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A Petrographic Analysis of Early Bronze Age Ceramics from Sonqor County, Kermanshah

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Abstract: The petrographic analysis of ceramics can often answer a wide variety of archaeological questions, especially regarding fabrication, manufacturing processes which were despite focused on the construction and trade of pottery. However, ceramics which were collected from the same site can mostly differ in their chemistry as well as fabrics. As is applied in many cases, essential archaeological survey and documentations in a theoretical framework are key to the proper application of ceramic petrography through the archaeometrical research. This paper deals with the petrographically approach on Kura-Araxes or Early Bronze Age ceramics manufacturing processes of Sonqor Plain. It is of worth-knowing to contribute that the contact and exchange strategies between indigenous communities and several cultural-spheres during Early Bronze Age (beginning of the fourth millennium BC) in this area. Morphological data along with mineralogical composition of ceramics were applied to determine the major elements of the pottery sherds. Based on the result, one can be suggested that all of sherds are in the same group and were demonstrated mightily local productions. The ceramic manufacturing technology indicates same patterns of material interactions during the ETC or Kura-Araxes in all of the investigated sites in Sonqor Plain.

Keywords: Petrography; Ceramic; Provenance; Early Bronze Age.

Introduction

In the past and recent years, several excavations at Godin Tepe (Young, 1969; Young & Levine, 1974), Tepe Gorab (Khaksar 2006), and Tepe Pissa (Mohammadifar *et al.,* 2009), intensive surveys in the Kolyaei Plain (Heydarian, 2004; 2010: Heydarian & Ghorbani, 2016.), the adjoining valley of Kangavar (Young, 1966; 1975), and more fieldwork in the neighboring valleys of Malayer (Howell, 1979) and Alvand Mountain (Motarjem, 2008) conducted in west of Iran. These works, in this region have yielded substantial amounts of pottery fragments from the early to mid-third millennium B.C. In this period, Early Bronze Age, the material culture of central-western Iran was influenced by the cultural phenomenon known as Kura-Araxes, or the Early Trans-Caucasian (E.T.C). The ETC pottery spectrum mainly consists of hand–made burnished grey tableware decorated with geometrical and helical designs, raised concentric circles, groove designs, engraved helical designs and zigzags on the brims of different wares. This culture around 3500 BC, or slightly earlier, came into prominence in the lands south of the Caucasus and neighboring regions. This material culture complex stretched across a remarkably wide area from Transcaucasia through northwest Iran to eastern Anatolia, south of Russia and the upper regions of Euphrates for more than 1,500 years (Japaridze, 1961; Khanzadian, 1967, Sardarian, 1967; Burney & Lang, 1971; Munchaev, 1975; Sagona, 1984; Kushnareva & Markovin, 1994; Kushnareva, 1997; Miroschedji, 2000; Philip & Millard, 2000; Palumbi & Chataigner, 2014).

The geographical area discussed in this paper is located in the western part of Iran and the Zagros Mountain range and consists of several adjoining river and valley systems. The archaeological sites of Vizheh, Āgāh, Ghanāt, Khāki, Kürdmazrae, Khodāei, Kalgāh Zamān, Ali Baeig, Shaeikh Jalil and Ghabristān are currently regarded as the main Early Bronze principalities or Early Trans-Caucasian (E.T.C) in the study area. These sites, situated on prominent landscape, can be described as major settlements governing large agricultural plains. All sites from which samples were taken are located within Sonqor County, which is the northern east part of Kermanshah bordering

Kurdistan and Hamedan. The sites were included in this study, spanning several geographical regions and sites: (1) in northwest of area-Tepe Vizheh and Tepe Āgāh; (2) in north-Tepe Khāki; (3) in the wider area of central plain-Kalgāh Zamān; (4) in east- Ali Baeig; (6) in southeast- Khodāei and Ghabristān (Fig. 1).

In this study, we aim to map the provenance of raw materials and ceramics on a territorial scale, and thereby move beyond a static categorical classification of types. In addition to identifying components of the ceramic, their temperature and exploring the possibility of characterization or importation of these ceramics were studied. Petrographically, ceramic thin-sections may be analyzed qualitatively (descriptive and often subjective), quantitatively (less descriptive and more objective), or both. Each has distinct advantages and disadvantages. Qualitative descriptions are useful for identifying a potsherd's unique aesthetic and technological features, mineral inclusions, different ceramic fabrics, and, in some cases, mineral inclusions, but can often be overly reliant on a researcher's subjective opinion. Quantitative analysis, on the other hand, depends on the identification and systematic counting of a sherd's microscopic components (i.e., sand, silt, clay matrix, and void space), which produces statistically comparable ratios of each sample's fabric constituents. Quantitative analysis applied on its own, however, omits characteristics such as optical reactivity, birefringence, and grain distribution, all of which can be invaluable to the microscopic study of ceramics and can influence research results. Thus, petrographic research is most effective when both methods are applied together, thereby allowing data to be gathered that serve to answer questions about a pot's manufacture, former function, and, in some cases, production provenience (Parsons, 2005).

