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Sources of Late Chalcolithic obsidian artefacts from Tepe Gheshlagh, Kurdistan province, western Iran

Amir Saed Mucheshi[a,*], Amir Esna-Ashari[b], Mahnaz Sharifi[c], Abbas Motarjem[d], Michael D. Glascock[e]

[a] Department of Art and Architecture, Payame Noor University (PNU), Tehran, Iran
[b] Department of Geology, Payame Noor University (PNU), Tehran, Iran
[c] Iranian Center for Archaeological Research (ICAR), Research Institute of Cultural Heritage and Tourism, Tehran, Iran
[d] Department of Archeology, Faculty of Art and Architecture, Bu - Ali Sina University, Hamadan, Iran
[e] Research Reactor Center, University of Missouri, Columbia, Missouri, USA

*Corresponding author
Email address: saedmucheshi@pnu.ac.ir

Abstract

Many archaeological studies, especially those on obsidian artefacts and their origins, have been conducted in the western half of Iran. An exception is the province of Kurdistan as previous studies have mainly taken place in the surrounding provinces. However, the diversity of prehistoric cultures in the surrounding areas increases the importance of studying sites within the province of Kurdistan. In this paper, the results from studies of Late Chalcolithic obsidian artefacts from the site of Tepe Gheshlagh in eastern Kurdistan are reported. Geochemical studies of the obsidian show that they belong to the Nemrut Dağ and Meydan Dağ sources located north of Lake Van in eastern Turkey. These obsidians seem to have been exchanged through Mesopotamia by paths that connect the Zagros to Tepe Gheshlagh.

Keywords: Obsidian; Tepe Gheshlagh; Kurdistan Province; Late Chalcolithic period; Nemrut Dağ; Meydan Dağ.

1. Introduction

Kurdistan province is located in western Iran. It is adjacent to the province of West Azerbaijan from the north, to Kermanshah province of the Central Zagros from the south, to the region of Iraqi Kurdistan from the west and to provinces located north of the central plateau of Iran from the east. The unique archaeological and geological features for each of these areas suggest different paths of

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communication, different cultural materials and different traditions. Up to now, most archaeological studies have been conducted in the areas surrounding the Kurdistan province. In order to understand the history and cultural materials of Kurdistan province, including the site of Tepe Gheshlagh, it is also necessary to have knowledge of the surrounding areas (Fig. 1).

