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2018 JAPANESE INSTITUTE OF ANATOLIAN ARCHAEOLOGY
The Middle Eastern Culture Center in Japan

In 1985, the Middle Eastern Culture Center in Japan conducted a preliminary archaeological survey at Kaman-Kalehöyük in the Central Anatolia in the Republic of Turkey. Since 1986, the archaeological excavation survey has been carried out every year until today. In 1998, Japanese Institute of Anatolian Archaeology (JIAA) was established in Cağırkan village in Kaman. In 2005, new buildings for research were built and in 2010, Kaman-Kalehöyük Archaeological Museum was built next to the research institute.

Since 2009, in addition to the surveys at Kaman-Kalehöyük, JIAA has conducted excavation surveys at Yassıhöyük and Büklükale. All the artifacts excavated from these sites are housed and/or exhibited at the Kaman-Kalehöyük Archaeological Museum.

The *Anatolian Archaeological Studies* (*AAS*), which was published for the first time in 1990, has been the platform to present reports and studies on excavation surveys at Kaman-Kalehöyük. From this volume, those on Yassıhöyük, Büklükale and Central Anatolia will also be presented. We would like to take this renewal of the contents as an opportunity to renew the design of the *AAS*.

Your further, continuous support will be greatly appreciated.

Director of JIAA
Dr. Sachihiro Omura

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Cover symbol : stamp seal made of ivory from Stratum II, Kaman-Kalehöyük

Anatolian Archaeological Studies *vol.* XXI

Aspects of Late Bronze Age glass in the Mediterranean

Proceedings of JIAA Late Bronze Age Glass Workshop
held at 27th - 28th September, 2014 in Kaman, Turkey

Edited by

Julian Henderson and Kimiyoshi Matsumura

Japanese Institute of Anatolian Archaeology

2018

Preface

The Japanese Institute of Anatolian Archaeology (JIAA) was founded in 1998 in order to enrich the research activities based on the excavations at Kaman-Kalehöyük. Largely due to the intensive efforts of H.I.H. Prince Takahito Mikasa and H.I.H. Prince Tomohito and with the support of the Turkish government, the construction of its research facilities was completed in 2009.

The institute has three main purposes: the first is to conduct research into archaeology and other related fields as part of a team of international scholars and scientists and to publish the results of these endeavours; the second is to cultivate and nurture promising new researchers; and the third is to enlighten the local people, particularly the younger generation, so that they recognize the importance of cultural heritage and wish to protect it by independently by themselves.

To achieve the second purpose, the institute runs field courses in archaeology, conservation and other related scientific fields. With regard to the third purpose, the institute tries to transfer information about Anatolian history to local people through the excavations and the lessons given every week.

One of the intentions behind the establishment of the institute was to provide opportunities for researchers from all over the world to come together in one place in Turkey and to discuss issues on various themes which arise from excavation research. It is also a good opportunity for archaeological students and archaeologists in Turkey to join such workshops or symposiums easily.

Today, we are pleased to announce the publication of this volume"Glass Workshop" in which are included the collected papers of the "JIAA Late Bronze Age Glass Workshop" held from the 27th – 28th 2014 at the Institute. In 2010, we found a glass bottle and pendant in the 2nd Millennium BC from Büklükale. These findings are very rare in Anatolia and the glass bottle was only the second one. It was a good opportunity to hold a Glass workshop in our institute.

It is an honor for us if the activities of our institute will contribute to Anatolian archaeology, even if it is only a little.

It is also hoped that all the activities conducted by the Japanese Institute of Anatolian Archaeology should contribute to the improvement of the cultural relationship and friendship between Turkey and Japan.

Dr. Sachihiro OMURA
Director of the Japanese Institute of Anatolian Archaeology

Introduction

The workshop was held at the Japanese Institute of Anatolian Archaeology between the 27th and 28th September 2014. The basic inspiration for the international workshop was the rich discoveries of Late Bronze Age glass from excavations at Kaman-Kalehöyük and Büklükale carried out by the Japanese Institute of Anatolian Archaeology.

Little work had been published on glass found in Hittite contexts, including its scientific analysis, and it was felt that the workshop would be a good opportunity to place the results of such findings in the public domain through presentations. Following discussions with Dr. Omura and Dr. Matsumura it was decided that the workshop should include presentations on Late Bronze Age glass not only from Turkey but also from sites in other parts of the Middle East. In the end there were 12 presentations covering glass found on sites in Turkey, Egypt and Greece. Apart from the presenters Prof. Dr. Fikri Kulakoğlu and Prof. Dr. Üzlifat Özgümüş attended.

Best regards,
Dr. Julian Henderson
Editor

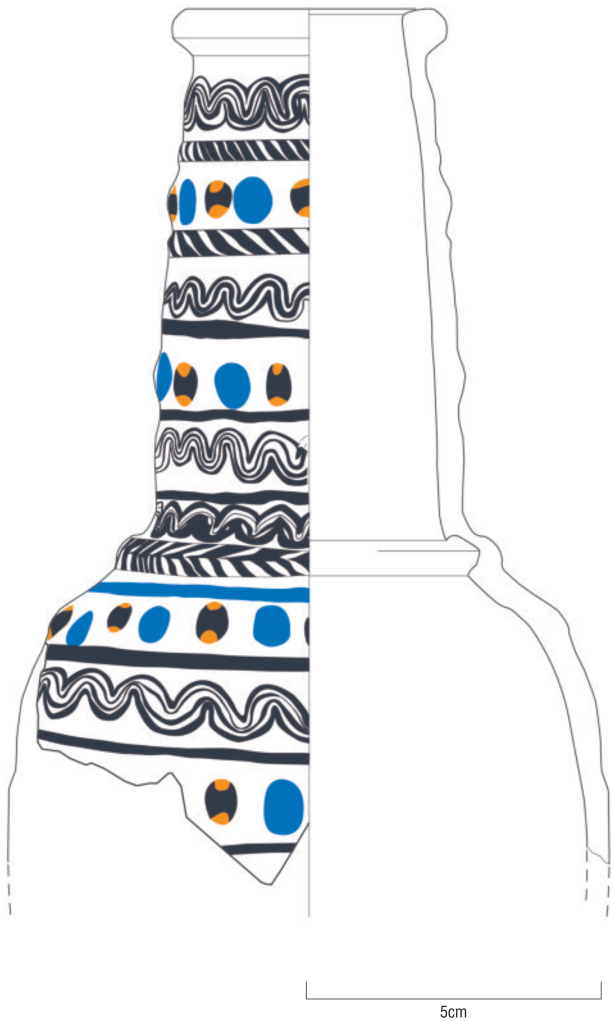
1. Participants for the Glass Workshop
Photo S. Ue

2. Aerial Photograph of Büklükale
Photo S. Ue

3a. Glass Bottle from Büklükale (BK100177)
Photo K. Matsumura

3b.

3c.



