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Mohammad Hossein REZAEI * (Shiraz University, Iran)

Parastoo MASJEDI KHAK** (University of Neyshabur, Iran)

Ali MOTAVALI RAMEH*** (University of Neyshabur, Iran)

Study of Pottery Technology in Kura-Araxes Culture of Astanakroud 2 Site of Kojur County Using Petrographic Method

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Abstract: *The pottery samples under investigation in this study include the findings of the Astankroud 2 Site in the Kojur region of western Mazandaran Province. The site was uncovered during an archaeological survey of the region in 2010 and has been thus far the easternmost site of Kura-Araxes. Considering the importance of discussions concerning the characteristics of this culture and the reasons for its spread in a vast geographic area extending from the southern coast of the Caspian Sea to the eastern shores of the Mediterranean Sea, 15 pottery pieces of Kura-Araxes were subject to petrographic study in order to determine the mineralogy structure of the pottery recovered from Astanakroud Site. The experiments on these pieces were conducted using a polarizing microscope (James Swift) at the Petrographic Laboratory of the Institute for Protection and Restoration of Works affiliated with Cultural Heritage Research. According to the results of experiments, it was revealed that all the pottery had been locally produced. A petrographic study of Astanakroud pottery reveals that the pottery has been produced using soil resulting from erosion of geological structure in the northern part of the Kojur region (with volcanic structure) that has been washed up by natural currents traversing the valleys of Nimvar, Avil, and Kouhpar to the foot of the site.*

Key words: Archeology, History, Iran, Pottery, Kura-Araxes, Bronze Age, Petrography, Astanakroud 2

Introduction

Archaeologists distinguish Bronze Age in Iran and Near East with the emergence of stratified societies, the appearance of states and urbanization as well as a complex set of changes. An important issue in the archaeology of the Bronze Age

* Corresponding Author. ORCID ID: https://orcid.org/0000-0002-5999-1609. mohammad.1561@yahoo.com
** ORCID ID: https://orcid.org/0000-0002-7566-4464. parastomasjedi@yahoo.com
*** ORCID ID: https://orcid.org/0009-0002-2678-7270. motvali2015@yahoo.com

in Iran is a cultural rise in the northwest of the country with unique and completely different characteristics from the previous period. This pottery tradition has dispersed to a vast area from the north of the Iranian Plateau to the Levant and from northern Caucasus, Dagestan, and Chechnya to the Harsin region of Kermanshah, which has been designated with various names such as Transcaucasia, Kura-Araxes, Yannik, Karaz, Khirbet Kerak, and Shengavit.[1] This culture appears to have originated from the region between Kura and Araxes rivers[2] and expanded to adjacent regions during the second period of this culture (i.e. Early Transcaucasia II).[3]

Perhaps the important features of this culture can be mentioned as follows: the round and rectangular architecture of adobe, clay, and sometimes stone, stoves in human and animal forms both fixed and portable, glossy hand-made pottery (black, gray, brown, and red) with a variety of decorations, especially carved design, rail and adjunct, bronze objects with high arsenic content, bony objects, Nakhchivani handle, standard tools and arrowheads from obsidian.[4] Due to some similarities between different studies, this culture was attributed to a single ethnicity.[5] Studies on the material left by these populations showed a wide variety of livelihoods. Connor and Sagona introduced these peoples as pastoralists;[6] Kohl also believes that the habitat of these folks was appropriate for livestock farming,[7] while Rothman considers them as merchant and farmer peoples.[8]

Investigation and study of pottery, classification, and typology according to the form, ornamentation, texture, and chemical elements of pottery provide archaeologists with relatively comprehensive information about the people who used these potters and containers. In this research, we attempted to conduct a petrographic study on Kura-Araxes pottery samples recovered from Astanakroud 2 Site in the Kojur area in western Mazandaran Province, which was discovered in 2010 during a survey by Mostafa Khazaie Kouhpar and since been found to be the easternmost Kura-Araxes Site. During a superficial survey of the site, pottery from Chalcolithic, Bronze Age, Iron Age, historic and Islamic periods was also found;[9] accordingly, the proper location of the site in the region can be considered in terms of permanent access to necessities for the life of human societies, highlighting the importance of conducting archaeological research on the site. In particular, the proximity of this site to Tapeh Kelar further emphasizes the necessity of future studies to complete the prehistoric studies

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[1] Alizadeh, 2010.
[2] Burney, 1962; 1964; Kohl, 2009.
[3] Burney & Lang, 2007.
[4] Alizadeh, 2010; Sagona & Zimansky, 2009.
[5] Sagona & Zimansky, 2009: 163.
[6] Connor & Sagona, 2007.
[7] Kohl, 1992.
[8] Rothman, 2003.
[9] Khazaie Kouhpar, 2011: 119-9.

in the north of the country. In this research, the pottery from Astanakroud 2 Site was subject to petrography analysis in order to determine the soil type and mineralogy structure of the pottery. Petrography is a method by which thin sections of rocks and minerals are studied under an optical microscope.

