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PETROGRAPHY ANALYSIS OF FOURTH MILLENNIUM B.C. POTTERIES AT KUL TEPE (NW IRAN)

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ABSTRACT

Kul Tepe of Jolfa is located at Hadishahr, East Azerbaijan province, northwestern Iran. Kul Tepe is situated near the border of Iran with Azerbaijan and Armenia and, thereby, it assumes particular importance in terms of the study of communications with these areas. This site is among the few prehistoric areas of East Azerbaijan province, which has witnessed continuous chronology since the 5th millennium BC until the start of historic when it experienced systematic archaeological excavations. During two seasons of archaeological excavation, evidences such as pottery, architecture, stone tools and etc., relating to late Chalcolithic age and early Transcaucasia culture were found. Due to the complex issues on the expansion method of this culture in Near East, the potteries of this area withhold significant importance to be studied. The availability of absolute dating from Kul Tepe and also the absence of any gap between these two periods added to the significance of present work. Therefore, ten characteristic potsherds from Late Chalcolithic and ten potsherds from Early Transcaucasia culture (Kura-Araxes) were studied by thin section microscopic (petrographic) method. These potsherds had been obtained during the excavations on Kul Tepe. It has been revealed that the combination of them is consistent with the soil of the area and, thereby, the potsherds of Kul Tepe have been locally produced although they show some differences in terms of technical issues and temper.

KEYWORDS: *Late Chalcolithic Age, Early Bronze Age, Kul Tepe, petrography, East Azerbaijan*

1. INTRODUCTION

One of the most important topics in the archeology of Near East is the traditional potsherd emergence in this area with characteristic features which are totally different from that of the previous period. This culture is known as Kura-Araxes and is expanded in a large area from north-eastern Iranian plateau to the eastern coasts of the Mediterranean Sea (Fig. 1). Evidence of this culture has been found in Iranian plateau (Fazeli & Ajourloo, 2004; Mousavi Kouhpar, 2008; Mousavi Kouhpar & Abbasnejad, 2007; Khazaie Kouhpar, 2011; Fahimi, 2005; Piller, 2012; Young, 1969; Howell, 1979; Mason & Coper, 1999; Motarjem, 2008; Khaksar, 2006; Burton-Brown, 1951; Alizadeh & Azarnoush, 2003; Burney 1962, 1964, 1975; Maziar, 2010), in Levant region (Batiuk, 2005; De Miroschedji, 2000), in North Caucasus, Dagestan, and Chechnya (Burney & Lang, 2007: 13-76; Jaimoukha, 2005; Sagona, 1984), and in the Northeast and East of Turkey (Sagona & Zimansky, 2009) (Fig. 1). This culture is known with different aboriginal names such as Early Transcaucasia, Kura-Araxes, Yanik, Karaz, Khirbet Kerak, and Shengavit (Alizadeh, 2010). Then, it was spread to adjacent areas during the second period of this culture (early Transcaucasia II) (Burney & Lang 2007, Ajourloo, 2004).

The following are among the basic questions about the way Kura-Araxes culture has spread: Has this phenomenon been the result of emigration from Transcaucasia? Or has it been the result of technology of metallurgy trade and/or mining trade and/or the import of the potsherds pertinent to this culture by people from other places? Have these tools been made in Anatolia, the Levant, Iran, and other places

by local potters in aboriginal and local manners only through the imitation of exotic styles or have they been brought to the area by immigrants from the Caucasus to the region? Or have all of these developments occurred in different areas at different periods of time? (Batiuk & Rothman, 2007).

Several theoretical approaches have been raised in connection with the development and spread of Kura-Araxes culture. These approaches include immigration, trade, and consequently the release of hand-made tools and their styles and/or imitation or replication of the tools by local builders. Immigration or "movement of groups or individuals from their first place of living to another one" afford the negative factors of migration source (drive) to the positive factors of destination (pull) (Batiuk 2005). Migration in long-range distance is easily recognizable in archaeological findings because these movements and migrations go beyond the cultural and geographical boundaries. The approach entitled "ripples in a stream" is expressive of the point that the social organizations of immigrant groups had been separately divided into smaller groups which had been derived from a larger population group while they had still retained the cultural similarities of that larger group. Hence some findings of this culture in Iran, especially Zagros are recognized as the characteristic indicators of prehistoric migration (Rothman, 2003; Kohl, 2009). There is another possibility that many of the tools of this culture have been made in Anatolia, Iran or in Transcaucasia and, then, have been traded in other areas; however, releases and innovations also might have been the origin of these changes (Abay, 2005).

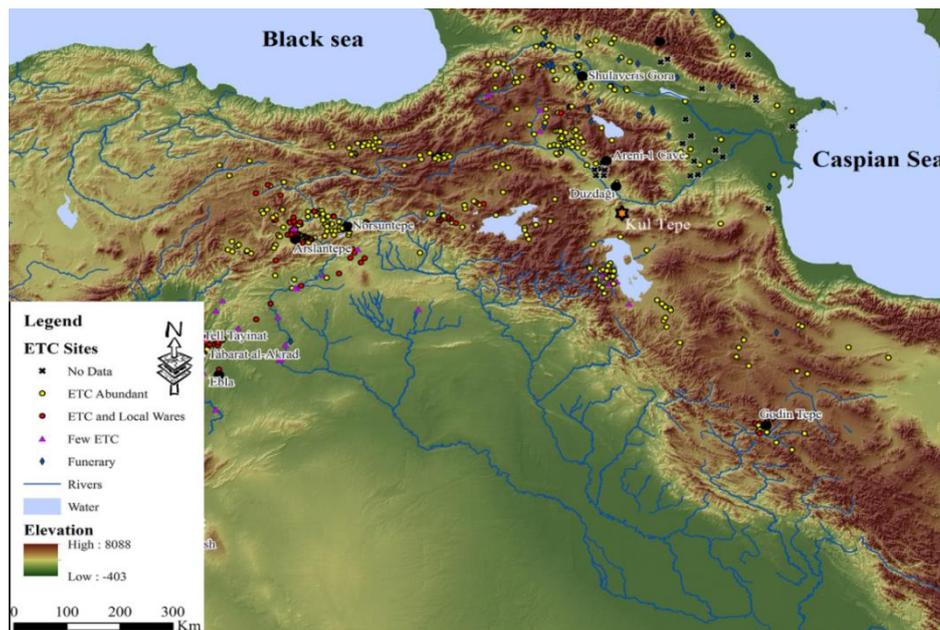


Fig. 1: distribution of Kura Araxes Sites in Near East, Kul Tepe showed in star shape (map after Batiuk, 2013 with some changes).