4. Drawing of the Glass Bottle from Büklükale (BK100177)
Photo K. Matsumura

5. Leopard's Head from Büklükale
Photo K. Matsumura

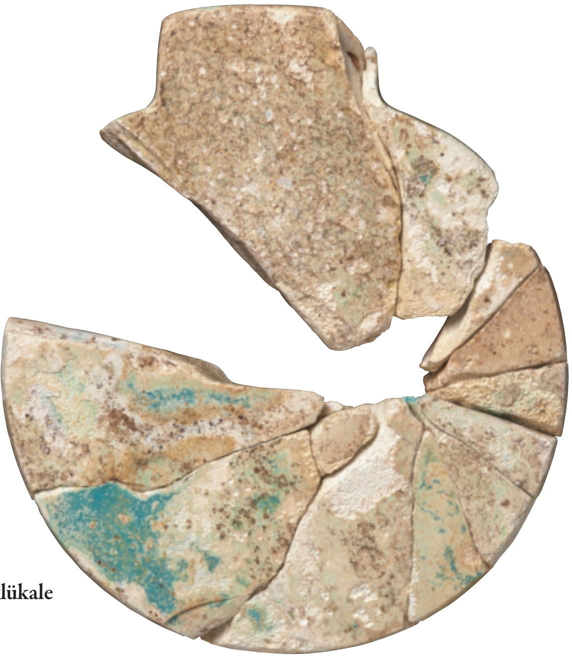


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Photo K. Matsumura

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The Bronze Age Glass Workshop conducted by the Japanese Institute of Anatolian Archaeology, MECCJ, in 2014 was supported by the following organizations (in alphabetical order):

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The Preliminary Archaeological and Scientific Evidence for Glass Making at Tell Atchana/Alalakh, Hatay (Turkey)

Gonca Dardeniz
İstanbul

ABSTRACT

Tell Atchana/Alalakh is known as a location where sophisticated vitrified materials, especially glass objects, of the 2nd millennium B.C. were found. Excavations in 2011 yielded archaeologically unique Late Bronze Age glass production debris, including various types of glass, faience, frit objects, and fragments found *in situ* with a pyrotechnological installation. This paper examines the possibility that Alalakh was a 2nd millennium B.C. glass making site located in southern Anatolia/northern Syria. Existence of a Bronze Age glass making site other than the Egyptian counterpart of Amarna enables us to discuss new zones for glass making besides establishing new linkages in production technologies and trade of glass among Anatolia, Syria, Mesopotamia, and Egypt.

INTRODUCTION

Locating production centers of the vitrified material assemblages from the 2nd millennium B.C., especially those where glass making occurred, has been the research focus of scholars in recent decades.[1] Glass artifacts recovered at Bronze Age sites in Egypt, Mycenae, and Mesopotamia have been evaluated to determine local or import characteristics of the assemblages as well as to localize glass working and glass making sites. Glass working sites where glass artifacts were processed into their final forms were found in Egypt and Mycenae, whereas identification of glass making sites where glass was produced from its major raw materials, namely silica, soda, and lime, are restricted to the Egyptian sites of Amarna (14th century B.C.), Malkata (14th century B.C.), and Qantir (13th century B.C.) (Keller 1983; Nicholson 1995, 2007; Rehren 2000; Tite *et al.* 2002). Contemporary Mesopotamian sites like Nuzi, Tell Brak, or Tell al-Rimah yielded glass objects, although neither glass making nor glass working zones were recovered at these sites (Barag 1970; Vandiver 1983; Oates *et al.* 1997). Recent research proposed two or at least three glass making sites at the Near East supplying Nuzi (Shortland *et al.* 2017), however a localization for a production unit (*i.e.* glass making site) outside Egypt could not have been possible yet due to the lack of archaeological data. While research and debate continue on identifying glass making areas for Egypt, Mycenae, and Mesopotamia, Anatolian or Syrian glass assemblages and possible production zones in that region have often been overlooked.

Recent archaeological investigations at sites like Tell Atchana/Alalakh and Büklükale provide promising information for determining the potential of glass making sites in Anatolia dating to the 2nd millennium B.C. This paper introduces new archaeological and scientific evidence of Late Bronze Age glass production found at Tell Atchana/Alalakh.[2] After summarizing the previous research regarding a workshop area (Dardeniz 2014; 2017) and evaluating an area of production at the site, the possibility of determining glass making area(s) in southern Anatolia/northern Syria is discussed.

[1] I would like to thank Prof. Dr. Sachihiro Omura, Prof. Dr. Julian Henderson and Dr. Kimiyoshi Matsumura for organizing the Late Bronze Age Glass Workshop at the Japanese Institute of Anatolian Archaeology in 2014 to discuss recent research on the 2nd millennium B.C. glass.

[2] The glass research at Büklükale can be found in this volume.

TELL ATCHANA/ALALAKH AND ITS IMPORTANCE FOR 2ND MILLENNIUM B.C. GLASS RESEARCH

Although Alalakh was the Bronze Age name of this locality, the modern archaeological site is known as Tell Atchana; both names are used throughout this paper. The tell is located in the Turkish state of Hatay's plain of Antioch, today called the Amuq Valley. Situated close to the westward bend of the Orontes River, the site is ca. 2 km as the crow flies from the modern Turkish-Syrian border. The first excavations at the site were started by Sir C. Leonard Woolley on behalf of the British Museum and Oxford University. Eight seasons of excavations were conducted in 1936-39 and 1946-49 by Woolley, and a new round of excavations was initiated by K. Aslıhan Yener since 2000 which uncovered deposits corresponding to the Middle and Late Bronze Ages and Iron Age I-II (Woolley 1955; Yener *et al.* 2000; Yener 2005, 2013).

The city of Alalakh and its territory was the capital of the small Bronze Age Mukish Kingdom serving as a vassal to the Mittanni kingdom (ca. 15th century B.C.) and later to the Hittites (ca. 14th century B.C.) (Woolley 1955; Magness-Gardiner 1994; Yener *et al.* 2000; Yener 2005, 2010, 2013; von Dassow 2008). Tell Atchana has a special strategic location, which physically links Anatolia, Syria, and the Levant. The Orontes River that surrounded the city during the Middle and Late Bronze Ages provides access to the Mediterranean, creating an interaction route with Cyprus and the Aegean (Yener 2005; 2010; 2013).

The location of Tell Atchana serves as a contact zone for different cultures, resulting in a hybrid material culture reflected in traces on various forms of archaeological assemblages including glass. Early examples of glass as a product of a highly sophisticated technology were found at Tell Atchana, which increase the significance of the site in terms of ancient glass research. The earliest core formed glass vase (AT/39/225), the molded female glass figurines (AT/48/4, AT/39/106, AT/39/66), and the eyes of the Statue of Idrimi made of dark blue glass are some well-known examples from the site's collections (Woolley 1955; Barag 1970, 1985; Dardeniz 2016). These examples among many others were found during Woolley's excavations. Due to bureaucratic agreements of that period, artifacts were distributed among the British Museum, the Ashmolean Museum, University College London, and the Hatay Archaeology Museum collections.[3] Ongoing excavations at the site by Yener expanded the glass assemblage with significant new examples and increased the amount of information gathered from archaeological contexts to solve specifically designed research questions. One such question involves understanding the glass production technologies at Tell Atchana.[4]

Evidence for the diversification and hybridity of production technologies was found during the 2003-2004 excavation campaigns at Tell Atchana. Eight pyrotechnological installations dated to the Late Bronze Age II (ca. 1400-1200 B.C.)[5] levels (Yener and Yazıcıoğlu 2010: 36, 41, Figs. 2.3, 2.4, 2.12) were located on the northeast margin of the tell (Area 2) and were described elsewhere (Yener and Yazıcıoğlu 2010; Dardeniz 2012, 2013, 2017) (*Fig. 1*). Archaeometric analysis of three out of eight installations[6] determined the maximum firing temperatures used, showing the presence of a well-established ceramic production locality in Area 2. Wall linings and slag samples were examined with a scanning electron microscope (SEM), scanning electron microscope-electron dispersive X-ray (SEM-EDX), and X-ray diffraction (XRD) which presented important new information about the production of vitreous materials and the interrelationship of crafts

[3] The British Museum and The Hatay Archaeology Museum collections were studied in 2014 with necessary permissions and are a part of the author's doctoral dissertation (2016) entitled "Vitreous Material Crafting in the Second Millennium B.C.: Glass, Faience and Frit Production at Tell Atchana, ancient Alalakh."