Research Background

There have been several petrography studies in different regions on Kura-Araxes pottery, especially on Kura-Araxes pottery in the Levant as well as several other investigations conducted in Turkey and Caucasus, some of which will be briefly cited. The research by Batiuk studied pottery in the Bayburt region of northeastern Turkey.[10] It was concluded that each site produced pottery with a specific texture of its own, which could protect the idea that the pottery was a homemade product. Mason and Cooper[11] studied the petrography of Godin Tepe, Sanglan Tepe, and Tepe Baba-qassim from the Bronze Age, and identified that each one produced pottery with a distinct texture. Kibaroğlu (with Sagona & Satir)[12] performed petrography and x-ray analysis on the Kura-Araxes pottery of the Souss Hoiuk Site in northeastern Turkey and compared their findings with those of other studies on adjacent regions, concluding that pottery production was local and probably meant for home use. In another research in 2012 by Iserlis (with Greenberg & Gore) on Kura-Araxes pottery of Beth-Shean and Beth-Aur, it was specified that producers and local traditions of people in Beth-Aur separately coexisted with Khirbet Kerak tradition and that the Khirbet Kerak tradition gradually abandoned the local tradition in Beth-Shean.[13]

Based on the relative frequency of minerals as well as evidence of deliberate manipulation and smoothing of raw material, three texture groups were identified in Tsaghkasar Site belonging to Kura-Araxes I in Armenia by Iserlis (and colleagues) study.[14] Soil sources were located nearby (from Tsaghkasar Mount) and even were derived from the site itself, but the interesting point is the use of volcanic ash in some vessels as an additive, which is known to have been provided from outside the site. Volcanic ash was used to prevent imperfections in pottery baking steps, which was a common practice among Mayans in Guatemala and is still prevalent in contemporary Ethiopia.

Schwartz and colleagues worked on Malatya and Elazığ pottery. Generally, Malatya and Elazığ pottery were locally produced.[15] A new research has been con-

[10] Batiuk, 2000.
[11] Mason & Cooper, 1999.
[12] Kibaroğlu Sagona & Satir, 2011.
[13] Iserlis, Greenberg & Gore, 2012.
[14] Iserlis, Greenberg & Gore, 2015.
[15] Schwartz, Erdman & Morison, 2009.

ducted in the form of a doctoral thesis at Tarbiat Modarres University by Khazaie who analyzed examples of Gourab Tepe in Malayer, Kul Tape of Jolfa, and Tapeh Kelar in Kelardasht. The results showed that pottery from all three sites was produced locally despite the change in technology and soil resources for pottery.[16]

Astanakroud 2 Site

Astankroud Site is located in western Mazandaran Province in the Kojur District of Nowshahr County west of the small town of Poul. A homonymous village is located on the east side of the site [Fig. 1]. The site lies on the eastern edge of Lector Plain, which is more elevated than other parts of the plain.