Methodology

For this research, thirty-three ceramic thin sections were described qualitatively and quantitatively. Polarized light microscopy was used to investigate these thirty-three samples, requiring the creation of 2.7 mm thick[1] 'thin sections,' examined petrographically in both plane polarizes light (PPL) and under cross polarized light (XPL). All minerals and inclusions have been considered and abbreviated after Whitney, D. L., and B. W. Evans (2010) (Whitney and Evans, 2010). The thin sections were prepared and analyzed professionally on a binocular polarizing microscope (James Swift), by Sayed Iraj Beheshti of the Petrographyical Lab in the Cultural Heritage, Handicrafts and Tourism Organization of Iran. This optical microscopy was used as a primary analytical method for providing a sustainable fabric classification, incorporating information on an object's origin, production (textural analysis) and burial. The quantity of inclusions was estimated by looking at several grids and measuring these against other inclusions and matrix. Petrographic examination of the ceramic inclusion revealed that it consisted of mineral grains and rock fragments. Five ceramic samples (12, 21, 24, 25, 28) from Tepe Āgāh were analyzed, 5 (4, 19, 27, 29, 33) from Tepe Vizheh, 6 (14, 15, 17, 18, 20, 30) from Ghabristān, 5 (5, 11, 13, 26, 32) from Tepe Khāki, three (2, 3, 10) from Tepe Khodāei, four (7, 8, 9, 16) from Tepe Ali Baeig and finally five (1, 6, 22, 23, 31) from the Kalgāh Zamān Tell site. To name the specimen, each sherd was given a number following the type name (e.g., AG-1, 2, 3, 4, 5 for Āgāh 1, 2, etc.). Their origin was noted and each sherd was described, photographed, and drawn. Once the portion used to prepare the thin section was removed, it was recorded in the original drawing (Fig. 2).

Results

The purpose of this paper is to study the microscopic structure of pottery samples based on the four components of clay, temper (including mineral, and pottery fragments), organic materials and empty spaces. In addition, determine the types of geological resources for the access and their changes over time, the nature of the pottery inclusion and identification of local and imported pottery are other goals of this article. Only the fabrics will be discussed in this paper. The results section

[1] 0.5 mm is considered the 'optimal thickness for thin sections.

will remain short and technical to allow their cultural discussion in the following sections. After the petrographic analysis, ceramics were divided based on their composition and texture or petro-fabric, into two categories as seen in Table 1, which provide a link with the geological substrate. One category is of silt textures which are divided into two groups of microcrystal silts and heterogeneous and coarse crystals. The other category of potteries has 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. Fabric groups are identified according to their association with mineralogical composition of major geological units in the region and the igneous, metamorphic and sedimentary groups are identified by a dominant presence of large amphibole, plagioclase, pyroxene, and calcite. The main minerals in the sherds are plagioclase feldspar and minerals with magmatic (in some cases metasomatic) origin such as pyroxene and amphibole. All these inclusions are indicative of a native origin of the raw material (Figure 3). Calcite and quartz are predominant in all of the samples. Calcite is seen in coarse grain or in combination with the texture. In sample 7, the abundance of these mineral varies from 2-20 percent. Quartz is often seen as phenocrystal and its angled edge up to half rounded indicates its low displacement from its original location or adds silica to the soil by the potter. The clay used as a matrix in one case may be used as a temper in others and vice versa. Limestone is used as matrix given that they are the most common texture types found in the region. Their presence in most samples is the result of the geological features of the area.

The clay in all specimens is rich in iron oxide and all have quarts, feldspars, and small red particles (likely hematite or other iron rich minerals). There is also evidence in some of them of biotite mica. The calcite (sedimentary and grog-calcite) group contains few siltstone/sandstone fragments, which may argue in favor of a local limestone or flysch origin. This petrographic group seems to have been widely distributed throughout the region. Muscovite crystals and radiolarian chert occur mainly in samples derived from the Gavrud basin.

The volcanic group is identified by a dominant presence of large idiomorphic plagioclase, amphibole, and pyroxene and chert class. This group occurs extensively within the northeastern part of the area.

The formation technique (handmade or wheel made) of each of 33 samples was investigated on the macroscopic level. However, the wheel marks can be eliminated by secondary treatment. For instance, the ETC potters, eradicate all trace of the wheel-made pottery by completely burnishing and polishing. The difference between handmade and wheel marks are visible, to some extent, in thin-section. The micro fabrics of wheel thrown ceramics generally present a random orientation and distribution of the coarse grains, and the occurrence of elongated vesicular pores (Samples 5 and 16, Figs. 3: 12 and 11).

Firing temperature can be estimated by identifying changes in optical properties of samples (Maggetti, 1982; Badreshany & Genz, 2009). We can distinguish between "high" firing temperature (above 850°C), "moderate" (700-850°C) and "low" temperatures (under 700°C). A low temperature is indicated by an optically active matrix, with little or no decomposition of calcareous matter. In general, it can be said that the temperature in the samples is completely non-uniform and varied from 780 to 920 degrees Celsius. As noted above and due to the geology of the region, most pottery is calcareous, so the samples also contain calcite but in some of them they are gone because of firing temperatures higher than 800 degrees Celsius. In some instances, we saw a difference in color which indicates incomplete firing and a different location in the kiln. Kneading of the pottery has also been completely non-uniform. The materials depending on the soil of each area are used randomly in the pottery fabric. Due to the presence of many rivers and good precipitation in the area, soil displacement is commonplace and this causes diversification in the presence of different minerals in different sizes.

The samples of Tepe Agah, Tepe Vizheh and Tepe Qanat are located in the 1:100000 of the Mianrahan sheet and, samples of Tepe Khaki, Tepe Ali Baieg and Tepe Kalgah Zaman are located in the 1:100000 of the Soqor sheet. These two sheets are adjacent to each other and they are considered to be a part of the 1:250,000 Kermanshah sheet. The study area, in terms of structural geological divisions in Iran, is located in the Sanandaj-Sirjan zone. Roughness of the region in the northeast of Kermanshah province is a part of the interior pre-mountains of Zagros.

The interior pre-mountains of Zagros are mostly built from the metamorphic rock, such as schist and marble. The reason of the metamorphosed rocks in this section is the high pressure and heat caused by the collision of the central Iranian plate with the Saudi plate in different periods of geology. The cities of Kangavar, Soqor and Sahneh are located in this section. The Dalakhani, Madian and Amroleh Mountains, and Kangavar, Sonqor and Dinevar plains are respectively among the most important mountains and plains in this part of Zagros.