2. KUL TEPE

Kul Tepe site (E 45 ° 39 '43 " - N 38 ° 50' 19") with a height of 967 meters above sea level is a hill with an area of approximately 6 hectares and a height of 19 meters above the surrounding lands, which is located in Hadishahr city (Fig. 1). It is situated about 10 kilometers from south of the Aras River (Khatib Shahidi & Abedi, 2011).

During two seasons of excavation, some evidence were found from Dalma period (fifth millennium BC), LC1: Post-Ubaid = Pisdeli, LC2: Chaff-Faced Ware, LC3: Chaff-Faced Ware, Kura-Araxes I, early Bronze age, middle and new Bronze age, Iron Age III, Urartian era, and Achaemenid dynasty. Absolute chronology was conducted by carbon 14 (¹⁴C) whose resultant dating can be seen in Table 1.

Table 1: Sequence of the periods at Kul Tepe Jolfa (after Abedi *et al*, 2014).

Kul Tepe Periods	Period	Date cal BC
Kul Tepe VIII	Early Chalcolithic (Dalma)	5000-4500/4400
Kul Tepe VII	LC1: Pisdeli/ Hasanlu VIII/Post Ubaid	4500/4400-4300-4200
Kul Tepe VIB	LC2: Chaff-Faced/Chaff Tempered Ware	4300/4200-4000/3900
Kul Tepe VIA	LC3: Chaff-Tempered	4000/3900-3700/3600
Kul Tepe V	Kura-Araxes I	3700/3600-3200-3100
Kul Tepe IV	Kura-Araxes II, III	3200-3100-2300/2200
Kul Tepe III	Middle Bronze Age (Urmia Ware)	First half of 2 nd mill. B.C.
Kul Tepe II	Iron III, Urartian	8-6 th centuries B.C.
Kul Tepe I	Achaemenid	6-4 th centuries B.C.

3. Fourth Millennium potteries from Kul Tepe (Late Chalcolithic/Early Bronze Age)

In this study, potsherds belonging to late chalcolithic and Kura-Araxes were investigated. We will talk on Kul Tepe potteries according to detailed study in Dr. Abedi's Ph.D. thesis.

(Kul Tepe VII = LC1 = Post-Ubaid Pisdeli Type): The potteries of this period are mainly placed in the color spectrum of buff, red brick, red, brown, gray, black, plum, pink, orange, and soot-covered potteries. Almost all these potteries (99 %) are handmade so that only a very few of them (1 %) have some traces of low-speed pottery wheel. In terms of temper, they also often have a combinational temper (85.5%), temper organic (12.7%), and inorganic temper (1.8%). Some of these potteries have sufficient heat (47.02%) while some others do not (52.98%). In terms of decoration, those potteries decorated with groove or shoulder, geometric painted pottery, and pottery with added and engraved relief take up the highest frequency. However, the main portion of the potteries of this period are simple without relief (80.1%).

Kul Tepe VIB = LC2 = Chaff-faced Ware: In terms of color, this type of pottery also is mainly found in red brick, gray, beige, red, black, brown, light and sooty brown, pink, and orange. All types of these potteries are hand-made like those of the previous period. In terms of the type of binder, the highest frequency belongs to combinational temper (91.6%), although some potteries with organic temper (7.09%) and inorganic temper (1.31%) exist among the pottery collection. About 54.51 % of this type of pottery has sufficient heat and 45.49% of it does not. In terms of

decoration, those potteries decorated with groove or shoulder take up the highest frequency; and pottery with added and engraved relief and rail-edged decoration stand in next ranks. In most examples of pottery of this period, no decoration is seen (75.66%).

Kul Tepe VIB = LC3 = Chaff-faced Ware: In terms of color, this type of pottery also is mainly found in red brick, buff, gray, beige, red, black, brown, light brown, plum, pink, orange, and soot-covered. All types of these potteries are hand-made like those of the previous period (= 100%). In terms of the type of binder, combinational temper (301 = 76.4%) takes up the highest frequency, although some potteries with organic temper (9 = 2.28%) and inorganic temper (84 = 21.32%) are observable among the pottery collection. The major portion of (288 = 73.09%) of this type of pottery has sufficient heat and the remaining part of it (106 = 26.91%) does not. In terms of decoration, those potteries decorated with groove or shoulder take up the highest frequency; and pottery with added and engraved relief and rail-edged decoration stand in next ranks. In most examples of pottery of this period, no decoration is seen (335 = 85.02%).

Kul Tepe V = Kura-Araxes I: This type of pottery is mainly found in gray, black, red, pale goldenrod brown, and soot-covered. The significant increase of gray type of pottery compared with the previous period is evident here. The majority of these potteries are hand-made like those of the previous period (92.82%) while a small number of them have some traces of pottery wheel (7.18%). In terms of the type of binder, the highest frequency belongs to inorganic temper (98.2%) which shows a significant change compared to the previous period. Due to the frequency of gray and black pottery in this period, the

potteries without decoration makes up the highest frequency among the whole collection (93.72%) and a few examples of them have added (3.14%) and engraved (3.14%) relief. In terms of shape, closed mouth bowls, bowls with vertical walls, necked vessels, and S-shaped bowls take up the highest frequency among the pottery collection.