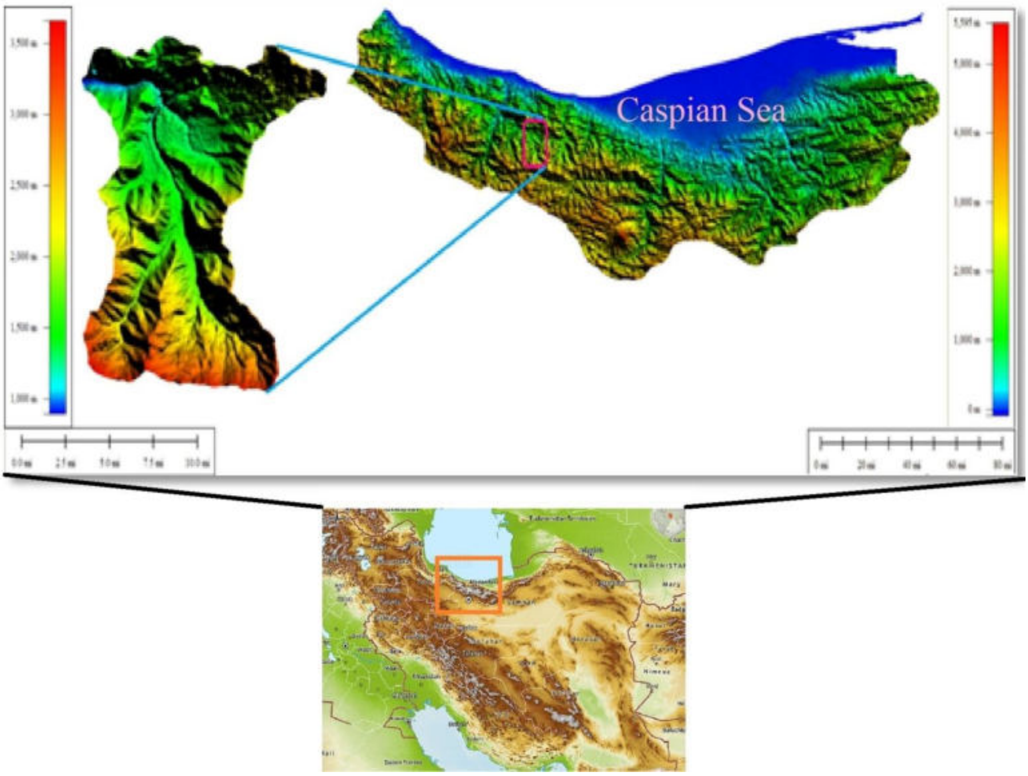


Fig. 1. Location of the studied area on the map of Iran

Kojur is a region in the west of Tabarestan (modern Mazandaran), which was formerly called Royan. This area is bounded from north by the Caspian Sea, Chalus, and Nowshahr counties, from the south by Alborz and Karaj mountains, from east by Nur County, and from west to Kelardasht and Marzanabad. Astanakroud 2 Site is loca-

[16] Khazaie Kouhpar, 2017.

ted in 36°38′56″N 51°29′46 coordinates at an altitude of 1370 meters. The proximity of the site to Astanakroud village is the reason for its designation. Typical finds of this site belong to Cheshmeh Ali, chalcolithic, Bronze, and Iron Age to Islamic periods. Considering the expansion of cultural materials, the dimensions of the site are at least 500×400 meters. This site is adjacent to the eastern margin of Astanakroud 1 Site. The surface of the hill, especially its southern parts, has been cultivated on wheat [Fig. 2]. There are several signs of unauthorized excavations, particularly in the eastern and southeastern parts of the site, which has likely been the cemetery due to the presence of a few long human bones. The pottery in the site indicates settlement in this place at least from Middle Chalcolithic. The water resource of the site was a spring 600 meters to the east of the site as well as running water in the bottom of the valley passing the northern wing of the site.[17]

Fig. 2. A view of Astanakroud site, Eastern perspective (after Khazaie Kouhpar, 2011: Fig. 5)

Methodology

In this survey, 15 samples of Kura-Araxes pottery collected from the Astanakroud Site in 2010 were selected for petrography analysis. Petrographic experiments were conducted on these pieces by a polarizing microscope (*James Swift*) at the Petrographic Laboratory of the Research Institute for the Protection and Restoration of Works affiliated with the Research Institute of the Cultural Heritage to determine the extent of similarity between the pottery from this site and Tapeh Kelar as well as

[17] Khazaie Kouhpar, 2011: 119-20.

searching for evidence of intraregional relations based on the study of pottery. Subsequently, the samples were cut into thin sections in a workshop, placed on a slide, and examined by a light microscope to record the detected minerals. Finally, the minerals identified in the geological and petrologic context of Kojur and surrounding regions were analyzed [Fig. 3].

Fig. 3. Samples of Kura-Araxes pottery from Astanakroud Site

Research results

According to the results of petrographic experiments, it was found that all pottery was locally produced. A binocular polarized microscope (*James Swift*) with 4X magnification was used in this research. Petrography results are presented in Table 1 for ease of access. In the first row of the table, the components of the matrix and formation of pottery are presented, and in the first column, the name and number of each pottery are separately indicated. If the studied mineral was present in the sample, it was marked with *, and if it was absent in each of the formations, it was marked with a - sign. If the frequency of the mineral was low or trace, it was indicated by (tr).