The highland of the area forms a solid layer of lime and the sedimentary-volcanic rows form the low elevation of the area. The intrusive bodies of the area, except for the granodiorite-diorite mass located in the northeastern plate in Lojar Mountain and Mount Sinavand, are not much elevated. Cretaceous rocks morphologically have fairly loose lithology and it has been formed from reddish brown to burnish brown sandstone. Its minerals are mainly quartz and feldspar with iron oxide, carbonate and a little mica. The limestone's of the region, which has a lot of extent, is composed of dolomitic lime, sandy lime with many fossils. In parts, these stones have endured a slight metamorphism and their lithology is a collection of shale, marl shale, phyllite, thin-layer lime, volcanic rocks, and pelagic limestone. Volcanic rocks of the region are periodic rocks of pyroclastic, tuff andesite and basalt lavas. Near the three sites of Tepe Agah, Tepe Vizheh and Tepe Qanat, there are masses of intrusive igneous rocks with diorite, gabbro, granodiorite and granite outcrop which consist of plagioclase, feldspar with a variety of compounds, quartz and mica minerals. The newest sediments of the area are present sediments which consists of clay-silt zones, old rubble rocks which is caused by the process of degradation and sedimentation, and finally, sediments from river beds.

Tepe Āgāh Samples (12, 21, 24, 25 and 28 in Fig. 5): With the first look, porphyry texture is a common mode among all the specimens (mostly heterogeneous). In these samples, various rock fragments, grog, chert, quartz and limestone have been considered as their inclusion. Within the texture of these samples, two distinct clusters can be identified: The first group (12, 21, and 24) is potteries with an almost homogeneous clayey based, calcareous matrix consist of mainly grog, quartz, chert and calcite (Ho *et al.*, 2021). The second cluster (mainly only the sample numbers 25 and 28) can be classified as pottery with an inhomogeneous matrix, with divers inclusions consist of magmatic rock fragments such as mica, quartz (crushed stone fragments as granite) and its related minerals such as plagioclase, amphibole and pyroxene (Burton *et al.*, 2019).

Tepe Ghabristān Samples (14, 15, 17, 18, 20 and 30 in Fig. 6): The studied samples seem petrographically be the same. These samples have a fine-calcareous matrix which is mostly consisted of grog fragments. The sample 17 has a slightly more heterogeneous texture than the previous samples. Its matrix might have been oxidized and is a bit darker in color. Minerals with magmatic origin and grog are mostly applied additives (Mason and Cooper, 1999). In general, except for sample 15, other samples of this group are similar in composition of admixtures and indeed the use of carbonate-rich matrix. Quartz and calcite inclusions were considered as routine recipes in these samples.

Comparison of Tepe Vizheh Samples (4, 19, 27, 29 and 33 in Fig. 7): Three types of cluster regarding their matrix textures can be considered; silty matrix (samples 4 and 29), calcareous matrix (19), and porphyry matrix (Samples 27 and 33). The Sample 33 is characterized by means of low amount of calcite (due to manufacturing temperature or calc poor raw materials). By studying these five samples, once can be considered that the technology of pottering for making such samples were remained similar (Ho *et al.*, 2021). Samples number 4, 19, 27 and 29 have considered by means of calcareous matrix. The potteries from tepe Vizheh have also considered by means of diverse application of grog, calcite and quartz within their porphyry matrix. Sample 33, has a heterogeneous, but low amount of carbonate within the matrix. The main admixtures are igneous rocks, mica and quartz fragments.

Tepe Khāki Samples (5, 11, 13, 26 and 32 in Fig. 8): These samples were proved diverse structure and composition. The texture of all specimens is porphyritic, and admixtures are mainly consisting of coarse grain of grog, calcite, quartz, plagioclase. In the samples of this site, three groups can be identified: Group 1: Potteries' number 11 and 13 were shown calcareous matrix with coarse grain grog fragments. Group 2: This type of pottery (sample 26) has shown argyles-silica rich matrix with mostly, and mainly quartz and magmatic admixtures. Group 3: this group (Sample 5) has a heterogeneous matrix with coarse grog fragments within its paste. Group 4: pottery (Sample 32), in which, the coarse fragments of plagioclase, quartz and calcite can be seen within its matrix.

Tepe Khodāei Samples (2, 3 and 10 in Fig. 9): The samples are almost in the same category and are similar and have clayey based matrix with bi-chrome matrix fabrication. The texture of the samples is fine and silty. Fragments of fine aggregates of calcite, quartz with limited amount of grog within the matrix have to be considered. In sample number 10, the empty space in the paste is higher due to the remaining of vegetal space (Pradell and Molera, 2020).

Tepe Ali Baeig Samples (7, 8, 9 and 16 in Fig. 10): The samples are almost similar to other groups. Porphyry and calcareous texture are common in all investigated samples. Clayey based matrix with argyles-silica composition and igneous rock fragments have been used as matrix and admixture. In general, the pottery in this site is divided into two categories regarding the different size of admixtures. Calcite, quartz, plagioclase, alkali feldspars grog porphyry in coarse grains are consisted in the fabrication of the samples.

Tepe Kalgāh Zamān Samples (1, 6, 22, 23 and 31 in Fig. 11): the samples from this site are also very similar to the others. All matrices are heterogeneous and bichrome due to the firing atmosphere (Gualtieri, 2020). Quartz, calcite, plagioclase, alkali feldspars and seldom grog have been used as admixtures in all samples. The texture is mostly homogeneous both in color as well as in additives composition. However all samples have much higher porosity than the others studied in this paper. The reason of that might have been suggested due to the high amount of inorganic additives applied within the texture. The firing regime can be the other reason by that way high calcareous matrix produced high amount of void after decomposition of calcite to calc and volatile carbon dioxide. Calcite and quartz are mostly presented as coarse grain additives, in opposite grogs are mostly fine grained additives. Based on the observation, two groups of pottery can be clustered in this site: the first group (Samples 24, 31) consists of potteries with clayey based carbonate matrix with calcite and grog as temper. The second group (Samples 1, 6 and 22), with argyle-silica clayey matrix with quartz, fine grain calcite and grog as inclusion.