The morphology of the site: In terms of topography, this site can be divided into two parts, namely highland and lowland & foothill:

The mountainous highland of the area is spread in the east, central part, and somewhat in the North West of the area which is considered one of the highest peaks of Azerbaijan. The thick soil layer which usually covers the rocky units distinguishes the level of these heights by its round hill-like views with the help of the vegetation. The existing valleys in this area are deep and often V-shaped and there is a big height difference between the bottoms of the valleys mountain ridges.

Lowland and *mahoor hill* which is spread in the south and north of the region consists of the lowest points in the vicinity of Jolfa and Aras River and also the lowest elevation in this section is located in the North West of Siahруд. Generally, the land slope is reduced in two northern and southern sides towards Aras River and Marand plain. In the lowland and mahoor section, waterways are also shallow and the height difference between the bottoms of these waterways and the hill ridges is little. In addition to the existing old units, Tertiary volcanic rocks due to their thick and hard rock units also constitute the heights of the area. Shale and Marl formations and Quaternary deposits have also been involved in the

creation of the low points. Although the existing structures have been crushed and distorted or covered due to the infiltration of Oligocene dacite domes and also the coverage of sedimentary units and volcanic structures in the South East of the region, it is recognizable in the few available sound structures that, in old deposits, such synclines as North albino syncline constitute the lowland points and such anticlines as *dareh diz anticline* constitute the highland areas while, in Eocene Flysch deposits, such synclines as south syncline of Siahруд have created high points.

4. GEOLOGY

The area under study which is located in the North West of tectonic unit of Alborz-Azerbaijan has a general trend from North-West to South-East which is separable into two flysch and platform parts based on the type of exposed rocks and their facies. The oldest rock units available in the area are related to Mesozoic Era. These units are generally thin layers of limestone, gray and thick layers of limestone, dolomitic rocks, and conglomerate deposits.

In Cenozoic Era, the sediments obtained from previous rocks and the rocks obtained from volcanic activities entail a vast expanse in the area. This sedimentary-volcanic series generally entails all the time periods related to Tertiary in the region wherein the highest volume is related to the Eocene. Conglomeratic rocks, silt and marl deposits, sandstone, marl, volcanic rocks, and pyroclastic rocks are available in most parts of the area.

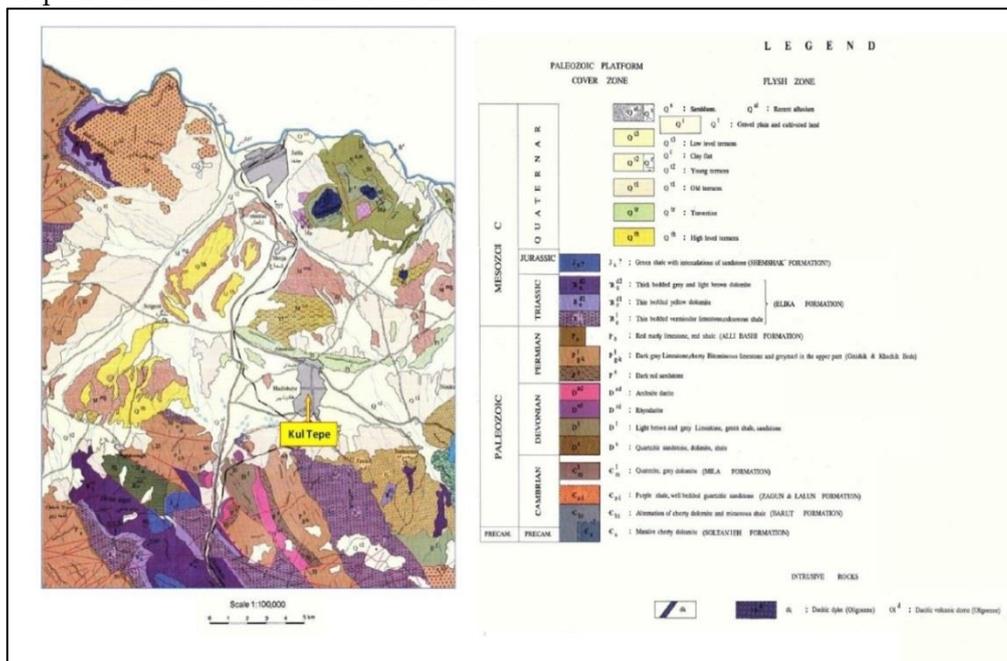


Figure 2: Geologic Map of Hadishahr

Volcanic rocks of andesite exist among pyroclastic deposits of the Eocene Era. This volcanic unit has been expanded in Zenouz *Chay* Valley, Ghareh Tepe, old Isaac, and the north of Yamchi located in the South West of the area. Plagioclase phenocrysts, pyroxene, and amphibole constitute the main minerals of this volcanic rock.

The above-mentioned Eocene pyroclastic unit is widely spread in the South and South West of the region, particularly from the north of Yamchi to old Isaac, and also from Sambrun to Zenouz. The rubbles and pieces existing in this unit are generally made up of oligoclase and dacite and tuff parts can be also seen in the unit. Oligocene dacite volcanic rocks in the area are visible more in the form of dacite domes. These domes have caused the swelling of their surrounding lands and also the fragmentation and breakdown of the natural process of older rocks through the creation of Kiamaki Dagh, Qlynj, Uch Tappeh, and other mountain peaks and in the East and central parts. Dacite rocks have porphyritic textures in microgranular context and feldspar, biotite, amphibole and pyroxene, epidote, and zeolite are its porphyries. In addition, alluvial terraces with silt to conglomerate degrees and low hardening levels are seen (Fig. 2).