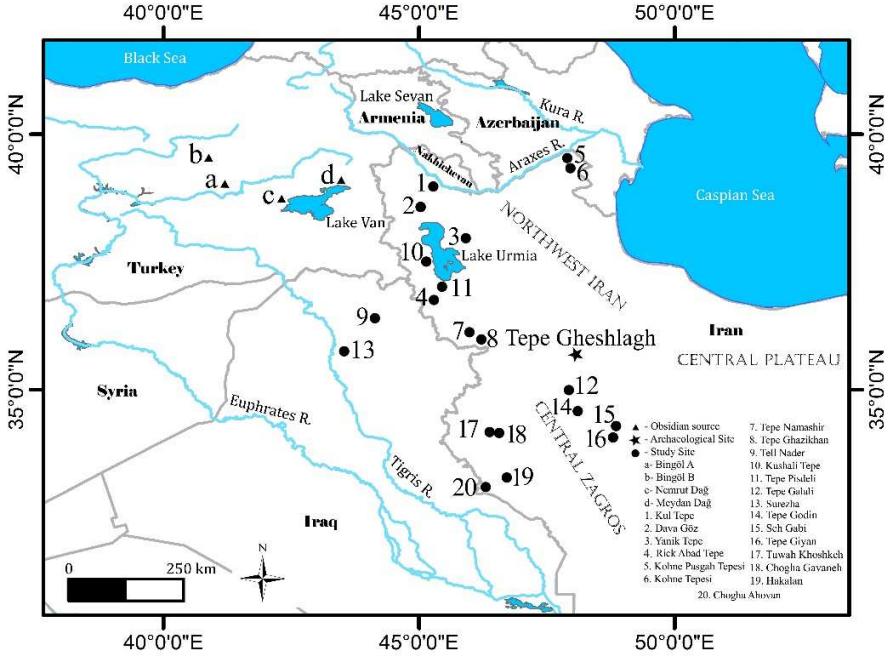

Fig. 1. The map showing the archaeological sites and obsidian sources

Different teams have carried out archaeological investigations of the Chalcolithic period in northwestern Iran and the Central Zagros of western Iran, but the archaeological features of Kurdistan province are largely unknown. In the northwestern region of Iran, various excavations have been carried out on prehistoric sites belonging to the Neolithic and Chalcolithic periods (Voigt, 1983; Dyson and Young, 1960; Dyson et al. 1969; Hamlin, 1975; Burton-Brown, 1951; Solecki and Solecki, 1973; Abedi, 2016; Abedi et al. 2014; 2018; Maziar, 2010, 2015; Hejebri Nobari et al. 2012; Dyson 1973 a, b). Numerous excavations have been carried out on sites from the Chalcolithic period in the Central Zagros region mostly related to the sites of Mahidasht in the west and Kangavar in the east of this region (Contenau and Ghirshman 1935; Young and Levine, 1974; Goff, 1971; Hamlin, 1974; Levine, 1975; Levine and Hamlin, 1974; Young 1969, 1974; Abdi 2001, 2003; Abdi et al. 2002). Although there are several excavated Chalcolithic sites in the Central Zagros the number of studies on obsidian is limited. The obsidian sites include: Tuwah Khoshkeh (Abdi et al. 2002: 61), Chogha Ahovan (Khazaie et al.

2014), Seh Gabi (Abdi 2006: 150) and Chogha Gavaneh (Wright 2005; Abdi 2006: 150). Obsidians were collected from Tepe Giyan (Contenau and Ghirshman 1935) and the cemetery of Hakalan (Haerinck and Overlaet, 1996), but unfortunately, their origin has not yet been determined. We do not know the sources of obsidian for this period or their entrance path. Based on available data, during the Early Chalcolithic period, the Mesopotamian path was used to transport obsidian to the Central Zagros (Barge et al., 2018: Fig. 8). It is noteworthy that Nemrut Dağ was the main source of obsidian during the Early Chalcolithic period (Barge et al. 2018; Renfrew et al. 1966; Renfrew et al. 1968). On the basis of collected pottery from the surface of Chogha Ahovan, the site dates from fifth millennium to the early second millennium BC. All its obsidian specimens were surface finds and the exact dates for the samples cannot be stated. The obsidians on this site were imported from the sources located near Lake Van especially Nemrut Dağ (Khazaie et al. 2014).

What we can say by comparing the western and eastern regions of the Central Zagros in the Chalcolithic period is that there are differences between their cultural materials and pottery from the Early to Late Chalcolithic periods, although common species are also seen. The excavated pottery from the Tepe Gheshlagh is similar to that from the eastern region of Central Zagros and this similarity can be observed from the beginning of Chalcolithic to the end of this period (Sharifi and Motarjem, 2018; Motarjem and Sharifi 2015). In addition to having obsidian, the Late Chalcolithic period at Tepe Gheshlagh is characterized by the occurrence of pottery that is often simple with a thick red slip, under-firing, with chaff and mineral temper. Also, the pottery has decorations such as finger-pinched wavy bands. In the east of the Central Zagros region, Hoseinabad (Godin VII) and Cheshmeh Nush (Godin VI) periods have been introduced as Late Chalcolithic periods (Henrickson 1983, 1985; Levine and Young 1987; Hole, 1987; Levine, and McDonald, 1977; Voigt and Dyson 1992).

Comparison of the northwestern region of Iran to the Central Zagros during the Early Chalcolithic period indicates that despite the commonalities there are differences in chronology and potteries. In the Late Chalcolithic, Seh Gabi period (Godin IX) pottery became common in the Central Zagros and the Pisdeli period (Hasanlu VIII) pottery in the region of Azerbaijan. Both types have similarities such as the existence of Black-on-Buff pottery, but differences are also obvious as the Chaff-faced pottery appears in Azerbaijan and Godin VII pottery in the Central Zagros. Chaff-faced pottery is found in a wide area including northwestern Iran, the Republic of Azerbaijan, Armenia and northern Mesopotamia (Stein, 2010; 2012; Stein and Alizadeh 2014: 134; Stein et al. 2013: 33-35; Abedi et al. 2014; Tobler, 1950; Kepinski, 2011: 65; Abu Jayyab, 2012).

Until recently, a limited number of archaeological studies have taken place in Kurdistan province. Recently, several sites from the Chalcolithic period have been excavated, including the site of Tepe Gheshlagh in the east and the Namashir site in the northwest of the province. On these sites, artefacts

from the Chalcolithic period as well as obsidian tools have been found. As mentioned before, Kurdistan province is a special location such that it has a combination of traditions from the Late Chalcolithic period of northwestern Iran and the Central Zagros. In Tepe Gheshlagh, the Godin VII pottery tradition resembles pottery from the east of Central Zagros. In western Kurdistan, which is adjacent to northwestern Iran and north of Mesopotamia, Chaff-Faced/Chaff-Tempered pottery tradition is common (Saed Mucheshi et al., 2017; Saed Mucheshi, 2011; Zamani Dadaneh et al, 2019). As mentioned earlier, the Namashir site located in northwestern Kurdistan province has the tradition of chaff-faced pottery.