Discussion

The potteries studied in this paper were devided in two groups based on the petrographical point of view, and interpretation of the manufacturing processes; the first group will be described as high carbonatic ceramics, which were include the residues of sedimentary-carbonate inclusions within the texture of the potteries. In this group, calcite and grog fragments (clay, silt and old pottery fragmets which were baked onece) are used as the main additives (inclusion) which is quite justifiable due to the expansion of calcareous roch formations and high calc outhcrops in the area. The second group, will be classifiede as the algileseouce potteries with obviouse well enrichments in quartz and siliceous sediments paste. The second groups of pottery are non-carbonated or the carbonate content in these samples are very low. Most of the temper materials in this group are composed of silica, quartz, chert and igneous rock minerals. Such minerals are common and the main outcrops of such based reservoire can well be distinguished in the region. The existence of igneous rocks around Āgāh, Vizheh and Ali Baeig can be a onlooker to these samples. In the pottery type from Tepe Āgāh, (Sample 25) well sorted and used of metamorphic rocks as inclusions and even temper can be visible which is completely different from other examples. In terms of firing temperature, pottery with primary calcite and carbonate mineral (unreacted) has tolerated to have a temperature below 800º. However, the absence of calcite or calcite-free matrix can be interprted as the potteries with firing temperature of more than 800º centigrade till ca. 950, depending on the firing atmospher. According to petrographic studies, most of the investigated ceramics are coarse-grained (porphyry tissue) and a limited number of them were proved to consist of fine-grained (silty) texture. The use of grog inclusios as tempering is acctually ordinary in the pottery manufacturing processes in these areas.

Conclusion

33 pottery shereds from Sonqor plain have been studied in order to find the nativeness of the samples to the reagion in where thay have been excavated. The potteries have been clustered based on the inclusions and their matrix effects. The calcareouse and the argilleouse pottey types have been reported. Calcites, quartz, crushed igneouse rocks as well as oxidation products from the sedimentary formations have been involved within the clustering and classification of the samples. The additives and matrix effects of all investugated samples are compatible with the geological character of the region. Grogs are the most important and fascinating additieves within the texture which are interpretable as the high technological addaptation between the potters and their material know-how in this region. Considering the geology of the region and the presence of various type of igneous and sedimentary rocks in the area, and, furthermore the existence of their traces and evidence in our investigated potteries, the nativity of the potteries was completely established.

References

[1] Badreshany, K., and Genz, H., (2009). Pottery production on the northern Lebanese Coast during the Early Bronze Age II-III: the petrographic Analysis of the Ceramics from Tell Fadous-Kfarabida, *Basor*, 355: 51-83.

[2] Burney, C. A., and Lang, D. M., (1971). *The People of the Hills*. Ancient Ararat and Caucasus. London: Weidenfeld and Nicolson.

[3] Burton, M. M., Quinn, P. S., Tamberino, A., & Levy, T. E., (2019). Ceramic composition at Chalcolithic Shiqmim, northern Negev desert, Israel: investigating technology and

provenance using thin section petrography, instrumental geochemistry and calcareous nannofossils. Levant, 50(2), 237-257. https://doi.org/10.1080/00758914.2019.1625656

[4] Gualtieri, S., (2020). Ceramic raw materials: how to establish the technological suitability of a raw material. *Archaeological and Anthropological Sciences*, *12*(8). https://doi.org/10.1007/s12520-020-01135-w.

[5] Heydarian, M., (2004). *Final Report of Archaeological Survey in Sonqor Koliyaie Plain* (first season), Submitted by the Research Center of Iranian Cultural Heritage, Handicrafts and Tourism Organization. Kermanshah. [In Persian]. (Unpublished).

[6] Heydarian, M., (2009). *Final Report of Archaeological Survey in Sonqor Koliyaie Plain* (second season), Submitted by the Research Center of Iranian Cultural Heritage, Handicrafts and Tourism Organization. Kermanshah. [In Persian]. (Unpublished).

[7] Heydarian, M., and Ghorbani, H. R., (2016). Prehistoric Evidence of Sonqor Koliyaie Plain in Central Zagros, *the Iranian Journal of Archaeological Studies* 6 (1): 19-31. https://DOI: 10.22111/ijas.2016.3413

[8] Ho, J. W. I., & Quinn, P. S., (2021). Intentional clay-mixing in the production of traditional and ancient ceramics and its identification in thin section. Journal of Archaeological Science: Reports, 37. https://doi.org/10.1016/j.jasrep.2021.102945

[9] Howell, R., (1979). Survey of the Malayer Plain. *Iran* Vol. 17.

[10] Japaridze, O., (1961). *Kartveli tomebis istoriis litonis tsarmoebis adreul sapekhurze* (On the History of Georgian Tribes in the Aeneolithic and Early Bronze Ages). Tbilisi (in Georgian).

[11] Khanzadyan, E. V., (1967). *Haykakan lernashkharhi mshakuyte m.t.a. III hazaramyakum (The Culture of Armenian Highland in the 3rd millennium BC).* Yerevan: ArmSSR Academy of Sciences Press.

[12] Kushnareva, K. K., (1997). *The Southern Caucasus in Prehistory, Stages of Cultural and Socioeconomic Development from the Eighth to the Second Millennium B.C.* Philadelphia: University of Pennsylvania Museum (University Museum Monographs 99).