5. PETROGRAPHIC STUDY OF CHALCOLITHIC POTTERIES

The ten potsherds were chosen according to their typology and cultural phase and belong to Chalcolithic age and along with Proto Kura-Araxes phase potsherds both obtained from Kul Tepe excavations were sent to the Institute for Conservation and Restoration of Iranian Cultural Heritage Organization to be examined (Fig. 3: upper level). Among these potsherds, the samples numbered 1, 2 and 3 were of Pisdeli typology (LC1) in which the pottery numbered 1 was in buff color and wheel-made, the pottery numbered 2 was light brown and hand-made, and the pottery numbered 3 was red. The samples numbered 4, 5 and 6 are brown and gray and from Proto Kura-Araxes. The samples numbered 7 and 8 are from late Chalcolithic II (LC2) and in orange and pink with straw temper and view (chaff face / Chaff tempered) and the samples numbered 9 and 10 are from late Chalcolithic III (LC3) in buff and brown. All samples except No. 1 are handmade. Potsherds have microcrystal structures and it is not possible to easily recognize their components with naked eye. Their thickness is variable within the range of 5 to 15 millimeters.

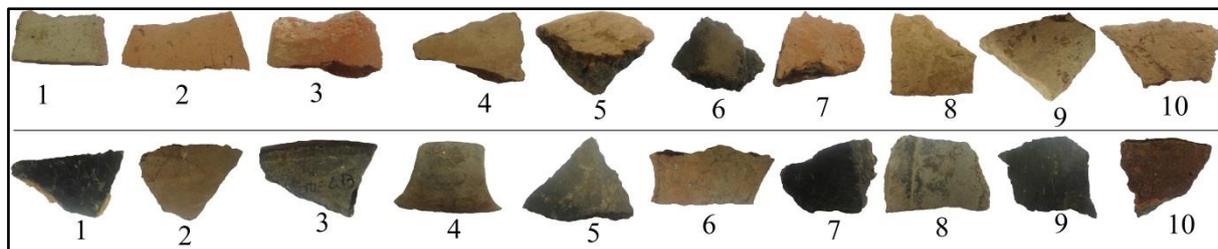


Figure 3: Pottery sample from Kul Tepe: upper level from Chalcolithic and Proto Kura Araxes; lower level from Kura-Araxes I

5.1 Microscopic study

For the microscopic study of the potteries, two-photon polarization microscopy (James Swift model) was used. The magnification types of 4X and 10X

were employed in this study. For the ease of achieving the petrographic results, the results have been presented in Table 2.

Table 2: Results of petrographic studies of Chalcolithic potteries in Jolfa Tepe, Hadishahr

Number of Sample	Qz (Clean)	Qz (Cloudy)	Plg	Am & Py	Fe-oxid	Mic	Cc(Mic)	P.Rock V.Rock	Grog	Texture
Kul Tepe-1	*	*	*	-	*	-	*	-	-	Silt
Kul Tepe -2	*	*	*	*	*	*	*	Tr	*	Silt
Kul Tepe -3	*	*	*	*	*	-	-	*	-	porphyries
Kul Tepe -4	*	*	*	*	*	-	*	*	*	porphyries
Kul Tepe -5	*	*	*	-	*	*	*	Tr	*	Silt
Kul Tepe -6	*	*	*	*	*	-	*	-	*	Silt
Kul Tepe -7	*	*	-	-	*	-	*	-	*	Silt
Kul Tepe -8	*	*	-	*	*	-	*	-	-	Silt
Kul Tepe -9	*	*	*	*	*	-	*	-	*	Silt
Kul Tepe -10	*	*	*	*	*	-	*	*	-	porphyries

The potteries under study were in the color spectrum of light brown to dark brown and in some cases they were bi-colored. This means that they have lighter margins compared to the center of pottery. Only sample No. 6 (Kul Tepe -6) has a dark-colored background. These potteries show two general isotropic and anisotropic structures in background. Isotrope is a state that does not undergo any changes in color with the full rotation of the microscopic table and remains quite dark. Isotrope is a state in which the background of pottery brightens four times or darkens four times with a full and 360-degree rotation of the microscopic table.

The samples numbered 5 and 10 have anisotropic backgrounds while the other ones have isotopic backgrounds.

In terms of texture or petro-fabric, two categories are recognizable as seen in table 2. One category is of silt textures which itself is divided into two groups of microcrystal silts and heterogeneous and coarse crystals. The other category of potteries have porphyritic textures. As it can be observed in the table; quartz, plagioclase, amphibole, iron oxide, and microcrystalline calcite are present in all the samples. However, it is noteworthy that the frequency of each of these components is different in each sample.

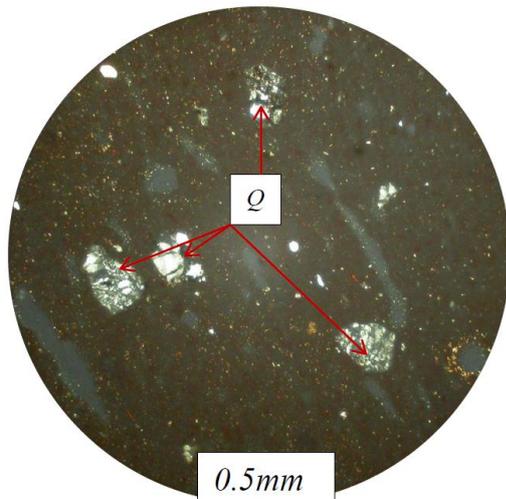


Figure 4: Photomicrograph, Kul Tepe -1, light XPL, field of vision length 2.7mm, phenocryst and polycrystalline quartz mineral. Background is homogeny and isotropic; empty space is linear and dark.

Sample No. 1 (Kul Tepe -1): This sample is quite different from the other samples in terms of structure. It contains a very small, homogeneous, and isotropic background and the mineral fragments of quartz, plagioclase, and iron oxide exist in it in porphyritic (coarse crystals) and scattered formats. In this sample, quartz exists in two forms of phenocryst and polycrystalline (Fig. 4). The size of the constituent components does not exceed 0.5mm. The remarkable point about this sample is the presence of

initial remains of macro-crystal calcite which have disappeared as a result of heat and some margin has been left from them (Fig. 2).