[4] For details of research design at Tell Atchana, see Yener 2010: 4-6.

[5] This dating is based on Yener's (ed.) 2010 publication. New archaeological evidence has led to a re-evaluation of the dating, which may assign the kilns mostly to the late 14th century B.C. Results will be available in *Tell Atchana, Ancient Alalakh. Volume 2: The Late Bronze Age II City*, (ed.) K. A. Yener, M. Akar, and M. T. Horowitz; Istanbul: Koç University Press.

[6] For sampling and selection strategies of the installations, see Dardeniz 2012.

at the site. These results contributed significant evidence for vitrified material production at the site and triggered further research on the topic (Dardeniz 2014; 2016; 2017). The scientific and typological studies of the assemblages from Area 2 together with the unique corpus of pyrotechnological installations suggested that vitrified materials, possibly glass, would have been produced in this craft area. Still, further research at the Area 2 and on the installations seems mandatory.

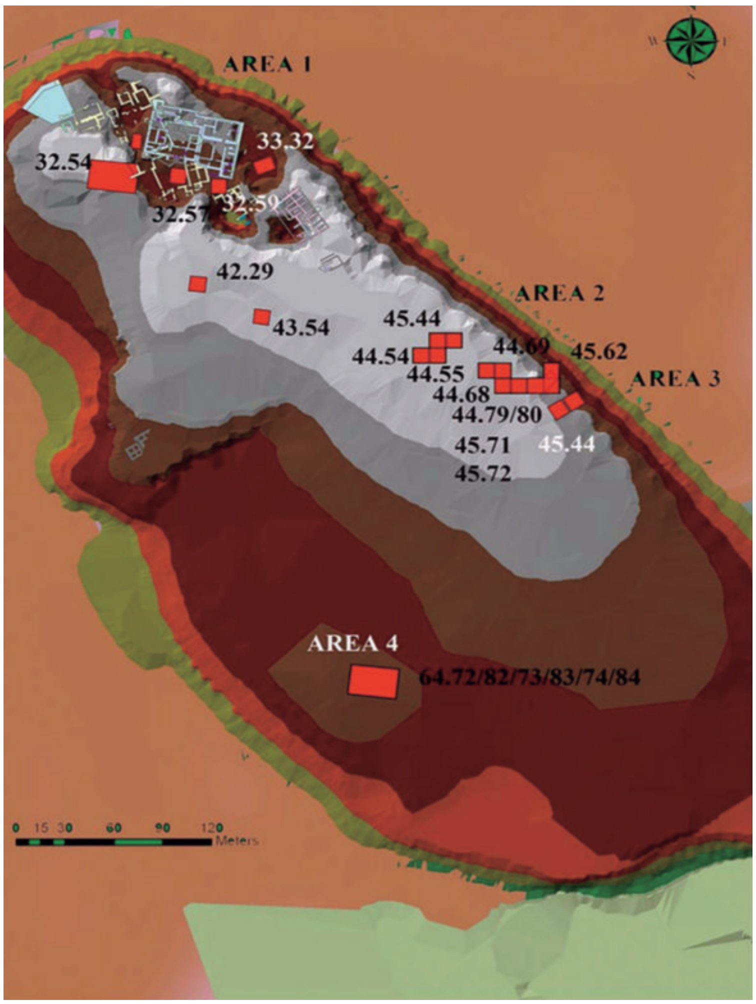

Fig. 1. Plan of Tell Atchana with excavation areas from the 2003-2011 seasons (used with permission from The Alalakh Excavations Archive, reproduced after Yener 2013).

THE GLASS MAKING EVIDENCE: ARCHEOLOGICAL CONTEXT, SCIENTIFIC ANALYSES, AND RESULTS

Archaeological Context

During the 2011 excavation season at Tell Atchana, Square 64.72 located in Area 4 at the southern part of the mound yielded Late Bronze Age debris from vitrified material production (*Fig. 1*). Various types of glass, faience objects, and fragments were found *in situ* with a pyrotechnological installation.[7] This vitrified material debris is archaeologically rare in the Late Bronze Age of Anatolia and Syria. The workshop area is dated to a transition period from the Late Bronze Age I (ca. 1500-1450 B.C.) to the Late Bronze Age II (ca. 1400-1300/1200 B.C.) period, increasing its importance as a 2nd millennium B.C. glass making site. This chronology leaves a narrow time interval for the transitional period (ca. 1450-1400 B.C.) and indicates that this workshop was several decades earlier than the glass workshops found in Amarna (ca.mid- 14th century B.C.).

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. 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 2007), 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.

In terms of the artifact assemblage in the context, metal fragments are common with 143 finds, including copper and bronze pieces with only one

[7] Final evaluation of the Late Bronze Age regional chronology as well as the dating of the workshop area will be published in *Tell Atchana, Ancient Alalakh. Volume 2: The Late Bronze Age II City*, (ed.) K. A. Yener, M. Akar, and M. T. Horowitz; Istanbul: Koç University Press.

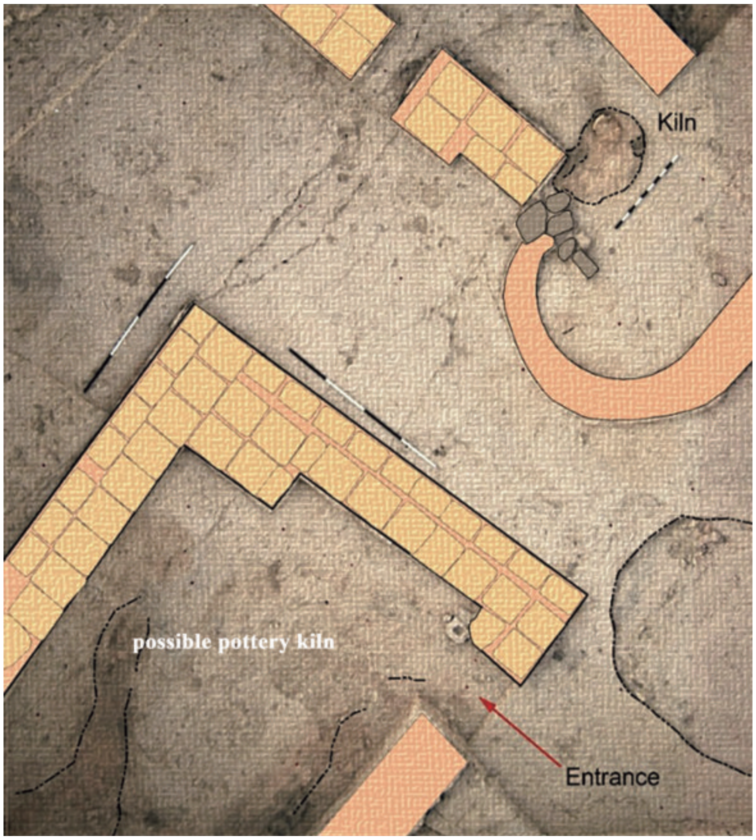

Fig. 2. Architectural plan of Square 64.72 (Dardeniz 2014: 172, fig. 4; The Alalakh Excavations archive).