[13] Kushnareva, K. K., and Markovin, V. I., (1994). The Bronze Age of Caucasia and Central Asia, *Archaeology in USSR, Moscow* (in Russian).

[14] Maggetti, M., (1982). *Phase analysis and its significance for technology and origin.* Archaeological Ceramic, eds. J. S. Olin and A. D. Franklin. Washington, DC: Smithsonian Institution. Pp: 121-133.

[15] Mason, R. B., & Cooper, L., (1999). Grog, petrology, and early transcaucasians at Godin Tepe. Iran, 25-31.

[16] Miroschedji, P., (2000). *La Ce´ramique de Khirbet Kerak en Syro-Palestine: E´ tat de la Question,* in C. Marro and H. Hauptmann, eds., Chronologie des Pays du Caucase ET de l'Euphrate aux IVe–IIIe Millenaires BC. Actes du Colloque d'Istanbul, 16–19 De´cembre 1998. Varia Anatolica 11. Paris: Institut Franc¸ais d'Etudes Anatoliennes, 255–277.

[17] Mohammadifar. Y., Motarjem .A. and Torabzade, H., (2009). Tepe Pissa: new investigations at a Kura‐Araxes site in central western Iran, *Antiquity* Vol. 83 Issue 320. UK.

[18] Motarjem, A., (2008). *Archaeological Survey and Patterns of Settlement Analysis of Early Bronze Age Sites in Alvand Basin, Hamadan*, PhD. Dissertation, Department of Archaeology, University of Tehran.

[19] Munchaev, R. M., (1975). *Kavkaz na zare Bronzovogo veka. Neolit, éneolit, rannyaya bronza* (The Caucasus at the beginning of the Bronze Age. Neolithic, Eneolithic, Early Bronze Age). Moscow: Nauka.

[20] Palumbi, G. and Chataigner, C., (2014). The kura-araxes culture from the Caucasus to Iran, Anatolia and the Levant: between unity and diversity. A synthesis. *Paléorient*, vol. 40.2, p. 247-260

[21] Parsons, T., (2005). A Petrographic Analysis of Early Copper Age Ceramics from Vésztö 20, Körösladány 14, Vésztö-Mágor, and Örménykút 13, in Bekés County, Hungary. *La Tinaja* 16.

[22] Philip, G., and Millard, A. R., (2000). *Khirbet Kerak Ware in the Levant: The Implications of Radiocarbon Chronology and Spatial Distribution,* in C. Marro and H. Hauptmann, eds.,Chronologie des Pays du Caucase et de l'Euphrate aux IVe–IIIe Millenaires BC. Actes du Colloque d'Istanbul, 16–19 De´cembre 1998. Varia Anatolica 11. Paris: Institut Franc¸ais d'Etudes Anatoliennes, 279–296.

[23] Pradell, T., & Molera, J., (2020). Ceramic technology. How to characterise ceramic glazes. *Archaeological and Anthropological Sciences*, *12*(8). https://doi.org/10.1007/s12520-020-01136-9

[24] Sagona, A. G., (1984). The Caucasian Region in the Early Bronze Age (3 vols.). Oxford (BAR Int. Ser. 214).

[25] Sardaryan, S. A., (1967). *Nakhnadaryan hasarakutyune Hayastanum* (Primi tive society in Armenia). Yerevan: Mitk.

[26] Whitney, D. L., and B. W. Evans, (2010). Abbreviations for names of rock-forming minerals, American mineralogist, 95(1), 185-187.

[27] Young, T. C. and Levine, L., (1974). *Excavation of the Godin Project: Second progress Report.* Occasional Papers no: 26 Art and Archaeology. Toronto

[28] Young, T. C., (1966). Survey in western Iran, 1961, *Journal of Near Eastern studies*, 25.

[29] Young, T. C., (1969). Excavations *at Godin Tepe: first progress report*. Toronto: Royal Ontario Museum. - 1975. Kangavar valley survey. *Iran* 13: 191-3.
[30] Young, T. C., (1975). An Archaeological Survey of the Kangavar Valley. On Archaeological Research Proceeding of the3rd Annual Symposium in Iran 3: 23-30.