Table 1. Petrography analysis results of Astanakroud Site

Number of Samples	Qz (Clean)	Qz (Cloudy)	Plg	Fe-oxide	Am & Py	Cc	Mica	grog	S.R & chert	Texture
1	*	*	tr	*	*	*	tr	-	-	Silt
2	*	*	tr	*	*	*	tr	-	-	Silt
3	*	*	tr	*	*	-	*	-	-	Silt
4	*	-	-	*	*	-	*	-	-	Silt
5	*	*	tr	*	*	*	*	-	-	Inhomogeneous Silt
6	*	-	-	*	-	*	tr	-	-	Silt debris
7	*	*	tr	*	*	-	tr	-	-	Silt
8	*	*	tr	*	*	*	tr	-	-	Silt
9	*	*	tr	*	tr	*	tr	*	*	porphyry
10	*	*	-	*	-	*	-	*	-	Coarse-grained silt
11	*	tr	-	*	tr	-	-	-	-	Silt
12	*	*	tr	*	*	-	*	-	-	Silt
13	*	*	tr	*	*	-	-	-	-	Silt
14	*	*	tr	*	*	*	-	-	-	Silt
15	*	tr	-	*	-	-	-	-	-	Silt

Discussion

In general, pottery consists of matrix (background) and temper. The substances added to the pottery matrix are of high importance in the petrographic study of pottery. Archaeologists consider components larger than 0.1mm as temper. During the baking of pottery, all the plant and organic materials in pottery are destroyed at 200-250°C and only their space remains; and at 400°C, all organic matter in the matrix is eliminated. There are different varieties of quartz (in single- and poly-crystalline forms), amphibole, iron oxide, and calcite in the matrix of the studied samples.

In geology, the word ‘texture’ is used to classify rocks under a microscope. Accordingly, if coarse crystalline components are dispersed in a microcrystalline background, they are called porphyry (coarse) texture. In this texture, the size of components is 1-2 mm, which are scattered and float in the field of fine crystals. Samples with a component size of 0.5mm or smaller are called silty textures. As shown in Table 1, in terms of texture or petrofabric, sample No. 9 has coarse grain or porphyry texture and other samples have silty texture. In samples No. 9 and No. 10, siltstone residues and grog pieces have been used as temper, respectively [Figs. 4 & 5]. In this sample, there are quartz, calcite, iron oxide, and amphibole minerals in the matrix as well as grog.

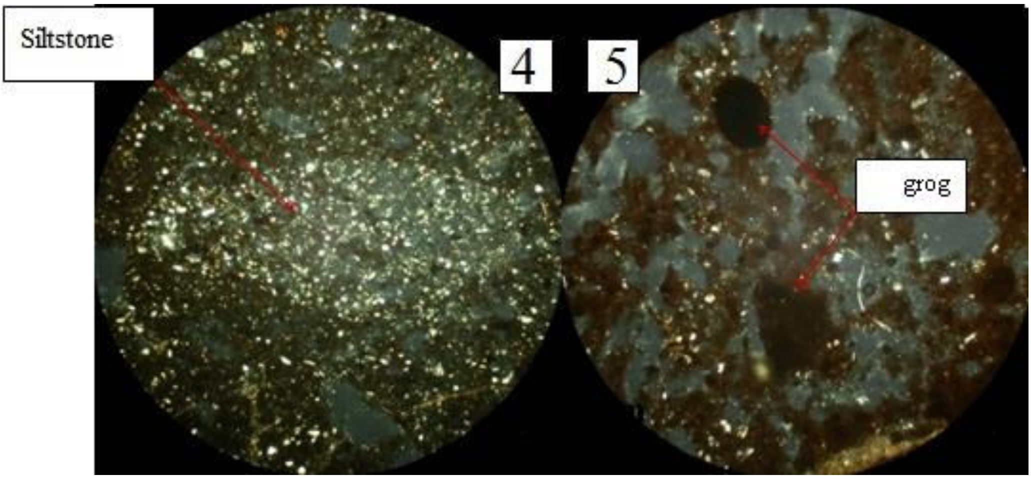


Fig. 4. Photomicrograph of sample No. 9, XPL light, 2.7 mm field of view, porphyry texture, coarse siltstone in center of the image. In this sample, siltstone and calcite pieces are used as temper.
Fig. 5. Photomicrograph, sample No. 10, XPL light, 2.7 mm field of view, coarse grain texture, large grog particles used as temper in pottery matrix.