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.[8] 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 (Dardeniz 2016; 2017).

[8] The total number of artifacts including the 2014 excavation season could be found in Dardeniz 2016.

Square 64.72 ended up being a fertile area for glassy material. The northwestern corner of the square is significant since two important artifacts were found in this zone: a piece of Egyptian blue (AT 13915) stuck to mud and a possible glass crucible (AT 13916). The latter is one of the milestone artifacts not only for the site, but also for 2nd millennium B.C. glass production in the region. AT 13916 was a piece of glass stuck on a ceramic shard, which provides spectacular evidence that glass was being produced in this region. Archaeologically, a similar artifact to AT13916 was found in Qantir Pi-Ramesse and analyzed by Melina Smirniou and Thilo 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.

The southwestern part of the trench also yielded a similar artifact assemblage in terms of spongy, greenish gray-colored slag imbedded in orange-colored earth. Pieces of mud bricks and basalt were uncovered together with glass fragment AT 15065. This fragment is blue with yellow stripes resembling the decoration of Nuzi glass vases. An object of interest here is a so-called pivot stone with quadratic fashion, which may have been used as a tool for glass working. 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 glass was still molten and viscous. Furthermore a blue glass (?) fragment (AT 15070) was also found in this locus.

The debris just above the pyrotechnical installation 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) and one clear blue glass (AT 14764) — were uncovered here. The removal of the yellow-orange-colored burnt first layer of the pyrotechnical installation yielded faience fragments (AT 16939) 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 were orange colored and full of ash

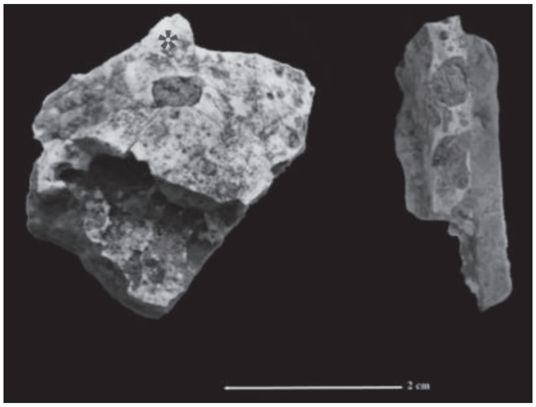

Fig. 3. AT 13916, possible glass crucible from the Late Bronze Age debris of Tell Atchana/Alalakh, Square 64.72 (The Alalakh Excavations archive).

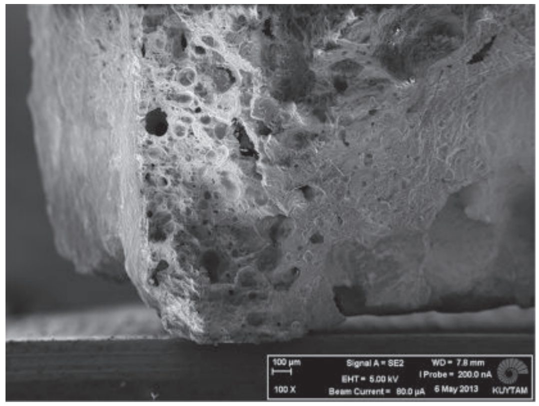

Fig. 4. An SEM image at 100× magnification of the Tell Atchana glass crucible (AT 13916) showing the vitrified microstructure of the sample.

that yielded metal (AT 16341) and glass (AT 16343) fragments together with two stones with flat surfaces (AT 16340). In the northeastern corner of the trench just above the installation, a glass bead (AT 16318) and some metal fragments (AT16324) were found in relation with yellow mud brick detritus and white-wash traces. Glass bead fragments (AT 16333, AT 16334) were also recovered from the same place. A possible extension of the pyrotechnological installation and working space is imbedded inside the northeastern part of the apsidal wall (Locus 89; lots 333, 334, 345) where many glass beads and fragments (AT 16923, AT 16966, AT 16968, AT 16969, AT 16970, AT 16928) were found.

Out of 326 vitrified samples collected from the area, 136 were collected from the aforementioned loci. The remaining 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 scientifically. The detailed scientific evidence will be introduced in the next section.

Scientific Analyses and Results

Major Elements

Vitreous artifacts collected from the Late Bronze Age I (LBI) to Late Bronze Age II (LBII) transitional strata (hereafter referred as LBI-LBII) 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[9].

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 details of all the instrumental methods are discussed elsewhere (Dardeniz 2016); this paper will focus on the results.

The most important piece comes from Locus 61, located in the northeastern part of the installation. This crucible with frit-like material (AT13916) shows a heterogeneous microstructure (*Fig. 3*). The frit-like material is white colored and porous with some holes visible at the cross section. The magnified microscopic view (100x) shows vitreous character of the surface and the heterogeneity of the structure (*Fig. 4*). The full chemical characterization of this fragment is subject to another article. Though it is worth to note here that a similar crucible fragment was found at the later Ramasside (13^{th} century B.C.) site of Qantir and confirmed as a crucible fragment containing the remains of a glass making batch (Rehren 1997). In the Qantir sample, diopside crystals were also detected. Rehren and Pusch (2005)

[9] For the analyses of faience and frit artefacts, the interested reader can refer to Dardeniz 2016.

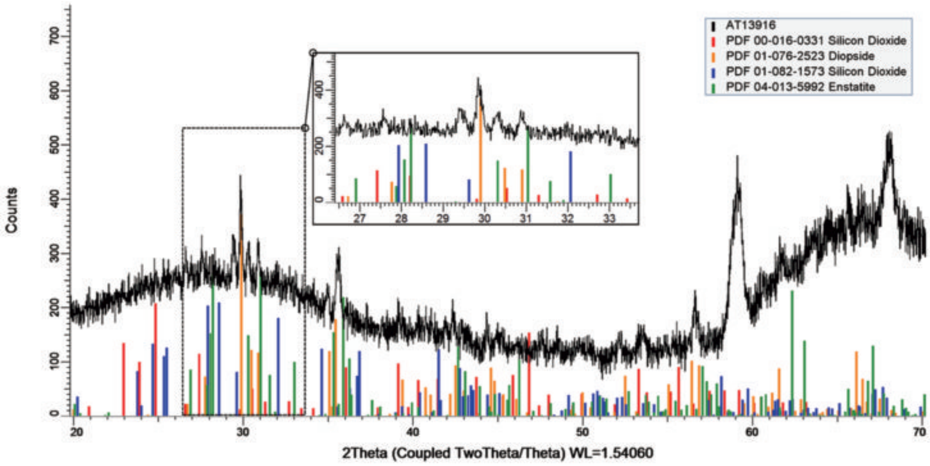

Fig. 5. XRD graph of AT 13916, peaks of the crystalline phases matching with silica, diopside, and enstatite.