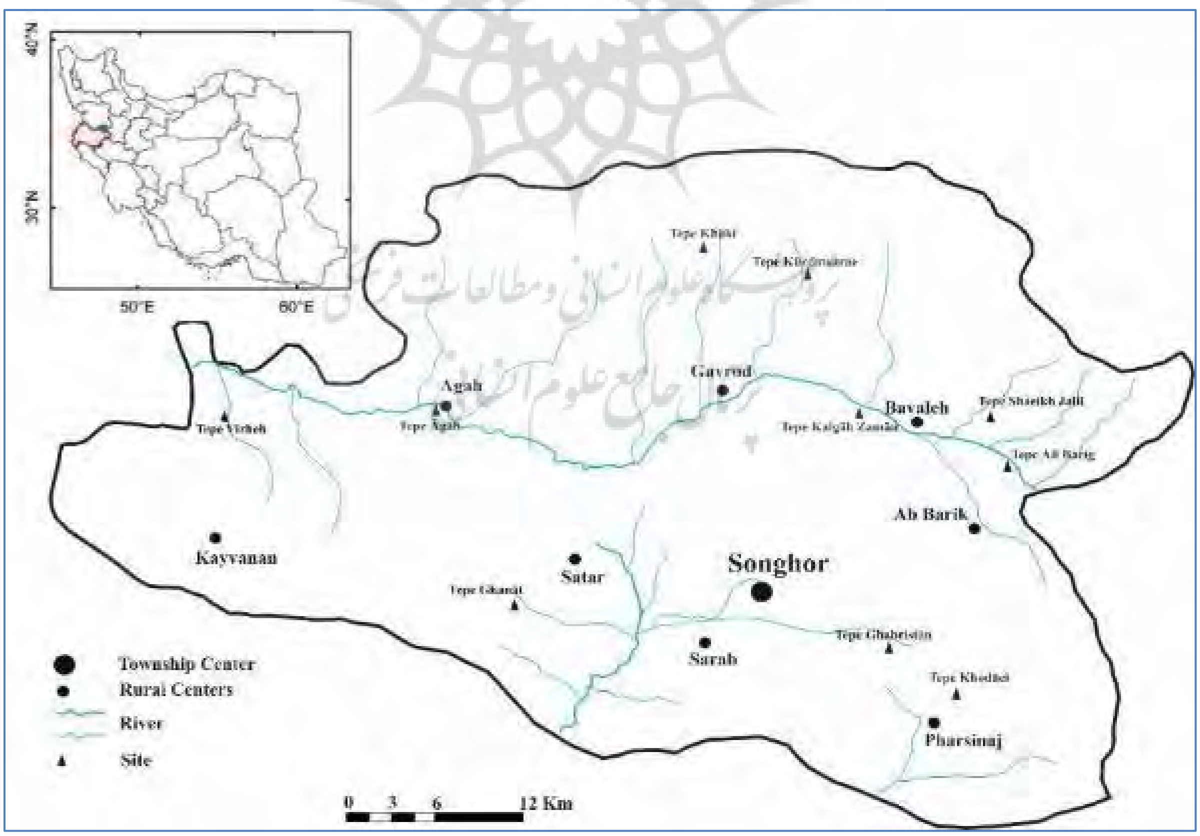

Fig. 1. Map of the region in west of Iran and the distribution of the Early Bronze sites.

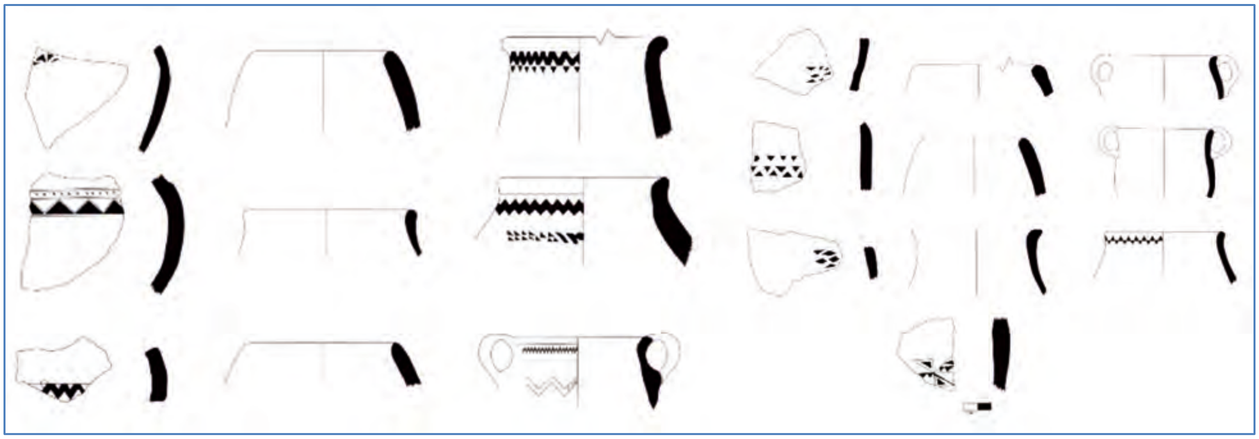

Fig. 2. **Some sherds of Godin IV selected for petrography**

Table. 1 .the result of the petrographic analysis Mineral abbreviation within the text; Quartz (Qz), Calcite (Cal), Plagioclase (Pl), Alkali Feldspar (Afs), Biotite (Bt), Hematite (Hem)

Sample	SITE	Qz (Clean)	Qz(polycrystalline)	Pl	Hematite	Pyroxene	Calcite	Biotite	P. ROCK V.Rock	M.Rock	grog	chert	Texture	TEMPER	TEMPER DENSITY
1	Kalgāh Zamān	*	*	*	*	*	*	-	-	-	-	-	porphyry	igneous rock	20 %
2	Khodāei	*	-	tr	*	-	*	tr	-	-	-	-	heterolithic silty	sandstone	10 %
3	Khodāei	*	-	-	*	tr	*	tr	-	-	tr	-	heterolithic silty	limestone	10 %
4	Vizheh	*	*	-	*	-	*	-	-	-	*	-	heterolithic silty	detritus and quartz	20 %
5	Khāki	*	*	tr	*	tr	*	-	-	-	*	-	porphyry	limestone	15 %
6	Kalgāh Zamān	*	*	*	*	tr	*	-	tr	-	*	-	porphyry	igneous rock and grog	20 %
7	Ali Baeig	*	*	-	*	tr	*	tr	tr	-	*	-	porphyry	grog	15 %
8	Ali Baeig	*	*	*	*	tr	*	-	tr	-	*	-	heterolithic silty	grog	15 %
9	Ali Baeig	*	*	*	*	*	-	-	-	-	-	-	heterolithic silty	diorite	20 %
10	Khodāei	*	-	-	*	-	*	-	-	-	-	-	silty	igneous rock	5 %
11	Khāki	*	*	*	*	-	*	tr	-	-	*	-	porphyry	limestone	15 %
12	Āgāh	*	-	-	*	-	*	tr	-	-	*	-	porphyry	grog	20 %
13	Khāki	*	*	-	*	tr	*	Tr	-	tr	*	tr	porphyry	grog and calcite	18 %
14	Ghabristān	*	*	tr	*		*	-	tr	-	*	tr	porphyry	igneous, sedimentary and grog	16 %
15	Ghabristān	*	*	*	*	*	-	-	*	-	*	-	porphyry	igneous rock and grog	18 %
16	Ali Baeig	*	*	-	*	tr	*	-	-	-	-	-	silty (wheel made)	grog	15 %
17	Ghabristān	*	*	-	*	-	*	-	tr	-	*	-	porphyry	grog	15 %