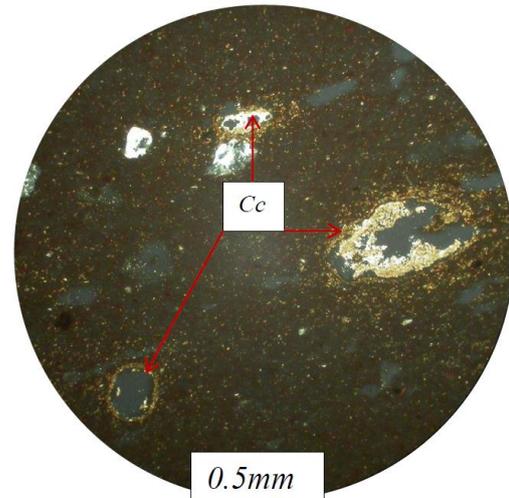


Figure 5: Photomicrograph, Kul Tepe -1, light XPL, field of vision length 2.7mm, The remains of calcite that destroyed by heat and just its margin is visible.

Samples Nos 2, 5 and 8: These samples are almost similar. They contain a silt texture and calcite is abundantly seen in these samples. This mineral is found in macro- to micro-crystals and also in combination with the background (Fig. 6). From among the other constituents of these samples, quartz, plagioclase, and amphibole along with grog fragments, plagioclase, and amphibole can be named (Fig. 7). In these samples, quartz exists in form of phenocryst and polycrystalline; furthermore, this mineral contains angular to semi-circled margins. The size of the constituent components does not exceed 0.5mm in these samples.

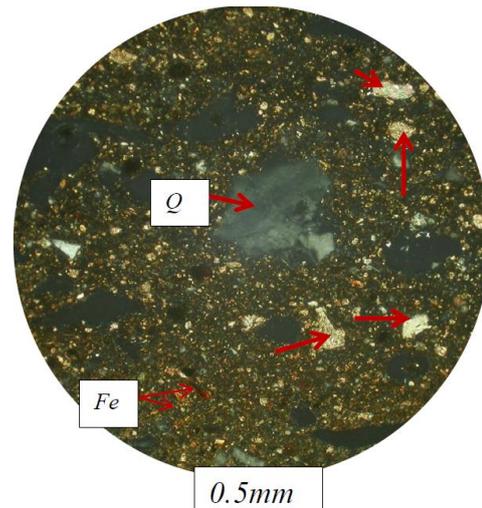


Figure 6: Photomicrograph, Kul Tepe -2, light XPL, field of vision length 2.7mm, Components of the picture that can be seen with brightly colored are calcites that are as plenty of fine crystal in background. In the center of the image, mineral quartz is in coarse gray crystal. Empty space is dark in this image.

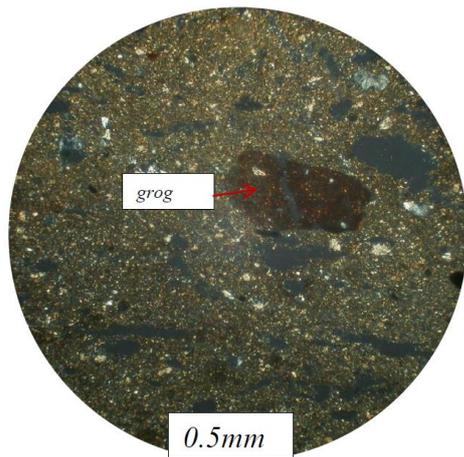


Figure 7: Photomicrograph, Kul Tepe -5, light XPL, field of vision length 2.7mm, silt piece (grog) is in center of image with dark color. Background is comprised of clay minerals associated with fine carbonate

The other category of these potteries includes the samples numbered 3, 4 and 10 (Kul Tepe -3, 4, 10). These samples contain porphyritic texture (Fig. 8) and heterogeneous backgrounds. In these samples, there exists an abundance of outer and inner igneous rocks (pyroclastic) (Fig. 9); quartz, plagioclase, and pyroxene (Fig. 10); amphibole and calcite (Fig. 11); and grog fragments and iron oxide. The size of macro-crystal pieces is higher than 1 mm. in sample No. 10, plagioclase is found more frequently than the other constituents.

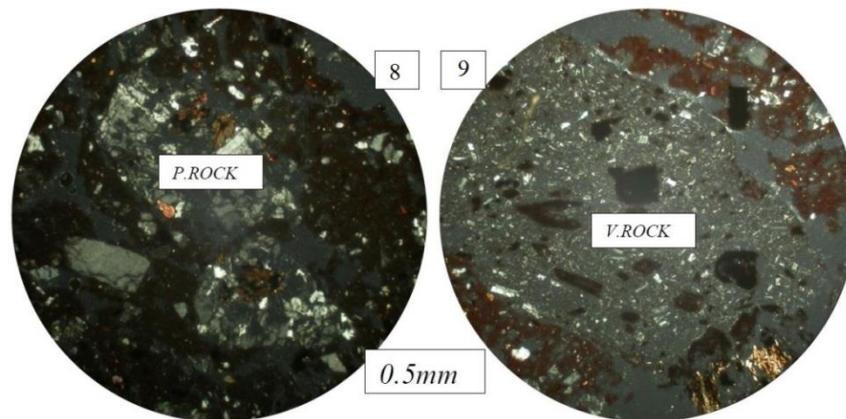


Figure 8: Photomicrograph, Kul Tepe -3, light XPL, field of vision length 2.7mm, The remains of Intrusive igneous rock (P. Rock) with fine crystal of mineral quartz is in the center of image.