It would be helpful to identify the sources of obsidian artefacts collected from the Late Chalcolithic sites in the northwestern and the Central Zagros in Iran in order to better identify the communication paths. Some obsidian tools have been analyzed from the Namashir phase III and Tepe Ghazikhan with chaff-faced pottery tradition (Saed Mucheshi et al., 2021) which are contemporaneous with Tepe Gheshlagh III. Despite the information we have from these sites (Fig. 1), our knowledge of the sources of Late Chalcolithic obsidian is incomplete. According to Saed Mucheshi et al. (2021) obsidian artefacts from the Namashir and Ghazikhan sites came from Nemrut Dağ and Meydan Dağ (around Lake Van, east of Turkey) and Syunik (Armenia). Therefore, the results obtained from Tepe Gheshlagh can be an important step toward increasing the available information.

2. Tepe Gheshlagh

Tepe Gheshlagh (E: 47° 52' 39.68", N: 35° 42' 46.78"; 1624 AMSL) is located in the Qezel Awzan river basin, Bijar County, east of Kurdistan province. This area is high as most of the archaeological sites and the villages are located at an altitude of 1600 to 2100 meters above sea level. It also has wide plains with hilly areas (Saed Mucheshi 2011). There is a north-south communication path in the province that can establish a connection between the northwestern region of Iran and the Central Zagros, and its west-east path can be the link between the west of the province and the north of the central plateau of Iran. The north-south communication path starts from the area around the Urmia Lake and reaches the Central Zagros through the east of Kurdistan Province plains and then to the more southern regions of Iran. The west-east path in Kurdistan Province starts from Marivan border crossing and continues to the east of the province. The natural path of Sanandaj-Marivan has been the communication route between Iran and Mesopotamia. This path extends from the west to Mesopotamia and from the east to the north of the Central Plateau of Iran (Barge et al. 2018: fig. 6; Algaze 1989: Fig. 3). The city of Marivan can directly connect to Iraqi Kurdistan through a natural path, so it could have easily built up a relationship with Mesopotamia during different periods of prehistory as well as history (Algaze 1989: Fig. 3; Levine 1973: Fig. 3).

The eastern part of Kurdistan province has less rainfall than the western regions of the province with an annual rainfall of 437 mm and average annual temperature of 9 degrees Celsius (Jafar Pour 1978). In a part of the Qezel Awzan River catchment area, a dam called Talvar has been constructed and in its rescue excavation project several prehistoric sites such as Tepe Gheshlagh were excavated (Sharifi and Motarjem, 2018).

Tepe Gheshlagh is 70 by 80 meters in width and length and has 14.6 meters of cultural layer (Fig. 2). The site was excavated for three seasons under the supervision of Abbas Motarjem. Early and Late Chalcolithic periods were identified in addition to traces related to later periods of Late Bronze Age and the Iron Age (Table. 1). Layer III of Tepe Gheshlagh with five meters of cultural deposits belongs to the Late Chalcolithic 2-3 and corresponds to the early fourth millennium BC (Thermoluminescence dating show 3915 ± 270, 3850 ± 280, 3600 ± 220 BC). The potteries obtained from this layer are comparable with those in the east of the Central Zagros region and the Godin VII period (Sharifi and Motarjem, 2018; Motarjem and Sharifi 2015). This chronology corresponds to the relative dating of the North Central Plateau of Iran as well as the absolute chronology of the site of Kalanan located near Gheshlagh (Saed Mucheshi 2020: Table 3; Voigt and Dyson 1992: 154; Sharifi and Motarjem 2018: Fig 18). It should be noted that the periods contemporaneous with Godin VII and VI in northern Mesopotamia and northwestern Iran are Late Chalcolithic 2 to 5 (Renette and Mohammadi Ghasrian 2020; Abedi et al. 2014: Fig 6; Stein and Alizadeh 2014; Stein et al. 2013: Table 1).

Table 1. Cultural layers at Tepe Gheshlagh

Layer	Period	Pottery Tradition
I	Iron Age III	
Gap	-	
II	Late Bronze Age	
Gap	-	
III	Late Chalcolithic 2-3	Godin VII and VI
IV	Late Chalcolithic 1	Seh Gabi and Pisdeli
V	Early Chalcolithic	Dalma

We recovered 858 lithic tools from Tepe Gheshlagh III (Late Chalcolithic) of which 25, equivalent to 2.9%, are obsidian. Other tools are made of chert, which includes different types (Table. 2). The small number of recovered obsidians in comparison with northwestern Iran shows the importance of this study. Among the collected obsidian tools, 15 were selected for chemical analysis (Fig. 3). No obsidians were recovered from the Early and Late Chalcolithic 1 periods.