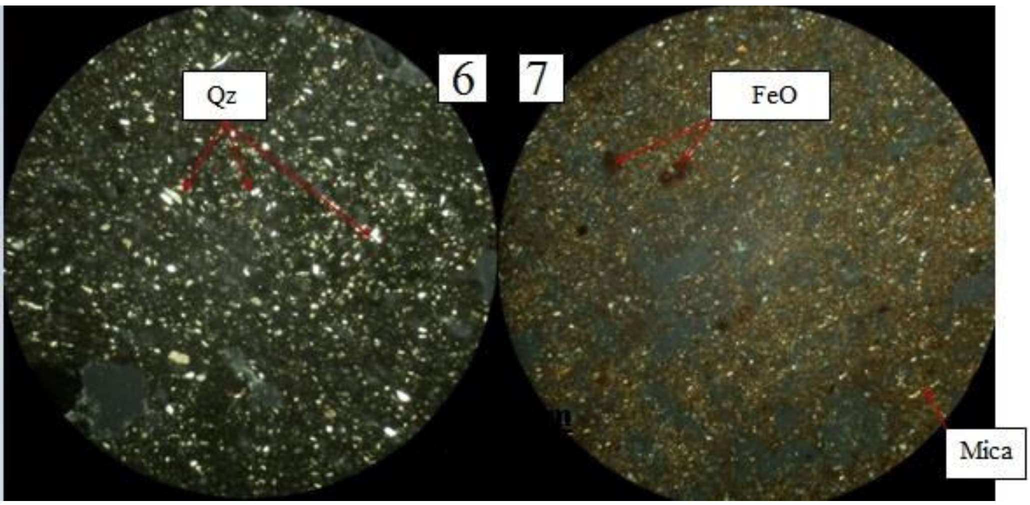


Fig. 6. Photomicrograph, sample No. 6, XPL light, 2.7 mm field of view, silty-debris texture, pottery temper composed of abundant quartz particles visible in transparent form.
Fig. 7. Photomicrograph, sample No. 4, XPL light, 2.7 mm field of view, silty texture, matrix a combination of clay and phyllosilicate minerals (mica), which are visible in a blade form within matrix together with quartz and iron oxide.

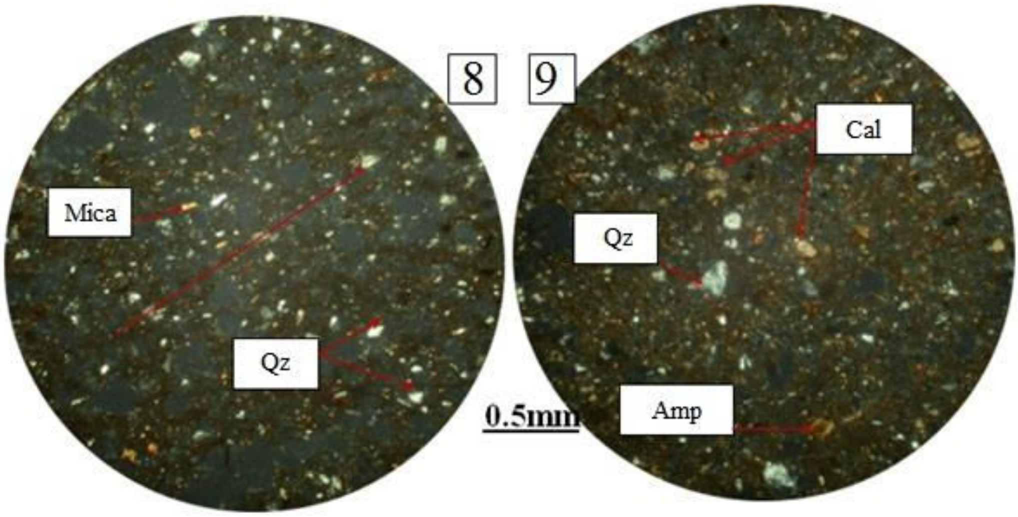


Fig. 8. Photomicrograph, Sample No. 3, XPL light, 2.7 mm field of view, silty-debris texture, matrix of pottery lacking calcite, and quartz pieces visible in transparent color together with mica.
Fig. 9. Photomicrograph, sample No. 14, XPL light, 2.7 mm field length, silty texture, calcite, quartz, amphibole with iron oxide visible in a mineral matrix.