Figure 9: Photomicrograph, Kul Tepe -3, light XPL, field of vision length 2.7mm, The remains of Extrusive igneous rock (V. Rock) are in the center of image. The size of the components can reach up to 3 mm. In this image, a dark-colored iron oxide mineralization seen

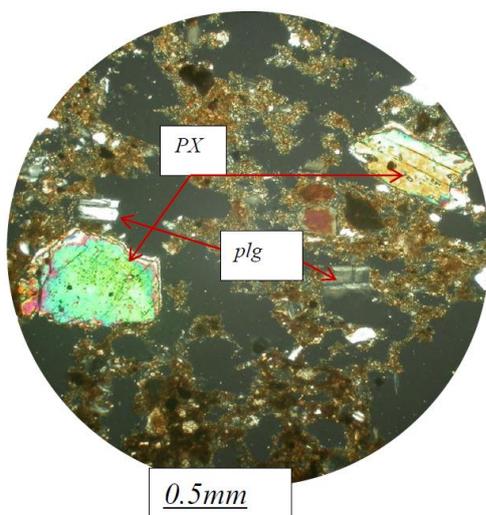


Figure 10: Photomicrograph, Kul Tepe -10, light XPL, field of vision length 2.7mm, Mineral pyroxene (PX) with Plagioclase (Plg) and iron oxide

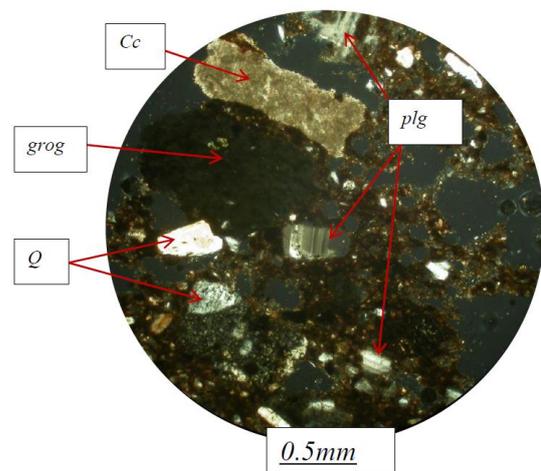


Figure 11: Photomicrograph, Kul Tepe -10, light XPL, field of vision length 2.7mm, Calcite (Cc), silt piece (grog), quartz (Q) and Plagioclase (Plg) are visible in Microcrystals background.

Samples numbered 6 and 7 (Kul Tepe -6 and 7): These two samples contain macro-crystal silt textures and the macro-crystal components (porphyry) are mainly silt and grog fragments (Figs. 11 & 12). The remarkable point about these two samples is the presence of very limited amount of plagioclase minerals while it is abundantly found in other samples.

Number 6 & 7 have large crystal silt texture. In these samples, most of large crystal components (Porphyry) are silt and grog pieces (Fig 13&12). It is remarkable that at these two samples amount of mineral plagioclase is very low in contrast to other samples.

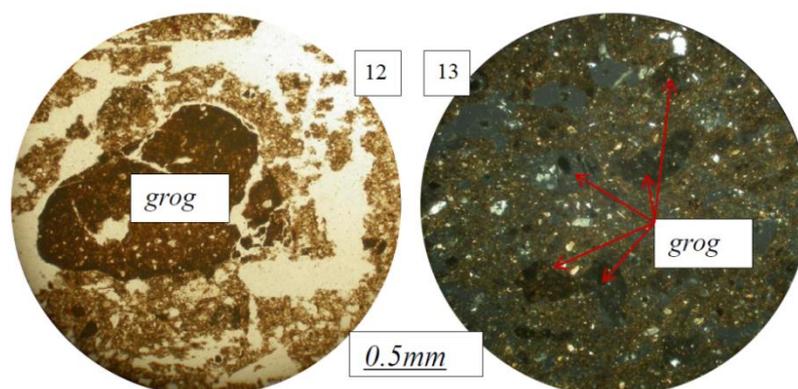


Figure 12. Photomicrograph, Kul Tepe -7, light PPL, field of vision length 2.7mm, Dark silt piece in the center and empty spaces are in light color.

Fig. 13. Photomicrograph, Kul Tepe -6, light XPL, field of vision length 2.7mm, Dark silt pieces with Microcrystalline quartz (this mineral is in light color).

6. PETROGRAPHIC STUDY OF BRONZE AGE POTTERIES

Kura-Araxes pottery I is found in brown, gray, orange/pink, and black. In the samples numbered 1 and 10, the margins are darker than the internal parts while the margins are brighter than the central parts in the pottery samples numbered 4, 5, 6, and 7. The samples numbered 3 and 8 are only in gray. The thickness of these two samples is variable from 5 to 15 mm.

6.1 Microscopic study

The results of petrographic study on Kul Tepe potteries of the Bronze Age are presented in Table 3. As it can be seen in Table 3, quartz, plagioclase, amphibole and pyroxene, iron oxide, calcite, and igneous rock fragments are observed in all these samples.

Quartz mineral is found in all samples in the form of microcrystals with angular and semi-circled margins, phenocrysts and polycrystalline. The size of this mineral does not exceed 5 mm (Fig. 14) and its frequency is variable from 10 to 15 percent.

Mineral plagioclase is usually found in gray to light gray, and generally has a twinning tape.

This mineral has the average frequency of 5 to 10 percent (Fig. 15). Calcite is found both in the form of macro-crystals (Fig. 16) and in combination with background. The samples numbered 6 and 8 lack any calcite whereas the highest concentration of this mineral can be seen in the samples numbered 5, 3, and 7. Silt and grog fragments related to the previous potteries exist in some samples (Table 3; Fig. 17).