Table 2. Late Chalcolithic 2-3 typology of lithic artefacts from Tepe Gheshlagh

Period	Core	Debitage	Tools	Debris	Obsidian	Total
Late Chalcolithic	192 (22.37%)	458 (53.37%)	154 (17.9%)	29 (3.3)	2.9%	858 (100%)

Fig. 2. Tepe Gheshlagh and its stratigraphic section.

3. Neolithic and Early Chalcolithic obsidians in the northwestern Iran and Central Zagros

3.1. Neolithic

Studies on the origins of obsidian in northwestern and western Iran show that the oldest are related to the Neolithic period (Renfrew and Dixon 1977: Table 1; Renfrew et al. 1966; Renfrew et al. 1968; Darabi and Glascock 2013; Pullar et al., 1986; Zeidi and Conard 2013; Khazaie et al. 2014; Barge et al. 2018: 306). The end of the ninth millennium and the beginning of the eighth millennium BC is the period of time that has been suggested for the import of obsidian to Iran from Mesopotamia path (Darabi and Glascock 2013; Barge et al. 2018: Table 4).

In the Central Zagros region, Nemrut Dağ #2 (i.e., Sıcaksu outcrop) was the source of obsidian in the Neolithic and Chalcolithic periods for the sites of East Chia Sabz and Chogha Ahovan (Darabi and Glascock 2013: 3808; Khazaie et al. 2014: 27). Studies at other sites report the presence of obsidian from Nemrut Dağ/Bingöl-A and Bingöl-B (Renfrew et al. 1966, 1968; Abdi et al. 2002: 61: Abdi 2006: 150; Wright 2005). Barge et al. 2018 published a synthesis of existing data. In addition to the Mesopotamia path, the other path suggested for the import of obsidian to Neolithic sites is the path through northwestern Iran. By this path, obsidian was imported from the northern sources of Lake Van (including Meydan Dağ and Nemrut Dağ) to the areas around Lake Urmia and then it was transferred to other parts of Iran (Barge et al. 2018: Figs 5-7). Hajji Firuz and Tamar Tepe are two examples of Neolithic sites from the northwestern Iran. The origin of their obsidian artefacts are respectively attributed to Meydan Dağ and

Syunik (Renfrew and Dixon 1977: Table 1). Meydan Dağ and Syunik obsidians enter the area via west-east and north-south paths, respectively (Barge et al. 2018: Fig. 7).

3.2. Early Chalcolithic

3.2.1. Northwestern Iran

The predominant sources of obsidian on sites in northwestern Iran (such as Kul Tepe, Dava Göz) are located around Lake Sevan in Armenia, while the Meydan Dağ and Nemrut Dağ in eastern Turkey are subordinate (Abedi *et al*. 2018a and 2018b: Table 3; Khademi Nadooshan *et al.* 2013: Table 2; Maziar and Glascock 2017: Table 2).

3.2.2. Central Zagros

During the Early Chalcolithic, a few studies have been conducted in the Central Zagros indicating that Nemrut Dağ was an important source of obsidian. This is different from the sources for tobsidian on sites in the northwestern Iran (Renfrew *et al*. 1966; Renfrew et al. 1968; Abdi, 2004; Wright, 2005). In the northwest of Zagros in Iraq, the situation is similar to the Central Zagros, where the sources around Lake Van (specially Nemrut Dağ) are the main sources of obsidian (Barge et al. 2018: Table 7; Khalidi *et al*. 2016).

3.2.3. Kurdistan Province

The source of Early Chalcolithic (Namashir V) obsidian artefacts on the Namashir site in northwestern Kurdistan province is Meydan Dağ. The suggested importing path has a north-south direction passing west of the Lake Urmia (Saed Mucheshi et al., 2021).

Fig. 3. Obsidian artefacts used in this study.

4. Obsidians of the Late Chalcolithic period in northwestern Iran, Kurdistan province and Northwest Zagros in Iraq

4.1 Late Chalcolithic 1 (LC1)

In earlier publications, the Chalcolithic period was divided into three categories of Early, Middle and Late. But more recently, it has been subdivided into Early and Late Chalcolithic periods. The dominant tradition of the Early Chalcolithic potteries in northwestern Iran, east of Central Zagros and Kurdistan province is the Dalma tradition. Later, it changes to Pisdeli and Seh Gabi in northwestern Iran and Central Zagros, respectively, which correspond to the LC1 (Renette and Mohammadi Ghasrian 2020).