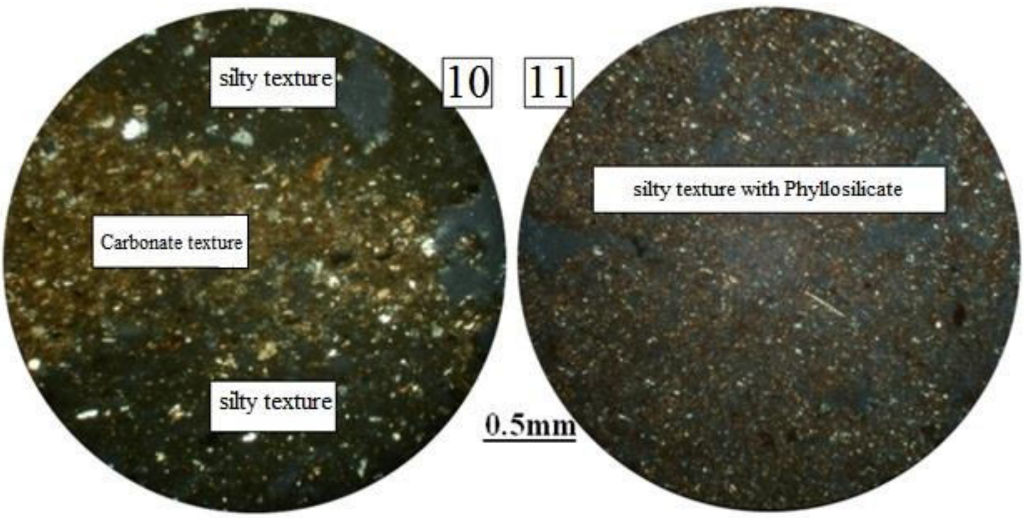
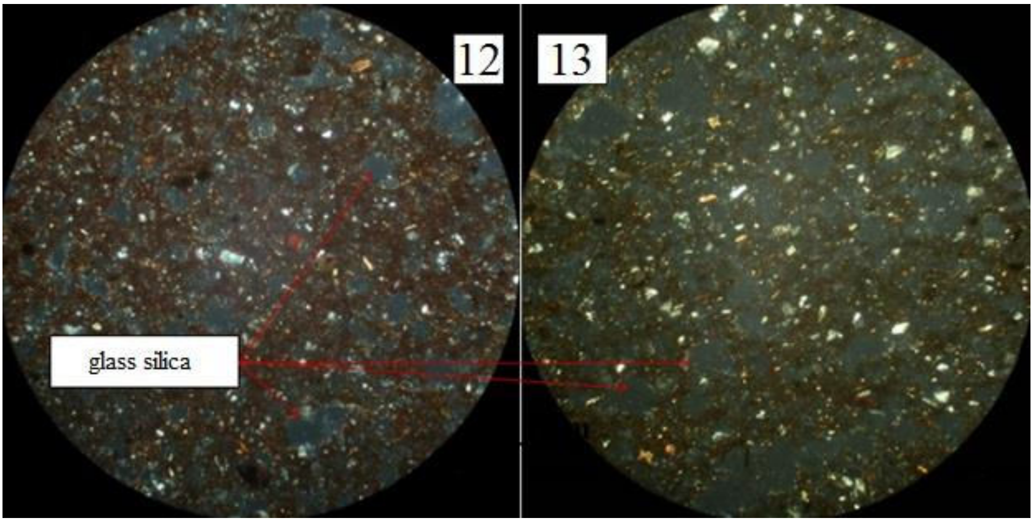


Fig. 10. Photomicrograph, sample No. 5, XPL light, 2.7 mm field of view, silty texture. The pottery matrix is composed of two carbonate compounds in the center and a clayey compound in the margin.
Fig. 11. Photomicrograph, sample No. 4, XPL light, 2.7 mm field of view, silty texture, clayey matrix with mica



Figs. 12 & 13. Photomicrograph, Sample No. 3 and 13 XPL lights, 2.7 mm field of view, fragments of glass silica not seen in other samples. These fragments always appear dark in cross-light (XPL).