18	Ghabristān	*	*	tr	*	-	*	-	-	-	*	-	porphyry	grog and calcite	15 %
19	Vizheh	*	*	tr	*	tr	*	-	tr	-	-	-	clastic	calcite	20 %
20	Ghabristān	*	*	tr	*	-	*	-	tr	-	*	-	porphyry	igneous rock and grog	17 %
21	Āgāh	*	*		*	-	*	-	tr	-	*	*	porphyry	igneous rock and grog	19 %
22	Kalgāh Zamān	*	*	-	*	-	*	*	tr	-	*	-	heterolithic silty	igneous rock and grog	22 %
23	Kalgāh Zamān	*	*	-	*	-	*	-	tr	-	-	-	silty	igneous rock	20%
24	Āgāh	*	*	-	*	-	*	*	tr	-	*	*	porphyry	grog and chert	20%
25	Āgāh	*	*	-	*	*	*	-	tr	*	-	-	porphyry	metamorphic	15 %
26	Khāki	*	*	*	*	*	-	-	-	-	-	-	clastic	qurtz	40 %
27	Vizheh	*	*	-	*	-	*	-	-	-	*	-	porphyry	quartz and calcite	12 %
28	Āgāh	*	*	*	*	*	-	-	-	-	-	-	porphyry	granite	-
29	Vizheh	*	*	tr	*	tr	*	-	-	-	*	-	silty	igneous rock	10 %
30	Ghabristān	*	*	-	*	-	*	-	*	-	*	-	porphyry	grog	20%
31	Kalgāh Zamān	*	*	-	*	-	*	tr	tr	-	*	-	heterolithic silty	mica and igneous rock	15 %
32	Khāki	*	*	*	*	-	*	-	-	-	-	-	porphyry	limestone	15 %
33	Vizheh	*	*	*	*	*	-	tr	tr	-	*	-	porphyry	igneous rock and grog	14 %