4.1.1. Northwestern Iran

The Kushali and Pisdeli sites located west and south of Lake Urmia are characterized by the occurrence of LC1 obsidians. The obsidian artefacts from Kushali Tepe and Pisdeli Tepe are mainly from the Meydan Dağ source (Chataigner 1998; Renfrew *et al.* 1966; Renfrew and Dixon 1977, Table 1). These studies propose that during the LC1 period the path in northwestern Iran and especially to the west of Lake Urmia was used to import obsidian from the Meydan Dağ source to the Iranian plateau. On sites located north and east of Lake Urmia, the origin of obsidian artefacts is mainly from sources around Lake Sevan. Examples include obsidian artefacts from the Kul Tepe (Abedi *et al.* 2018b), the Dava Göz (Abedi *et al.* 2018a) and south of the Araxes River (Maziar and Glascock 2017). Due to the short distance of these sites from the Syunik source, most obsidian artefacts came from this source (Abedi *et al.* 2018a, 763). In addition, some obsidian artefacts related to the Lake Van sources are present and are mostly from Meydan Dağ instead of Nemrut Dağ. In relation to the latter case, we refer to the Dava Göz site (Abedi 2016; Abedi *et al.* 2018a, Table 3).

4.1.2. Northwest Zagros

Nemrut Dağ and Meydan Dağ are the main sources of Late Chalcolithic obsidian artefacts on the Surezha site located in NW of Zagros (Khalidi *et al.* 2016, Tables 2). Sources of obsidian artefacts recovered from the site of Tell Nader located inthe same area have been attributed to Nemrut Dağ (Carter et al. 2013: 34 and fig. 30). This is in contrast to the obsidians observed in the north and west of Lake Urmia in northwestern Iran.

4.1.3. Kurdistan Province

LC1 obsidian artefacts from the Namashir (phase IV) site are from the Meydan Dağ source with an importing path through northwestern Iran. However, the obsidian from the Galali site that is contemporaneous to Namashir IV is from the Nemrut Dağ source (Saed Mucheshi et al., 2021). The

Galali site is located in southeastern Kurdistan province in the vicinity of Central Zagros with the pottery tradition of Seh Gabi common in the east of Central Zagros (Saed Mucheshi et al., 2021).

4.2. Late Chalcolithic 2-5

4.2.1. Central Zagros, Northwestern Iran and NW Zagros

Following the LC1, in the eastern half of the Kurdistan province and East of the Central Zagros, the pottery traditions of Godin VII and VI prevailed. These traditions are contemporaneous to the chaff-tempered/faced pottery tradition in northwestern Iran and northern Mesopotamia (Renette and Mohammadi Ghasrian 2020; Abedi et al. 2014; Stein et al. 2013).

Despite the presence of Late Chalcolithic (LC 2-5) obsidians in northwestern Iran, no studies have been done on Late Chalcolithic obsidian artefacts in the Central Zagros. Obsidian studies in the northwestern region of Iran (Dava Göz, Kul Tepe, Kohne Tepesi, Kohneh Pasgah Tepesei and Yanik sites) show that they are mostly from the Syunik (Armenia) and obsidian from the Meydan Dağ source is subordinate (Barge et al, 2018; Abedi et al. 2018a, b; Khademi Nadooshan et al. 2013; Maziar and Glascock 2017; Renfrew and Dixon 1977; Renfrew et al. 1966). However, the site of Tepe Rick Abad is an exception due to its geographical location at the southwestern end of the northwestern region of Iran close to Kurdistan province. This site is connected to Mesopotamia through the Tamarchin/Haji Omran natural path. Therefore, the obsidian artefacts are from the Nemrut Dağ source (Binandeh et al. 2020). This provides evidence supporting the importance of proximity to Mesopotamia for importing obsidian from different resources. In Tell Nader in NW Zagros during the LC 1-3, Bingöl and/or Nemrut Dağ are the main sources (Carter et al. 2013).

4.2.2. Kurdistan Province

A recent study of eight obsidian tools from the Kurdistan province belonging to LC 2 period (5 from Namashir and 3 from Ghazikhan sites) shows the appearance of obsidian from sthe Nemrut Dağ and Meydan Dağ sources around Lake Van and the Syunik sources around Lake Sevan ion these sites. Four analyzed artefacts are from Nemrut Dağ, two are from Meydan Dağ and two are from the Syunik sources (Saed Mucheshi et al., 2021).