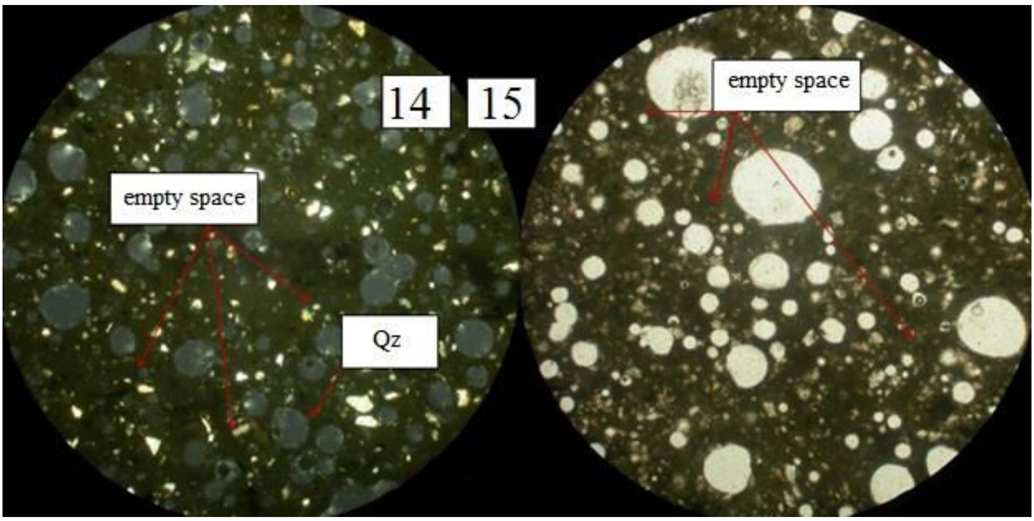


Fig. 14. Photomicrograph, sample No. 15, XPL light, 2.7 mm field of view, silty texture. The hollow circular space in the matrix is a function of gas evaporation during the baking of pottery and its rapid cooling.

Fig. 15. Photomicrograph sample No. 15, PPL light, 2.7 mm fie of view (Figure. 14 in polarized light).

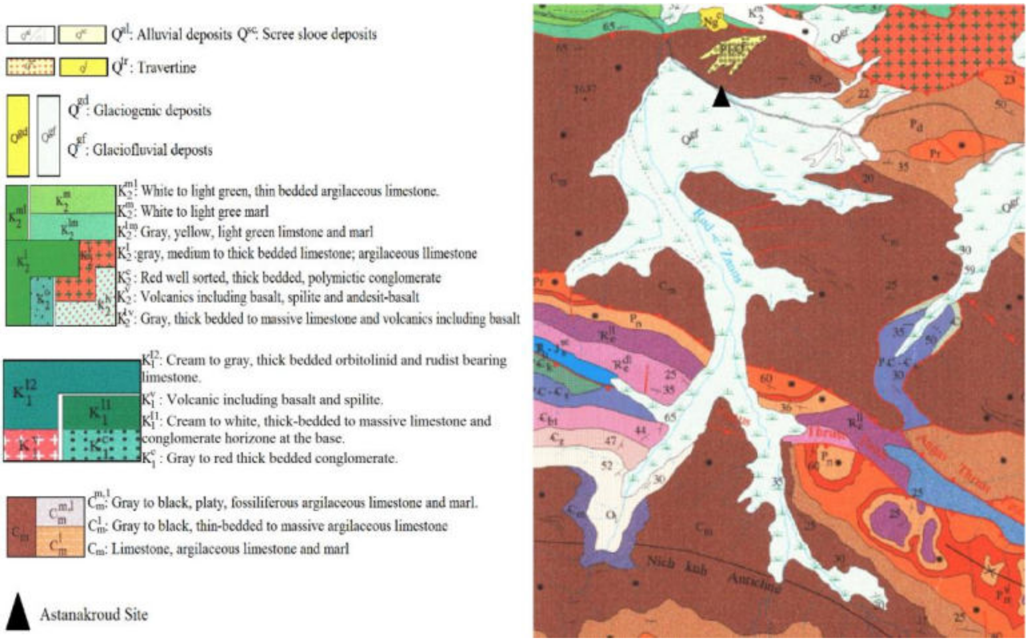


Fig. 16. Geological map of Kojur and Astanakroud site (Baladeh Geological Organization map with minor changes).

It seems that the 15 pottery samples under investigation are almost identical in terms of components, and their major difference is in the percentage of each of the minerals in the matrix. In these samples, quartz has the highest frequency, which is mostly in the form of phenocryst (monocrystalline) and to a lesser extent in poly-crystalline form. The percentage of quartz varies between 3-20% in samples and the margin of this mineral is oblique to half-round, indicating negligible displacement from the original site or the addition of silica to the soil by potters. Other components in pottery matrix include calcite, iron oxide, amphibole, mica, siltstone pieces, and grog which are found in various amounts in pottery temper. In samples No.9 and 10, grog pieces and siltstone residues are observed but are absent in other samples such as samples No. 4 and 6 [Figs. 6 & 7].