	Sample Name	13157	13175	14764	15013	15065*	15070	15075	15653-1
	Period	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII
	Sample Color	*opaque white, gray*	*beige, gray*	*blue*	*opaque white, gray*	*amber*	*turqoise*	*light blue*	*blue vase fragments*
SiO_2	Conc. (wt%)	63.73	56.30	64.87	67.42	66.24	66.00	69.08	59.22
Na_2O	Conc. (wt%)	14.22	9.25	19.87	16.23	21.97	14.52	17.57	15.29
CaO	Conc. (wt%)	5.67	3.41	7.90	6.67	8.78	7.42	7.57	4.24
MgO	Conc. (wt%)	2.87	1.24	2.79	2.98	3.74	1.66	1.99	2.77
Al_2O_3	Conc. (wt%)	1.00	1.79	1.36	0.17	1.36	0.17	0.95	1.00
Fe_2O_3	Conc. (wt%)	0.52	0.75	0.90	0.34	0.36	0.15	0.26	0.20
7 Li	Conc. (ug/g)	6.68	bdl	bdl	bdl	bdl	bdl	bdl	19.81
31 P	Conc. (ug/g)	301.67	445.68	441.12	501.71	439.57	459.83	450.30	506.38
34 S	Conc. (ug/g)	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
K_2O	Conc. (wt%)	2.28	2.72	3.12	2.86	2.83	1.94	2.11	2.56
47 Ti	Conc. (wt%)	0.05	0.02	0.03	0.29	0.04	0.01	0.04	0.01
51 V	Conc. (ug/g)	4.22	8.35	10.67	7.87	11.55	5.25	6.27	5.98
52 Cr	Conc. (ug/g)	42.88	31.57	50.90	31.20	21.81	28.69	20.19	27.89
55 Mn	Conc. (ug/g)	305.60	388.21	156.42	275.94	370.83	141.91	200.12	154.90
59 Co	Conc. (ug/g)	0.02	1.00	0.98	1.56	2.12	3.08	1.24	2.19
60 Ni	Conc. (ug/g)	10.65	11.76	24.88	35.97	15.30	13.18	17.11	14.90
63 Cu	Conc. (ug/g)	35.68	34.29	7896.73	87.76	66.54	6757.76	5891.87	7254.90
71 Ga	Conc. (ug/g)	0.28	0.76	bdl	bdl	2.79	bdl	bdl	bdl
75 As	Conc. (ug/g)	35.69	29.57	367.89	129.32	166.45	238.65	289.46	302.11
85 Rb	Conc. (ug/g)	15.21	3.56	5.78	3.21	25.34	8.82	11.88	9.76
88 Sr	Conc. (ug/g)	673.29	567.21	674.47	272.12	674.47	272.12	288.09	392.66
89 Y	Conc. (ug/g)	1.99	1.12	2.78	0.09	3.0884	0.0664	1.35	3.19
118 Sn	Conc. (ug/g)	bdl	bdl	11.90	14.68	bdl	bdl	bdl	bdl
121 Sb	Conc. (ug/g)	29.88	bdl	bdl	19.68	bdl	bdl	bdl	11.85
133 Cs	Conc. (ug/g)	0.19	bdl	bdl	bdl	0.46	bdl	bdl	bdl
137 Ba	Conc. (ug/g)	26.36	18.76	12.55	21.57	42.61	31.33	39.68	67.74
139 La	Conc. (ug/g)	1.63	1.36	3.14	3.24	4.14	0.97	2.79	7.76
140 Ce	Conc. (ug/g)	1.87	bdl	1.54	bdl	1.54	bdl	bdl	bdl
146 Nd	Conc. (ug/g)	2.74	4.78	bdl	bdl	bdl	bdl	bdl	bdl
197 Au	Conc. (ug/g)	0.12	bdl	0.02	bdl	bdl	bdl	0.03	0.02
Pb	Conc. (ug/g)	5.87	3.45	7.12	6.87	28.09	36.41	21.76	22.76

Table 1: ICP - MS results of glass artifacts of LBI-LBII Alalakh glasses, elements detected in weight percent and ppm are specified in the second column. The samples with * have also isotope results.

have discussed the occurrence of diopside minerals as evidence of glass making. The XRD analysis of AT 13916 (*Fig. 5*) shows crystalline phases, which are identified as diopside and silica supporting the glass making at Alalakh.

The crucible fragment is one the most spectacular finds for glass production, and more specifically for glass making evidence from the LBI-LBII strata; further examinations were done with inductively coupled plasma-mass spectrometer (ICP-MS) on fragments of amber, turquoise, a blue and opaque white-colored beads, vases, and ingot. A total of

Table 1 *(continues)*

	Sample Name	15653-2	16306	16333	16343	16923	16968*
	Period	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII	LBI-LBII
	Sample Color	*yellow vase fragments*	*blue*	*pale blue*	*turqoise*	*blue*	*blue ingot fragment (from kiln)*
SiO_2	Conc. (wt%)	62.79	68.01	64.22	63.57	64.45	61.67
Na_2O	Conc. (wt%)	19.57	22.49	21.56	17.78	15.16	18.58
CaO	Conc. (wt%)	7.88	3.78	4.46	7.78	6.90	7.95
MgO	Conc. (wt%)	3.78	3.43	3.14	2.08	2.14	3.46
Al_2O_3	Conc. (wt%)	1.02	1.88	1.57	0.68	0.47	1.41
Fe_2O_3	Conc. (wt%)	0.54	0.72	0.13	0.20	0.67	0.78
7 Li	Conc. (ug/g)	bdl	bdl	7.67	9.89	bdl	bdl
31 P	Conc. (ug/g)	459.89	447.76	560.78	440.09	468.89	448.90
34 S	Conc. (ug/g)	bdl	bdl	bdl	bdl	bdl	bdl
K_2O	Conc. (wt%)	2.98	2.75	1.89	1.98	2.19	2.11
47 Ti	Conc. (wt%)	0.02	0.06	0.04	0.04	0.02	0.02
51 V	Conc. (ug/g)	5.89	14.13	11.36	12.57	10.11	11.04
52 Cr	Conc. (ug/g)	23.12	23.48	21.09	27.57	19.09	25.10
55 Mn	Conc. (ug/g)	150.42	437.25	411.79	378.10	350.12	440.80
59 Co	Conc. (ug/g)	2.91	63.60	59.24	2.09	1.21	1.10
60 Ni	Conc. (ug/g)	24.22	50.62	10.68	9.46	19.57	22.20
63 Cu	Conc. (ug/g)	45.18	5434.25	3701.87	6057.98	5991.10	8903.46
71 Ga	Conc. (ug/g)	bdl	3.53	bdl	bdl	bdl	bdl
75 As	Conc. (ug/g)	bdl	600.44	111.89	198.76	221.50	585.98
85 Rb	Conc. (ug/g)	23.78	26.12	25.87	19.78	7.79	9.90
88 Sr	Conc. (ug/g)	379.75	667.16	300.10	277.89	66.46	664.89
89 Y	Conc. (ug/g)	1.76	4.10	2.90	3.80	2.75	3.75
118 Sn	Conc. (ug/g)	bdl	bdl	bdl	bdl	bdl	bdl
121 Sb	Conc. (ug/g)	29.95	bdl	bdl	bdl	bdl	bdl
133 Cs	Conc. (ug/g)	bdl	bdl	bdl	1.87	bdl	bdl
137 Ba	Conc. (ug/g)	50.65	112.87	47.65	53.65	42.50	40.89
139 La	Conc. (ug/g)	8.76	7.44	2.76	4.86	8.86	4.76
140 Ce	Conc. (ug/g)	bdl	bdl	1.46	1.85	bdl	bdl
146 Nd	Conc. (ug/g)	bdl	6.18	bdl	bdl	bdl	bdl
197 Au	Conc. (ug/g)	0.01	bdl	0.04	0.02	bdl	bdl
Pb	Conc. (ug/g)	34.75	30.22	21.75	29.75	22.85	35.75

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	64.11	3.43	67.10
Na_2O	17.43	3.64	17.87
CaO	6.46	1.79	6.03
MgO	2.72	0.79	3.98
Al_2O_3	1.06	0.46	0.75
Fe_2O_3	0.46	0.26	0.58
K_2O	2.45	0.42	3.69

Table 2: **ICP-MS mean compositions for LBI-LBII Alalakh glasses. For the standard deviation values of Brill's analysis, see Brill and Stapleton 2012.**

14 glass fragments were analyzed. All of them were found as soda-silica-lime glass, reflecting the typical 2nd millennium B.C. major glass composition (*Table 1*). The average soda-silica-lime levels are provided in *Table 2*, in comparison with Robert Brill's published data of Alalakh (Brill and Stapleton 2012: 264).