5. Materials and Methods

Fifteen obsidian artefacts from Layer III (Late Chalcolithic 2-3) at Tepe Gheshlagh were selected for study by energy dispersive X-ray fluorescence (ED-XRF). Thirteen of the studied artefacts ranging in size from 1x2 cm to 4x4 cm are shown in Fig. 3. Measurements were conducted in Tehran by D. Steiniger using a portable XRF device (Thermo Scientific Niton XL3t 950-HE GOLDD+ Serial nr. 89086) equipped with an Ag node operating at 50 kV and silicon drift detector. The XRF was operating in the Test All Geomode using an 8 mm aperture and 360 second measuring time. To ensure data reliability,

standard reference materials NIST2780 and NIST2709a were used for quality control. Although the factory calibration was used to measure up the 26 elements shown in Table 3, the most reliable elements for assigning provenance are usually Rb, Sr, Y, Zr, and Nb (Glascock, 2020). However, in this study the ability to measure additional elements (especially Mn and Fe) proved to be advantageous.

The well-known geochemical similarity of Nemrut Dağ to Bingöl-A has been a challenge in many previous studies when relying on limited suites of elements (Barge et al. 2018; Gratuze et al. 1993; Khalidi et al. 2009). Although studies using additional elements (Blackman 1984; Frahm 2012; Glascock 2020) have proven that differentiation is possible. Therefore, in order to supplement the pXRF measurements on the artefacts in this study, a collection of source samples from Bingöl-A, Bingöl-B, Meydan Dağ, and the Nemrut Dağ (Sıcaksu subsource) were analyzed at the University of Missouri Research Reactor (MURR) as shown in Table 4. A table top XRF spectrometer (Thermo Quantx ARL) operating at 35 kV was used to measure Mn and Fe along with the usual elements Rb, Sr, Y, Zr, and Nb. The XRF at MURR was calibrated using a suite of samples from 40 different sources (Glascock 2020).

Table 3. Element compositions (ppm) and source assignments for the recovered obsidians.

	L3 4 1	L3 4 2	L3 4 3	L3 1 1	L3 1 2	L3 2 1	L3 2 2	L3 3 1	L3 3 2	L3 5 1	L3 5 2	L3 6 1	L3 6 2	L3 7 1	L3 8 1
Source	Meydan Dağ			Nemrut Dağ (Sıcaksu subsource)											
Al	76686	77840	86138	49777	61759	63255	56912	63344	59270	65311	70498	63020	70772	68806	71902
Fe	10318	10159	11182	19440	22030	22468	20576	20896	20727	20512	21680	20648	22726	22606	20924
Mn	384	353	366	461	385	384	447	470	406	470	454	417	411	393	383
Mg	4531	3830	5007	0	0	0	0	0	0	0	0	0	0	0	0
Ca	3855	3789	4069	1104	1373	1292	1219	1493	1543	1777	1626	1342	935	1149	1430
K	39356	38882	42502	34831	39262	42102	38537	37538	36910	37224	39305	37678	41894	41917	38783
P	74	59	91	0	0	0	0	0	0	0	0	0	0	0	0
S	154	141	261	50	105	56	54	99	107	250	214	68	100	56	67
Cl	1100	1067	1018	1068	1496	1324	1181	1285	1283	1616	1690	1235	1293	1376	1311
V	4	10	4	15	20	24	21	21	23	26	22	21	18	23	22
Cr	35	35	30	51	57	55	57	62	57	58	56	56	51	50	58
Co	0	0	0	31	0	8	22	2	0	0	0	12	0	0	0
Ni	0	1	0	16	3	1	15	19	7	21	17	12	9	7	14
Cu	3	3	-7	15	9	8	14	16	11	17	17	14	9	11	8
Zn	68	65	66	152	170	171	165	164	161	158	174	159	177	176	167
As	3	3	3	20	21	22	22	23	22	22	21	20	22	23	22
Rb	196	196	216	203	225	233	211	216	212	211	218	206	225	221	217
Sr	21	20	22	2	1	1	1	1	1	1	1	1	1	1	0
Y	51	52	56	115	128	127	119	122	118	121	124	115	126	122	125
Zr	287	293	312	1276	1390	1400	1296	1352	1331	1348	1371	1271	1393	1358	1371
Nb	29	28	32	54	57	59	56	57	58	58	60	55	59	57	58

Pb	31	29	32	27	29	31	30	30	30	28	31	29	31	31	27
Bi	25	27	30	28	30	30	28	24	28	24	25	24	28	27	25
Th	15	16	19	17	19	18	18	17	18	17	18	16	20	18	17
U	35	35	38	20	26	27	30	31	35	36	38	42	41	42	44
Ce	0	0	0	215	0	0	182	250	57	237	182	109	0	0	55

Table 4. Concentrations of elements measured by XRF in source samples from Nemrut Dağ (Sıcaksu subsource), Meydan Dağ, Bingöl-A and Bingöl-B.