Samples No. 3, 4, 7, 11, 12, 13, and 15 do not contain calcite and in other samples, this mineral can be seen in combination with the background or as distinct parts in the matrix. Calcite is used to check the pottery baking temperature. Calcite or carbonate-based minerals are destroyed at 800°C by heat and lack of calcite in pottery samples shows baking temperatures over 800°C for these potters. As shown in Table 1, the baking temperature of samples containing calcite (for example, samples No.3 and 14) has not exceeded 800°C [Figs. 8 & 9].

A notable point about these samples is the difference in matrices used to produce pottery, which specifies the differences in their composition and origin. Some samples, including samples No. 1, 2, and 5, show a clay-carbonate matrix, which appears in dark color in polarized and cross light (PPL, XPL). In these samples, the margin of pottery is darker than its center [Fig. 10]. Some pottery also has clayey and non-carbonate matrix and phyllosilicate minerals (mica) can be seen in their composition, including samples No. 4 and 8 [Fig. 11].

Pottery sample No. 6 has a silty-debris texture. 20% of the matrix in this sample consists of several monocrystalline quartz pieces. In addition to quartz, a small amount of calcite and iron oxide are also observed. Samples No. 9 and 10 have coarse grain (porphyry) texture. In this sample, grog and siltstone are used as temper.

Samples No. 3 and 13 have a clayey matrix. However, an interesting and important point is the presence of glass or glass silica pieces that are not visible in other samples [Figs. 12 & 13]. Sample No.15 has a carbonaceous texture with high porosity and is round, which differentiates it from other samples [Figs. 14 & 15]. The reason for porosity is probably the rapid and abundant discharge of gas and volatile matter from pottery and its instant cooling. Another thing about the studied pottery is that all the samples are wheel-made (except for sample No. 15), which is evident due to the orientation of the components in the pottery matrix.

The lithology of the Kojur area in the Baladeh Plate is represented with high precision in Figure 16. Based on this map, Astankroud Site is formed on a glacial alluvial surface. However, due to the presence of amphibole and mica in pottery samples, this research showed that the samples are derived from volcanic not sedimentary or calcareous soil. According to a geological report of the Geological Survey of Iran and the research conducted by Ansari (*et al.*),[18] there is a volcanic structure in the northern part of the region (K2v in red color with green plus sign inside) encompassing Kojur. This structure, which is located in the northern part of the site, is transferred up to the foot of the Astanakroud Site through the activity of natural and atmospheric factors. Based on the geomorphology structure, river currents, and floods reached up to a distance of 50 meters from the site through the duct of the valley; therefore, the resulting soils containing minerals and volcanic elements have been used by inhabitants of the area.

Conclusions

Petrographic analysis of the Astanakroud Site indicates that the pottery has been made using the soil resulting from erosion in the geological structure of the northern part of Kojur and washed by natural currents in paths of Nimvar, Avil, and Kouhpar valleys, which has reached the foot of the site. In terms of fabric or texture, silty and porphyry (coarse grain) textures are detected in pottery subject to petro-

[18] Ansari, *et al.*, 2010.

graphic analysis. In calcite-containing samples, the mineral can be seen in coarse and fine crystals. The presence of calcite in the composition of pottery shows that the pottery baking temperature has not surpassed 800°C, but in samples without calcite, the temperature of pottery baking exceeds 800°C. 9 out of 10 analyzed Bronze Age samples of Astanakroud have porphyry texture, and from 5 samples of the Middle Bronze period, only 2 have porphyry texture. Hence, it seems that the samples selected on this site are more similar to the Middle Bronze period of Tapeh Kelar. Assuming simultaneous settlement in both sites and given the lack of opal and nephalin in the texture of these potteries unlike that of Tapeh Kelar pottery, it appears that the transfer of pottery between the two sites has not been considerable. Although the number of samples tested in this study was only 15, these minerals have been reported in the same number of samples examined from Tapeh Kelar.

An interesting point is that Kelar and Astanakroud sites are the only examples of this culture in Mazandaran, and the only other site belonging to this culture is located on the southern shores of the Caspian Sea in Diyarjan Site of Gilan; nonetheless, there is little association between Kelar Tepe and Astanakroud in terms of clay samples.

Astanakroud Site has been formed on a glacial alluvial bed. However, the presence of amphibole and mica in samples of tested pottery shows that the soils have a volcanic origin and neither sedimentary nor calcareous structure. In terms of calcite presence, a majority of the 15 samples of pottery subject to analysis lacked calcite but some samples contained grog. According to the results of petrographic tests on pottery, it seems that 15 samples of pottery are almost identical in terms of components, and their major difference is in the percentage of each of the minerals in the matrix.

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