfedilen camların Alalah ile ilişkilendirilip ilişkilendirilemeyeceği hususu ilerleyen çalışmalar ile aydınlatılabilecektir.

Alalah'ın tabaka/dönem 3, yerel evre 4'te (period 3, local phase 4) ortaya çıkarılan üretim alanının kronolojisi üzerine yapılan çalışmalar ve yerleşimin genel kronolojisi üzerindeki araştırmalar tam anlamıyla netlik kazanmamıştır. Ancak bu noktaya kadar yapılan kronoloji çalışmalarında, bu teze bahis olan üretim alanı M.Ö. erken 14.yy'a atfedilmiş ve böylelikle Amarna'dan (yaklaşık M.Ö. 1353–1336) daha

erken bir döneme tarihlendirilmiştir. Bu tez çalışması camın kökeni ile ilgili savlardan arındırılmış ve köken ile alakadar tüm tartışmalardan özellikle kaçınılmıştır. Buna rağmen, kronoloji ile ilgili şu ana kadar elde edilen veriler ışığında Alalah'ın bugüne kadar bilinen en eski cam üreticisi olan Amarna'dan daha erken tarihlerde de üretim yaptığı savunulabilir. Bu durum (Kuzey) Mezopotamya veya Mezopotamya civarını cam üretiminin kökeni olarak işaret eden yazılı metinler (bknz: chapter III ve VIII) ile uyum gösterir. Bu doktora çalışmasında elde edilen veriler, Kuzey Suriye/Güney Anadolu'nun potansiyel bir cam üretim bölgesi olduğunu göstermiştir.

Camın dışında, fayans ta bu çalışmanın konusudur ve dönemi içerisinde farklı renklerde örneklerle karşımıza çıkmaktadır. Bu doktoraya konu olan işlik/üretim alanında bulunan fayansların analizi sementasyon ile fayans üretim tekniğine işaret etmektedir ki, bu yöntem tüm fayans üretim metotları içerisinde en yüksek sıcaklıkların kullanıldığı yöntemdir. Amarna ve Lisht gibi Mısır merkezli üretim merkezlerinde, fayansın eflorasan ve direk uygulama yöntemleri ile üretildiği ispatlanmıştır (Nicholson 2008). Bu iki bölgede üretim metotlarında bu tip farklılıklar ile karşılaşılaşılması, Alalah'ı Mısır Yeni Krallık Dönemi'nden (yaklaşık M.Ö. 1539–1077) farklılaştırmıştır. Alalah'ta şu ana kadar (özellikle incelenen işlik alanda) eflorasan ve direk uygulama yöntemleri ile üretilmiş fayansa rastlanmamıştır. Buna rağmen örneğin Nuzi'de yapılan analizlerde fayansın her üç yöntem ile de üretildiği ortaya konulmuştur, dolayısıyla Alalah'ta üretildiği düşünülen fayansları Kuzey Mezopotamya üretimlerinden ayırmak mümkün olamamıştır. Alalah'ta sementasyon ile fayans üretimi kanaatimce bilinçli bir tercihtir, zira aynı işlik alanında entegre olarak devam eden aktiviteler de göz önüne alındığında, camın da

aynı alanda üretiliyor olması sebebiyle fırında kullanılan yüksek sıcaklıklardan fayans üretimi için de faydalanılmış olsa gerektir.

Arkeoloji ve arkeometrinin beraber kullanılması, eski zanaatkarların teşkilatlanmasını aydınlatmak ve muhtemel fikir, buluş ve teknolojik bilginin bir bölgeden diğerine geçişini ve/veya yayılmasını anlamak için önemli bir kılavuzdur. Alalah'ın coğrafi konumu, yerleşimi döneminin uluslararası sayılabilecek ticari ağlarına bağlayabilecek avantajlı pozisyonu ve ham maddelere erişim kolaylığı yerleşimde melez bir kültürün yanı sıra, lüks mamullerin de üretimini içeren bir grup endüstrinin ortaya çıkmasına ve/veya gelişmesine olanak sağlamıştır. Alalah her ne kadar stratejik olarak kritik olan öneminden faydalansa da, yerleşim var olduğu süre içerisinde dönemin süper güçleri olan Hitit, Mısır ve Mitanni arasındaki politik ve askeri kargaşa ve çekişmenin ortasında kalmıştır. Kentin maruz kaldığı askeri seferler yıkıcı olmakla birlikte buluş ve fikirlerin bölgeler arası taşınmasında da belirli miktarlarda etkili olmuş olmalıdır.