Table 3: shows the petrographic results of Kul Tepe potteries of the Bronze Age (Hadishahr)

Number of Sample	Qz (Clean)	Qz (Cloudy)	Pig	Am & PX	Fe-oxid	Mic	Cc(Mic)	Cc(Sp)	P-Rock	V.Rock	Sand & Silt Ston	grog	Texture
Kul Tepe -1	*	*	*	*	*	-	-	*	*	*	-	*	porphyries
Kul Tepe -2	*	*	*	*	*	-	*	-	*	*	-	*	porphyries
Kul Tepe -3	*	*	*	*	*	-	*	-	*	*	-	*	porphyries
Kul Tepe -4	*	*	*	-	*	-	*	-	*	*	-	*	porphyries
Kul Tepe -5	*	*	*	*	*	-	*	*	*	*	*	*	porphyries
Kul Tepe -6	*	*	*	*	*	-	-	-	-	*	*	-	porphyries
Kul Tepe -7	*	*	*	*	*	-	*	-	*	*	*	-	porphyries
Kul Tepe -8	*	*	*	*	*	-	*	-	-	-	-	-	silt
Kul Tepe -9	*	*	*	*	*	-	*	-	*	*	-	-	porphyries
Kul Tepe -10	*	*	*	*	*	-	*	-	-	*	-	*	porphyries

Tin these samples, most remaining fragments of rock are from the pyroclastic rocks of the area that are found in the form of volcanic and intrusive rocks along with the remnants of limestone samples (Fig. 18 & 19).

As it is indicated in the last column of Table 3, the dominant texture of most of the potteries is porphyry (macro-crystals) (Fig. 20) while the sample No. 8 (Kul Tepe -8) is the only one with microcrystalline texture (silt) (Fig. 21). In this sample, the size of some of the constituent components reaches up to 0.5 mm which has provided a heterogeneous state for the background of the potteries. In sample No. 8, the

frequency of igneous rocks is less than 5% of the total sample. In this sample, the effects of heat and firing of pottery were found while such effects were not observed in other samples. The evidence for it is found in radial and star-shaped structure, as well as in volcanic glasses. Possibly, these structures and glasses have been created in the potteries of the Bronze Age because they could raise the furnace temperature so that melting process in some parts of the ceramic body and, in consequence, the pottery had been exited from the furnace and had quickly become cold (Figs. 21 & 22).

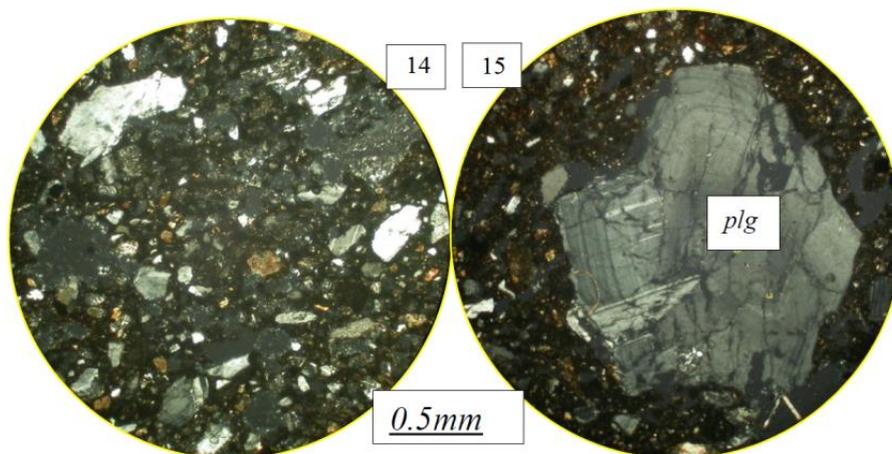


Figure 14: Photomicrograph, Kul Tepe -3, light XPL, field of vision length 2.7mm, plenty of microcrystalline quartz are seen in light gray on dark background. Calcite is dark cream colored in background.

Figure 15: Photomicrograph, Kul Tepe -5, light XPL, field of vision length 2.7mm, A large plagioclase crystal with twinning layer and zoned Building is in center.

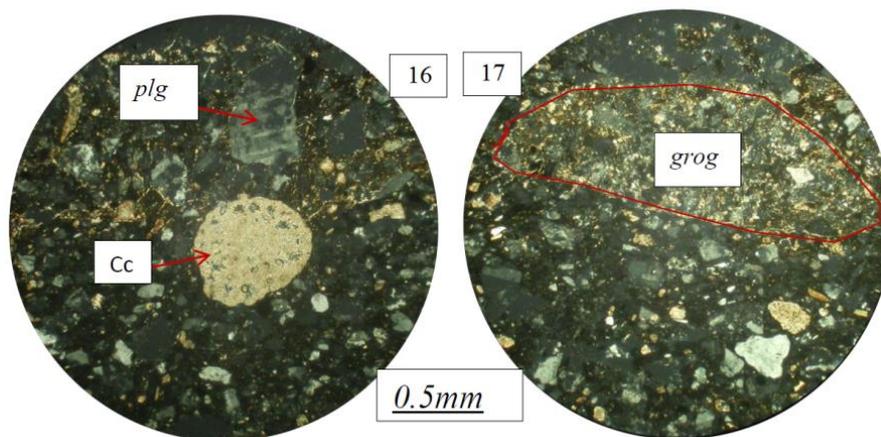


Figure 16: Photomicrograph, Kul Tepe -3, light XPL, field of vision length 2.7mm, large pieces of mineral Calcite crystal in center. In the top of image, a mineral plagioclase piece is visible.