XRF Element (ppm)	Nemrut Dağ Sıcaksu subsource [n=3] mean&stdev	Meydan Dağ [n=15] mean&stdev	Bingöl-A [n=11] mean&stdev	Bingöl-B [n=6] mean&stdev
Mn	413 ± 43	560 ± 101	792 ± 137	390 ± 77
Fe	20029 ± 11106	10349 ± 560	33010 ± 2606	14421 ± 1459
Rb	209 ± 11	205 ± 9	230 ± 11	225 ± 12
Sr	0.8 ± 0.2	16 ± 5	2.3 ± 1.4	25 ± 4
Y	112 ± 5	51 ± 2	135 ± 7	30 ± 3
Zr	1292 ± 54	276 ± 10	1370 ± 100	311 ± 18
Nb	60 ± 4	32 ± 2	63 ± 5	21 ± 3

6. Results

The artefact data are presented in Table 3 and the source data are summarized in Table 4. A scatterplot showing the concentrations for Fe versus Zr in the Tepe Gheshlagh artefacts is shown in Fig. 4 where 90 percent confidence ellipses for the sources Nemrut Dağ, Meydan Dağ, Bingöl-A and Bingöl-B are indicated. Based on this figure, three of the artefacts in Table 3 are assigned to Meydan Dağ and the remaining twelve are from Nemrut Dag. None of the artefacts were assigned to Bingöl-A or Bingöl-B.

The results clearly support that Meydan Dağ and Nemrut Dağ artefacts were found at Tepe Gheshlagh. Both sources are located in the Lake Van region.

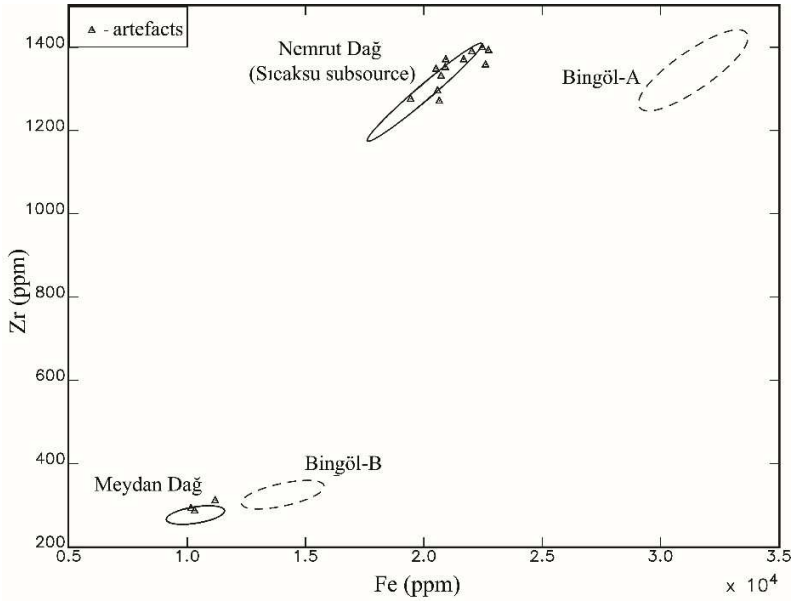

Fig 4. Scatterplot of Fe versus Zr from ED-XRF showing the sources for obsidian artefacts from Tepe Gheshlagh. The artefact groups are surrounded by 90 percent confidence ellipses.

7. Discussion

Neolithic period studies in the Zagros show that from the Early to Late Neolithic period Nemrut/Bingöl A are among the most important sources of obsidian. This can be seen in different regions of Zagros such as Northwest of Zagros in Iraq, Central Zagros, Southwest Zagros and Southern Zagros (Barge et al. 2018). The Mesopotamian-Zagros path has been suggested as one of the main possible paths for importing obsidian from mines to archaeological sites (Barge et al. 2018; Roustaei and Gratuze 2020; Darabi and Glascock, 2013). The situation is different in the northwestern region of Iran. In this region, due to the shorter distance, the nearest sources are Syunik in Armenia and Meydan Dağ in Turkey (Barge et al. 2018: Table 6). From the Neolithic to the Late Chalcolithic period in northwestern Iran, the main sources were near Lake Sevan (Abedi et al. 2018a, 2018b; Barge et al. 2018). The northwestern region of Iran isnearest to the sources located around Lake Sevan in Armenia and Lake Van in Turkey. Therefore, these are the main sources for obsidian artefacts found in this part of Iran. Obsidian from the sources around Lake Sevan and Lake Van entered northwestern Iran from the north-south and west-east routes, respectively.