Plan kare 64.72, cam üretimi, cam işlemeciliği, fayans üretimi, taş işlemeciliği ve muhtemelen metal işlemeciliğinin beraber yürütüldüğü çok amaçlı bir üretim alanını ortaya koymuştur. Bu işlik alanın bahsi geçen üretimler ile iştigal ettiği esnada, Alalah, Mitanni İmparatorluğu'nun politik gücü altındaydı. Mitanni'nin baskınlığı yalnızca politik alanda değil, Alalah'ın malzeme kültürü ve üretim teknolojilerinde de uzun süre etkili oldu. Mitanni'nin hegemonyasından Hitit etkisine geçtiğinde dahi yerleşimdeki vitrifiye malzeme kültürünü de içerisine alan eser topluluğunda Mitanni etkisi hakimdi. Burada Hitit'lerin cam ile olan ilişkilerinin az bilinir ve limitli olduğunun da altını çizmek önemlidir. Ayşe Baykal-Seeher ve Jürgen Seeher'in (2003: 108–09) yazdıkları gibi 1978 ve 2003 arasında Boğazköy'de gerçekleşen arkeolojik kazılarda, toplamda çoğunluğu boncuk olan yalnızca 25 adet

cam, fayans ve frit esere rastlanmıştır. Elde olan buluntular ışığında Hititlerin vitrifiye malzemelere ilgilerinin kısıtlı olduğu düşünülebilir. Hitit yazılı metinleri camdan bahsetmektedir (bknz: chapter IV) ancak bu konunun daha geniş kapsamlı olarak çalışılması şarttır.

Herhangi bir eserin yapımı/üretimi veya hammaddelerin değerli mamullere dönüştürülmeleri organizasyon, uzmanlaşma ve kesin bir teknolojik bilgi gerektirir. Metaller ve/veya yakıt gibi bazı ham maddelere erişim, Tunç Çağı'nda devletin kontrolündeydi (bknz: chapter VIII) ve bu sebeple bu tezde vitrifiye malzeme üretiminin bağlı (attached) bir üretim biçimi şeklinde devam ettiği önerilmiştir. Her ne kadar Alalah arşivleri vitrifiye malzeme zanaatkarlarının sarayın himayesinde olup olmadıkları ile ilgili bir yazılı kanıt sunmasa da, saray ve personel listelerinde metal ve seramik ustalarının saraya bağlı çalıştıklarına dair kayıtlar mevcuttur. Bu doktora tezinde ayrıca vitrifiye malzeme zanaatkarlarının yada en azından cam üreticilerinin, sarayın kontrolü altında çalışmaları, bu işin ileri uzmanlık gerektirmesi ve üretim esnasında gerekli olan azami dikkat vesilesiyle tam zamanlı (full-time) çalışan olmaları gerektiği savunulmuştur. Cam üreticiliği mevsimsel bir aktivite olmasının ve cam üreten zanaatkarlar uygun dönem süresince tam zamanlı çalışmalarının yanı sıra, cam ile uğraşan zanaatkarların yılın geri kalan süresi içerisinde entegre diğer üretim faaliyetleri ile iştigal etmeleri mümkündür.