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) was found to be colored with copper (8903.46 ppm) with a significant amount of arsenic (585.98 ppm).

In the LBI-LBII glasses, copper was detected as the colorant for blue; however, one blue (AT 16306) and one pale blue (AT 16333) glass fragment have 63.60 ppm and 59.24 ppm cobalt, respectively. These two blue glass fragments have the highest levels of cobalt among the LBI-LBII corpus.[10] In general, the cobalt values of the Alalakh glasses vary between 1-3 ppm.[11] Such elevated levels of cobalt in these

[10] These cobalt coloured glass beads also has the highest values of cobalt also among the Late Bronze Age I glass assemblage of Alalakh.

[11] The only one exception of these cobalt values is the Middle Bronze II turquoise bead (AT 15825) with

beads (AT 16306, AT 16333) point towards an Egyptian origin (Kaczmarczyk 1986); however, the high arsenic values (600.44 ppm and 111.89 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, has 585.99 ppm arsenic. Two other light blue and blue artifacts, the latter belonging to vase fragments, have 289.46 ppm and 302.11 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 of the site (Dardeniz 2016). This trend seems continuous for the glasses dated to the LBI-LBII transition period. Furthermore the tin contents of glasses dated to this transitional period are below the detection limit, except for AT 14764 and AT 15013. AT 14764 is a blue-colored bead and contains 11.90 ppm tin most probably indicating use of a scrap metal including tin (*i.e.* bronze). AT 15013 is an opaque white bead and has 14.68 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. If scrap metal had been used as a colorant, rather than tin bronzes, arsenical bronzes must have been preferred.

As reviewed in the archeological context section, 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 a doctoral dissertation. 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 29.95 ppm and a minimum of 11.85 ppm, thus indicating the use of antimony as the opacifier. In terms of yellow colorant, the yellow vase fragments (AT 15653-2) have 34.22 ppm lead. The highest lead content (31.41ppm) is found in the turquoise-colored (AT 15070) ingot (?) fragment. The blue ingot has 35.75 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.

Overall, the major elemental results of Alalakh glasses confirm soda-silica-lime characteristics of the known 2nd millennium B.C. glasses of the ancient Near East (*Table 2*). The silica levels of all samples average 63-64% and soda levels are around 17%. These values are within the range of Mesopotamian (Tell Brak) and Egyptian (Amarna) glasses of the Late Bronze Age as known from the literature (Shortland *et al.* 2007 with references). LBI-LBII glasses have a broader range in lime concentrations. For the magnesia levels 2.5-3.5% appears as the dominant range, which is lower than the Late Bronze Age comparatives of Tell Brak and Amarna. Low potash reported for the Late Bronze Age glasses (Lilyquist and Brill 1993: 42; Smirniou and Rehren 2011: 68) is observed in Alalakh LBI-LBII 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) rather than a selective use of plant ash.

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 Alalakh, were from LBI-LBII levels, where copper dominated cobalt ppm values except two beads (AT 16306, AT 16333) discussed above with approximately 60 ppm cobalt values. I suggest that these beads are imports from Egypt because the majority of the Alalakh glass artifacts, especially the ones found in the LBI-LBII debris of Square 64.72, contain copper as colorant for blue. Cobalt is generally rare in the local assemblage, thus

6.21 ppm cobalt (Dardeniz 2016).

supporting the fact that cobalt-bearing artifacts could have been related to Egypt.[12]

Lower alumina levels indicate use of purer silica source during glass making (Henderson 2009). However, the alumina levels of the LBI-LBII Alalakh 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 which might be a sign of experimentation with the raw materials *i.e.* silica sources during the transitional period. Iron levels also have elevated levels for this period.

The glass samples analyzed from the LBI-LBII transitional period of Alalakh, demonstrate unique characteristics with some elevated and diverse major element compositions 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 glass making. This idea is supported also with the trace element compositions.

Trace Elements

In this study, 30 trace elements were measured with ICP-MS. Three elements out of 30 — zinc (Zn), zirconium (Zr) and tungsten (W) — are not listed in *Table 1* 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 Late Bronze Age 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 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 research provides other possible compositional fingerprints to distinguish the Alalakh glasses from the published 2nd 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 research.

In this study, the best distinctions were made by using vanadium - chromium (V-Cr) and vanadium - nickel (V-Ni) binary plots. 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. 6*).[13] 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.

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.*

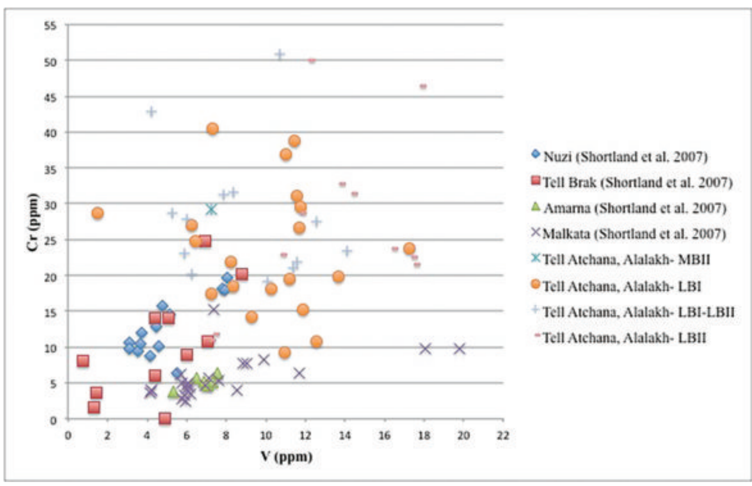

Fig. 6. **Covariation of V and Cr levels of Alalakh glasses distributed along the periods and among other glass compositions as known from the literature (Shortland *et al.* 2007).**

[12] Fort he rest of the cobalt values in the assemblage, see Dardeniz 2016.

[13] All trace elemental data of from Alalakh (regardless of presenting only LBI-LBII transitional period glass data) with the chronological distribution among periods is provided in the V-Cr and Ni-Cr graphs.