Studies of obsidian from the Neolithic and Early Chalcolithic periods in the Central Zagros region show that the obsidian was imported from eastern Anatolia and the proposed path for the arrival of them through Mesopotamia has been proposed (Renfrew and Dixon 1977; Renfrew et al. 1966; Renfrew et al.

1968; Darabi and Glascock 2013; 1986; Zeidi and Conard 2013; Khazaie et al. 2014; Barge et al. 2018: 306).

Unfortunately, our knowledge of the Central Zagros region is very incomplete. No obsidian has been analyzed from Late Chalcolithic period sites in this region, but obsidian from the earlier Chalcolithic that were analyzed are from the sources around the Lake Van (Abdi 2004; Wright 2005, Barge et al. 2018). These data are comparable to our results from Tepe Gheshlagh.

Assuming that the Mesopotamian path to the Central Zagros was used to transfer obsidian in the Late Chalcolithic period as in older periods, we can also consider using this path for importing obsidian to Tepe Gheshlagh. In addition, the short distance between Gheshlagh site and Central Zagros, the similar pottery tradition and the different results from obsidian studies in northwestern Iran are other evidence to support this conclusion. Several pieces of Mesopotamian-type buff (Ubaid) pottery are found at the Gheshlagh site belonging to the Chalcolithic, indicating communication between the regions (Sharifi 2019). In Northwest Zagros, unlike northwestern Iran, the use of resources from eastern Turkey (Nemrut Dağ and Meydan Dağ) is predominant (Khalidi et al. 2016; Khalidi et al. 2009), which is similar to what has been observed in Tepe Gheshlagh.

Comparison of the obsidian artefacts recovered from different archeological sites inthe Kurdistan province is important. Tepe Gheshlagh and Tepe Galali are close to the Central Zagros but Tepe Namashir and Ghazikhan are in northwestern Iran. The latter two sites are located in northwestern Kurdistan province and 200 km away from Tepe Gheshlagh. While their cultural traditions are different, their sources of obsidian are most similar. Chaff-faced pottery tradition, similar to northwestern Iran and Mesopotamia is common at Namashir and Ghazikhan, while the Godin VII and VI tradition similar to the Central Zagros is common at Tepe Gheshlagh and Tepe Galali. With regard to the obsidian artefacts, the sources for artefacts at the Gheshlagh site are similar to those at the Namashir and Ghazikhan sites. Obsidians found on the two latter sites are mostly from Nemrut Dağ and Meydan Dağ sources but minor obsidians from the sources around Lake Sevan have also been reported (Saed Mucheshi et al. 2021). Two reasons can be suggested for the presence of obsidian from the sources around Lake Sevan on the Namashir and Ghazikhan sites but not at Tepe Gheshlagh. i) the shorter distance from northwestern Iran to Lake Sevan and ii) the similarity of cultural traditions for the Namashir and Ghazikhan sites to other sites in northwestern Iran. In general, it can be said that most of the Late Chalcolithic obsidians from the Kurdistan province were imported from west-to-east using the Mesopotamia path, and the reason for that is the location of Kurdistan province and its proximity to Mesopotamia. In addition to this path, there was a subordinate path with north-to-south direction for the import of obsidian tosites located in northwest of Kurdistan (Saed Mucheshi et al. 2021).

8. Conclusion

Chemical analyzes of 15 Late Chalcolithic obsidians from Tepe Gheshlagh shows that three samples came from Meydan Dağ and 12 came from Nemrut Dağ. Both sources are located north of Lake Van and north of Mesopotamia. There is no previous report of chemical analysis for obsidian artefacts from this period in the Central Zagros. The results for Tepe Gheshlagh are different from northwestern Iran and are more consistent with the results from Mesopotamia. Therefore, the Mesopotamian path is suggested as the main route for the transport of obsidian to Tepe Gheshlagh. It should be noted that in Neolithic and Early Chalcolithic periods, this path has been proposed for the import of obsidian from Mesopotamia to the Central Zagros. Both Mesopotamia and the Central Zagros have large amounts of obsidian imported from Nemrut Dağ and also to some extent from Meydan Dağ. Pottery data also indicates a connection between the site of Tepe Gheshlagh and the Central Zagros.

The results for obsidian studies at other Late Chalcolithic sites in Kurdistan province, which are geographically closer to Mesopotamia and northwestern Iran, are most similar to Tepe Gheshlagh. This issue shows the importance of the short distance to Mesopotamia and its role in the import of obsidian from Mesopotamia in a west-to-east route.

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