Figure 17: Photomicrograph, Kul Tepe -3, light XPL, field of vision length 2.7mm, large pieces of silt crystal in top of image. There is also microcrystalline quartz and calcite

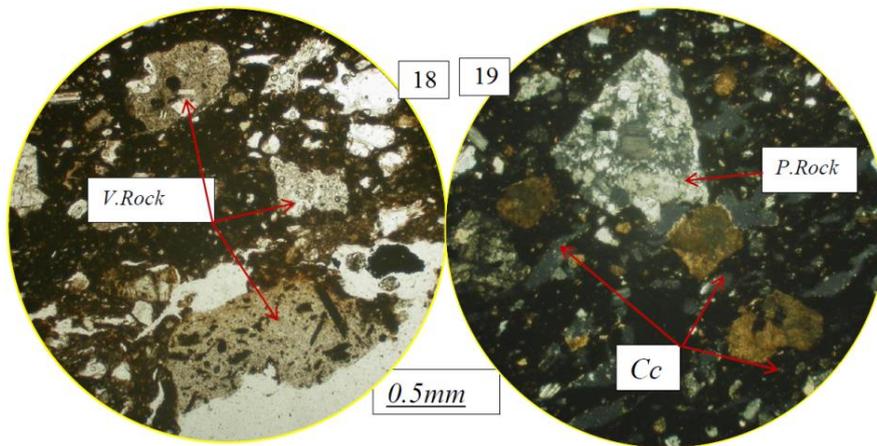


Figure 18: Photomicrograph, Kul Tepe -10, light PPL, field of vision length 2.7mm, The remnants of volcanic rock in pottery

Figure 19: Photomicrograph, Kul Tepe -7, light XPL, field of vision length 2.7mm, The remains of Intrusive igneous rock (P. Rock) with yellow limestone on dark background.

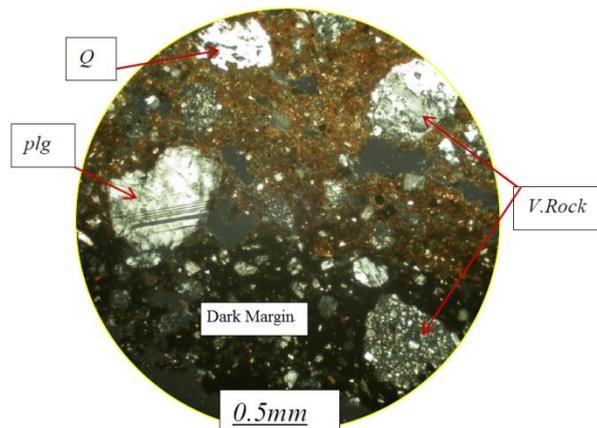
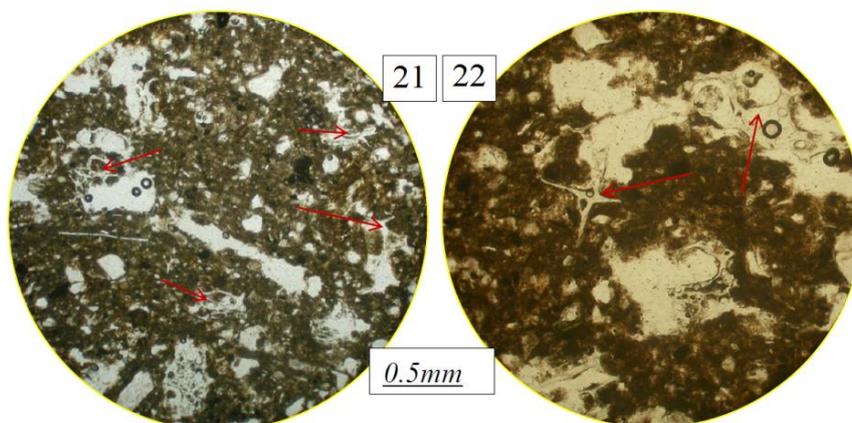


Figure 20: Photomicrograph, Kul Tepe -1, light XPL, field of vision length 2.7mm, porphyry texture that large pieces of Feldspar crystal, quartz and stone pieces are visible. Two-color texture is quite clear, with regard to homogeneity of components between tow section it is because of reduction condition and shortage of oxygen in upper section.



Figures 21&22. Photomicrograph, Kul Tepe -8, light PPL, field of vision length 2.7mm, silt texture, fragments in crescent, star and bubble Shape These fragments are the result of the above-mentioned heat, melting and rapid cooling of samples which have occurred at the time of pottery firing.

7. DISCUSSION AND CONCLUSION

According to the geology of the area, flysch sedimentation basin, volcanic and pyroclastic rocks, limestone, and sedimentary of the kaolin (clay) available in the region which has been created from the alteration igneous rocks, it can be expressed certainty that this pottery has a local origin. It is so because pyroclastic fragments and/or volcanic rocks can be seen in all these samples without exception. However, it should be noted that these potteries are different from each other in terms of the location they have been made and/or their combination in the area and these differences need to be considered.

For example, the pottery No. 1 pertinent to late chalcolithic is one of the differences.

This mineral is found in two forms of macro- and micro-crystals followed by clay backgrounds in the samples with calcite. The existence of this mineral in the components of pottery indicates that the pottery firing temperature is not higher than 800 ° C.

The quartz existing in these samples is micro-crystal, contains angular and semi-circled margins in two forms of phenocrysts and polycrystalline. There is a high level of plagioclase in these pottery samples because of the geological conditions of the area.

The potteries pertinent to late chalcolithic period and the Bronze Age are the same in terms of composition. In addition, as described in petrographic studies, the potteries of late chalcolithic period have often

silt to macro-crystal silt textures and the size of fragments gets bigger and the texture of most potteries becomes porphyry as one moves towards the Bronze Age.

The important point is the existence of volcanic glasses and crescent-shaped and circular fragments in pottery samples of the Bronze Age. These volcanic glasses have been created as a result of the intense heat of the firing and, thereby, the occurrence of partial melting in potteries. As a result of the quick exit of the sample from the furnace, these fragments do not find the opportunity of crystallization and, thereby, remain in the form of glass with crescent-shaped and circular fragments. This state has not been observed in late chalcolithic potteries and can be used as a factor to recognize the potteries of the Bronze Age in the area. In addition, the conduct of complementary studies with such methods as XRF and/or NAA in future is needed to become sure about the determination of the certain location where the soil for making these potteries has been used. However, what is clear from this study is that Kura-Araxes culture has been indigenous in Kul Tepe as a result of the innovations of people living in this area. This is quite possible due to Iran's north-western areas being considered as the core of this culture and the placement of the area in the vicinity of Caucasus.

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