Zanaat ve yeni teknolojilerin ortaya çıkabilmesi için yeni fikirler ve teknik bilgi birikimi gereklidir. Bu tip yenilikler ticaret, politik ilişkiler, saraylar arası iletişim ve askeri münasebetlerden etkilenir (faydalanır). M.Ö. İkinci Binyıl'ın yeniliği camdır ve cam (veya herhangi bir teknolojik atılım veya yenilik) yeterince sermaye birikimine sahip ve bu sayede yeni tekniklerle uğraşılmasını/denenmesini destekleyecek iyi kurulmuş ve organize olmuş bir politik sistem gerektirir. Alalah

plan kare 64.72 ile Amarna O45.1 (bknz: chapter VIII) arasındaki benzerlikler, teknoloji transferinin yalnızca son ürünü değil aynı zamanda üretim zincirini ve mimari yerleşim yapılanmasını de kapsadığını göstermektedir. Son ürünler (eşyalar) kendi başlarına yeniliklerin taşıyıcı olmakla beraber aynı zamanda vitrifiye malzemeler düşünüldüğünde lüks mamul olarak ta vazife görmüşlerdir.

Çok işlevli/amaçlı işlik alanların varlığı fikri, her cins malzeme için farklı birer atölye ve zanaatkar bulunması ihtimali ile karşılaştırıldığında akla daha yakın gelmektedir (Laffineur 1995: 199). Vitrifiye malzeme üreticileri düşük maliyetli silika (kum), bitki külü ve kireç gibi ham maddeleri değerli eşyalara dönüştürebilmekteydi ve bu sebeple üretimde kullanılan teknik bilgi muhtemelen gizleniyordu. Vitrifiye malzemeleri üretenlerin metal, fayans veya taş zanaatkarları ile bütünleşik çalışmaları üretimin belirli aşamalarında gerekli olabilecek ortak bir teknolojik bilgiye sahip olunması esasına dayanıyor olmalıdır. Cam zanaatkarları ile metal işleyicileri camın üretimi veya tavlama gibi sıcak işlemler (hot working) esnasında ortak çalışırken, taş ve fayans ustaları ile soğuk işlemler esnasında ortaklaşa çalışıyor olmalıdırlar. Bütün işi yapan aynı zanaatkar olabileceği gibi, bir usta ve çıraklarından oluşan ve üretimin farklı aşamalarından sorumlu bir grup zanaatkar ve/veya zanaatkar namzet(ler)i de olabilir. Ayrıca, metal oksitler ve piroteknik enstalasyonlar için yakıt gibi diğer ham maddelere nazaran daha maliyetli giderlerin varlığı sebebiyle aynı işlik alanı birden fazla işlev için kullanmak makuldür. Örneğin bir fırın veya piroteknik enstalasyon ateşlendiğinde, bunları belirli bir sıcaklığa getirmek ve o sıcaklık derecesini korumak oldukça vakit ve emek alan masraflı bir işlemdir. Bunun için, aynı fırın veya enstalasyonu mümkün olduğu durumlarda farklı işlevler için kullanmak yakıttan tasarruf sağlayan verimli bir uygulamadır.

Vitrifiye mallar, genişleyen elit sınıf için "mükemmelliğin sembolü" idiler (Aruz 2008: 6). M.Ö. İkinci Binyıl'ın genelindeki malzeme gruplarına bakıldığında, vitrifiye mamuller belki de genel buluntu korporalarının %1–2'si civarındadır. Vitrifiye mamuller her ne kadar nadir olarak görülseler bile, bu malzemeler eski teknolojileri ve bu teknolojilerin antik yerleşimlerin ekonomik ve sosyal yapılarındaki yerini anlamak açısından önem taşımaktadırlar. Bu malzemeler aynı zamanda ticaret, teknolojinin transferi, yaratıcılık ve yenilik ile ilgili yeni fikirlerin göstergesidirler. Vitrifiye egzotik ürünler, M.Ö. İkinci Binyıl'ın bilgi ve fikir dünyasına anlamamıza yardımcı olur ki, bu veriler arkeolojik kayıtların soyut hazineleridir.

Arkeolojik bağlamlarından uzak arkeometrik veriler herhangi bir netice sunmaktan uzaktır. Arkeolojik ve arkeometrik verinin bir arada sunulduğu, değerlendirmeye ve yorumlanmaya çalışıldığı bu doktora tezinin antik teknolojiler bilmecesinin birkaç kayıp parçasını daha yerine koyduğunu umuyorum.

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