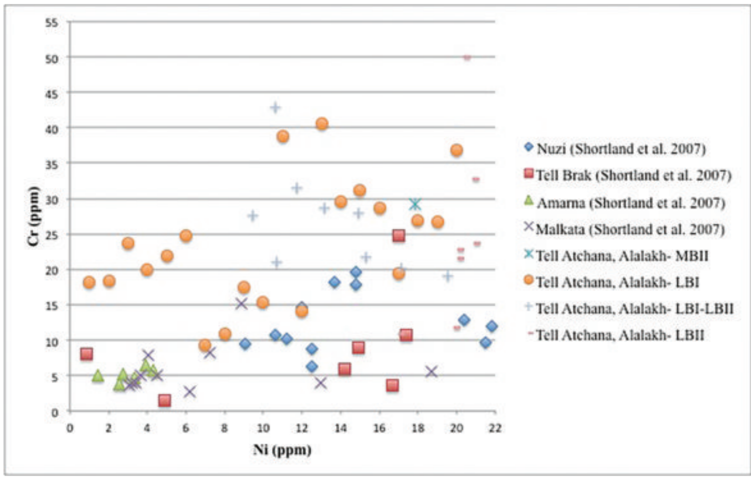

Fig. 7. **Covariation of Ni and Cr levels of Alalakh glasses distributed along the periods and among other glass compositions as known from the literature (Shortland *et al.* 2007).**

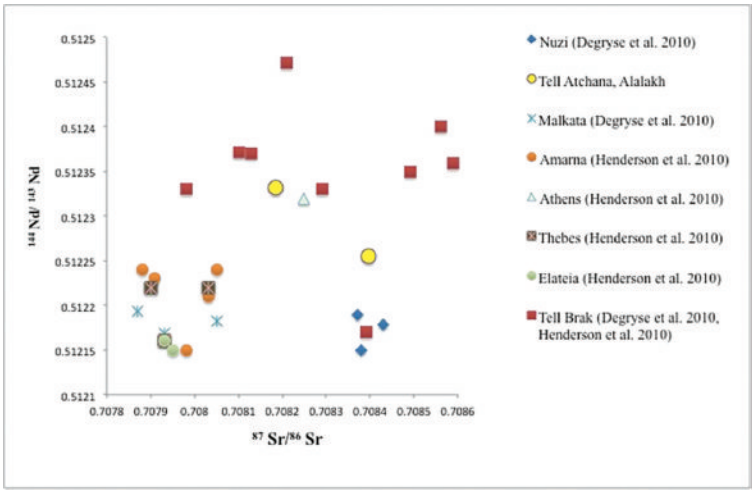

Fig. 8. **Sr-Nd isotope values of two glass fragments. AT 16968 (blue ingot fragment) and AT 15065 (dark amber vase fragment).**

7). It is also visible that the LBI- LBII glasses have similar nickel contents to Nuzi and Tell Brak.

To conclude, the trace elemental results of Alalakh glass also demonstrate variations from the comparative Mesopotamian (Nuzi and Tell Brak) and Egyptian sites (Amarna and Malkata) supporting another glass supply (production zone) than Mesopotamia or Egypt.

Isotopic Work

Isotopic analyses of glass potentially provide scientific evidence of provenance. Strontium (Sr) and neodimium (Nd) isotopes are often used to source the raw materials. Silica, the major component of glass, is obtained from quartz or sand deposits. These sources with different geological ages have different ratios of $^{143}Nd/^{144}Nd$, thus allowing calculations of the formation age of that particular rock, eventually facilitating the differentiation between different silica sources used for glass making (Henderson *et al.* 2010). Sr isotope analysis follows a similar principle and provides a method for distinguishing the plants used as flux (*i.e.*, materials that help decrease the melting point of silica) during glass making. Plants containing distinctive ratios of $^{87}Sr/^{86}Sr$ reflect the age and characteristic of the bedrock on which the plants grow. Therefore, Sr isotope values also serve as an indicator of local geology and provenance (Freestone *et al.* 2003; Henderson 2013: 328). The salt-bearing plant family *salsola kali*, which was used as flux in glass making, 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 glass making.

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-İnan 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) that was unearthed from inside the kiln. The second sample is the amber-colored vase fragment (AT 15065). Two different colors were specifically selected in order to observe possible variations in the different colored glasses.

The results are plotted in *Figure 8*. 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 wide range of Sr and Nd isotope values at Tell Brak may indicate the melting of raw materials from different sources to produce glass. They might also signify the possible import of glass at the site. Because a glass making workshop has not yet been located at Tell Brak, but some glassworking debris was found at the settlement (Henderson 1997; 2013), it is necessary to consider that glass was imported. Further, it is important to note that if glass was produced locally at Tell Brak, the possibility of importing some glass material remains. Glass could have been simultaneously produced and imported to fulfill specific requests such as different colors.[14]

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 local production, import, and trade of glass between Tell Atchana and Tell Brak. However, the scientific dataset from Tell Atchana needs to be expanded before establishing further linkages on glass production and trade relations 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 2nd 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 2nd millennium B.C., there must have been at least two or more glass making centers, including Alalakh. This is complementary to what was presented in the recent glass research regarding Nuzi, where it was postulated at least two possibly three glass production zones in the Near East (Shortland *et al.* 2017).

[14] For a discussion on importance of color in the 2nd millennium B.C. glass see: Duckworth 2012; Dardeniz forthcoming.

DISCUSSION

The ICP-MS analysis of glass artifacts from Alalakh demonstrate new interpretations to the literature of the 2nd 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 LBI-LBII glasses designate use of different plant ashes or same plant ash with varying levels of potash. It is worth to mention that 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.

The levels of aluminum and iron are noticeable, though higher iron and alumna levels at Alalakh are known from the literature (Erb-Satullo *et al.* 2011; Yener 2010; 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 2010; 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, which is located almost 10 km away from Alalakh (*Fig. 9*). 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 glass making 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 2012: 99). The high levels of alumina and iron in Alalakh glass also support the hypothesis that sand most probably from the Orontes was used systematically throughout production.

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

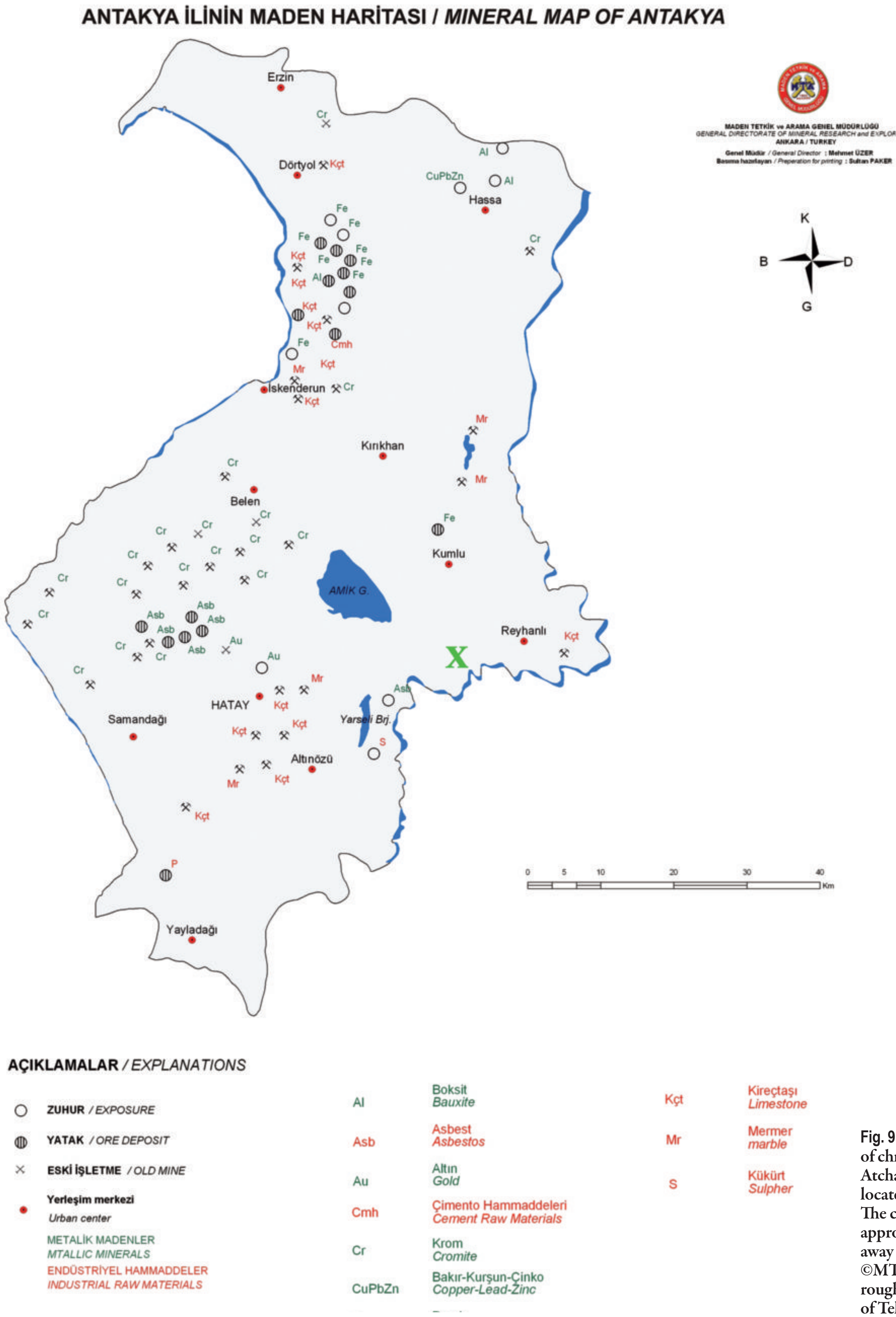

Fig. 9. Mining deposits of chromite around Tell Atchana/ Alalakh, which are located close to Reyhanlı. The chromite reserves are approximately 40-50 km away from Reyhanlı (map, ©MTA). The green 'X' roughly shows the location of Tell Atchana/Alalakh.

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 glass makers of Alalakh.

Based on the trace element results, 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. 9*).[15] 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).

The isotopic research conducted in this study is not sufficient for a detailed statistical assessment.[16] 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 regional trade between the northern Mesopotamian centers and the southern Anatolia/northern Syria might also include glass.

These scientific analyses together with the archaeological data support a scenario in which glass was locally produced at Tell Atchana. This is significant, as it identifies a glass making site dating to the Late Bronze Age in southern Anatolia/northern Syria independent from the other glass making sites of Amarna and Qantir in Egypt.

Several aspects of Tell Atchana, Square 64.72 (Area 4) and Amarna, Square O.45.1 (Nicholson 2007) reflect intriguing similarities. For example, artifact assemblages, the architectural layout, and the use of space in the activity areas of these two sites show parallels, which undoubtedly indicates sharing of technological practices between Egypt and southern Anatolia/northern Syria (Dardeniz 2017: 149-150). The assemblages from Tell Atchana already show an extensive amount of Egyptian finds other than vitrified materials (Woolley 1955), but such similarities in spatial arrangements of workshop areas and production practices demonstrate that regional connections must have also included technological knowledge, especially related to vitrified material production.

CONCLUSIONS

This paper introduces for the first time archaeological and scientific analyses of the archaeological context dated to the LBI-LBII transition period of Tell Atchana/Alalakh, where glass making was practiced. This new set of information extends the region of possible glass making areas to southern Anatolia/northern Syria, which has been less discussed for the glass industry, perhaps due to the relatively rich material evidence from the northern Mesopotamian sites. These results provide evidence for cultural connections between Egypt, Anatolia, Syria, and Mesopotamia. As the case of Tell Atchana shows, relations between these regions now appear to have encapsulated technological knowledge as well as the trade of artifacts.

Further excavations followed by archaeometric research at Tell Atchana as well as other sites of the Near East dating to the 2nd millennium B.C. will shed new light on the technological activities undertaken in workshop areas and the general raw material transformation technologies of the era. Through careful evaluation and interpretation of data collected from these sites, the socioeconomic and sociopolitical contexts of the ancient crafts and their *chaîne opératoires* during the 2nd millennium B.C. will become known.

ACKNOWLEDGEMENTS

I would like to thank Professor Aslıhan Yener for

[15] http://www.mta.gov.tr/v3.0/sayfalar/bilgi-merkezi/maden_potansiyel_2010/Antakya_Madenler.pdf

[16] The limited budgets restricted any further isotopic research.

providing me with unique archaeological data from the Tell Atchana excavations. I thank the entire Atchana team for their contribution to this research. I would like extend my gratitude to Dr. Barış Yağcı and Cansu Yıldırım at the Koç University Surface Technologies Center (KUYTAM), whose support and comments on the scientific research are much appreciated. I acknowledge Jane Evans from BGS for her help for the isotopic work. I am indebted to Cahit Dönmez (MTA) for the permission to use MTA maps during this research.

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ADDENDUM

The first draft of the article was prepared in 2014 when the author was conducting her doctorate at Koç University, Department of Archaeology and History of Art. A major revision was made in 2018 because of the necessity of an update to occur due to accumulated data and knowledge in the ancient Near Eastern glass research.

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ABBREVIATIONS

AA	Archäologischer Anzeiger
AAA	Annals of Archaeology and Anthropology
AAS	Anatolian Archaeological Studies
AASOR	The Annual of the American Schools of Oriental Research
ABSA	The Annual of the Britisch School at Athens
AfO	Archiv für Orientforschung
AJA	American Journal of Archaeology
ArOr	Archiv Orientální
AS	Anatolian Studiea
AST	Araştırna Sonunçları Toplantısı
BaM	Baghdader Mitteilungen
BASOR	Bulletin of the American Schools of of Oriental Research
BiOr	Bibliotheca Orientalis
BMECCJ	Bulletin of the Middle Eastern Culture Center in Japan
IM	Istanbuler Mitteilungen
JAOS	Journal of American Oriental Society
JCS	Journal of Cuneiform Studies
JGS	Journal of Glass Studies
JHS	Journal of Hellenistic Studies
JNES	Journal of Near Eastern Studies
KST	Kazı Sonunçları Toplantısı
MAOG	Mitteilungen der Altorientalischen Gesellschaft
MDOG	Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin
OIC	Oriental Institute Communication
OIP	Oriental Institute Publications
OLZ	Orientalische Literaturzeitung
PEQ	Palestine Exploration Quarterly
PKG	Propyläen Kunstgescichte
PRU	Le Palais Royal d'Ugarit
RA	Revue d'Assyriologie et d'Archéologie Orientale
RlA	Reallexikon der Assyriologie
SAOC	Studies in Ancient Oriental Civilisation
TAD	Türk Arkeoloji Dergisi
WdO	Die Welt des Orients
WVDOG	Wissenschaftliche Veröffentlichungen der Deutschen Orient-Gesellschaft
WZKM	Wiener Zeitschrift für die Kunde des Morgenlandes
ZA	Zeitschrift für Assyriologie und Vorderasiatische Archäologie
ZDMG	Zeitschrift der Deutschen Morgenländischen Gesellschaft