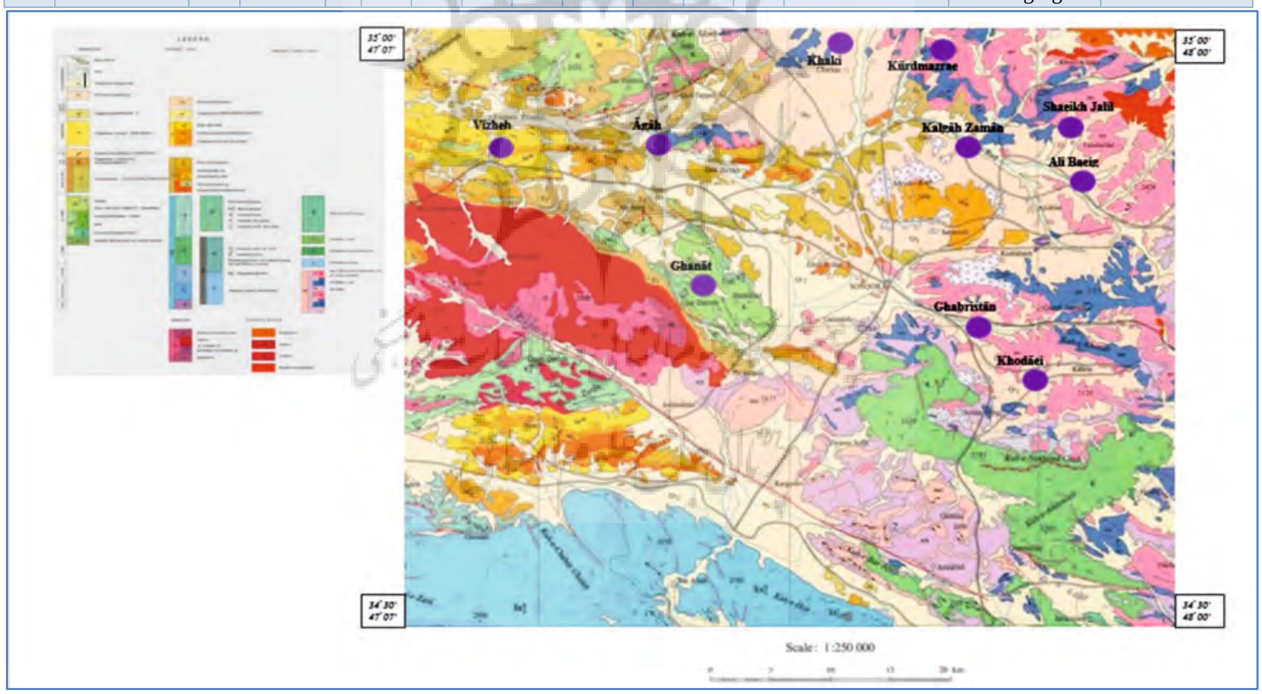

Fig. 3. Geologic Map of Sonqor

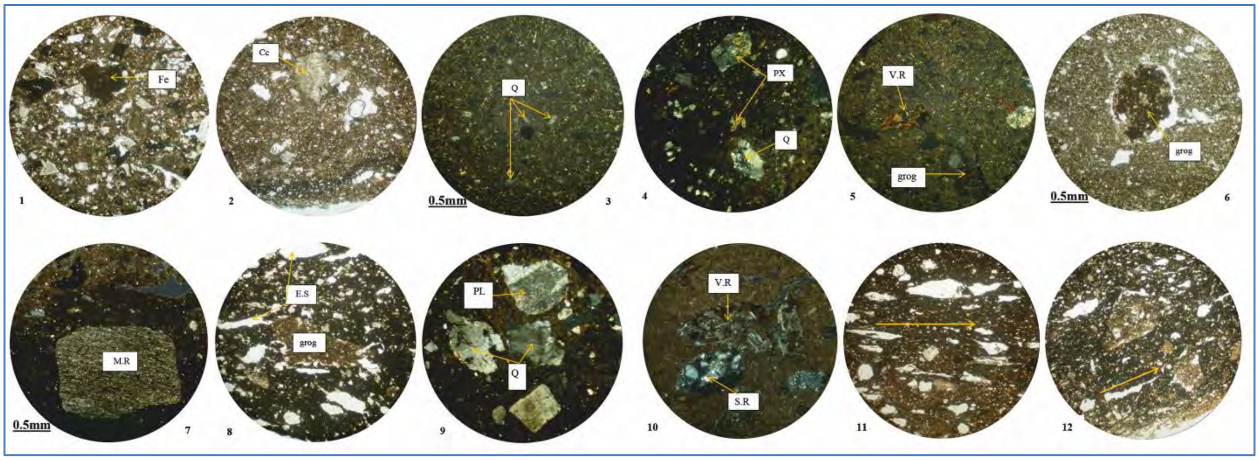

Fig. 4. Photomicrograph, 1 (Tepe Ghabristān. Light PPL, Fe-oxide, light minerals are quartz that seen in micro crystal form at center of picture is calcite in grey color), 2 (Tepe Khāki. Light PPL, residue of burned calcite), 3 (Tepe Vizheh. Light XPL, Silty Texture, quartz in phenocryst and polycrystalline form), 4 (Tepe Ali Baeig. Light XPL, Pyroxene and quartz), 5 (Kalgāh Zamān. Light XPL, volcanic rocks in center, grog are seen in dark), 6 (Tepe Khāki. Light PPL, silt mineral (Grog) is in dark at center, background is combination of silt and tiny carbonates), 7 (Tepe Khāki. Light XPL, metamorphic rock at center), 8 (Kalgāh Zamān. Light PPL, grog and volcanic rock at center and empty space are in light and dark color), 9 (Tepe Āgāh. Light XPL, Polycrystalline quartz and plagioclase), 10 (Tepe Āgāh. Light XPL, sedimentary rock, calcite and volcanic rock.), 11 (Tepe Ali Baeig. Light PPL, visible components and empty space), 12 (Tepe Khāki. Light PPL, visible components and empty space).

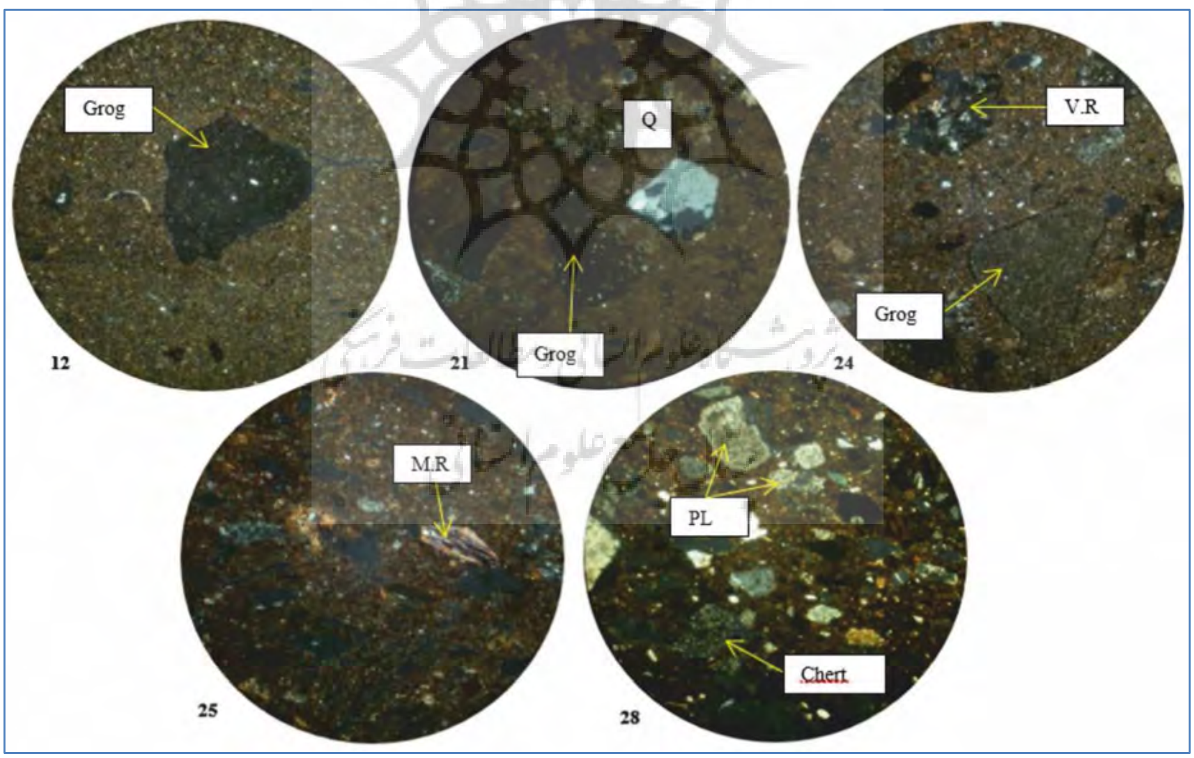

Fig. 5. Comparison of the Tepe Āgāh samples

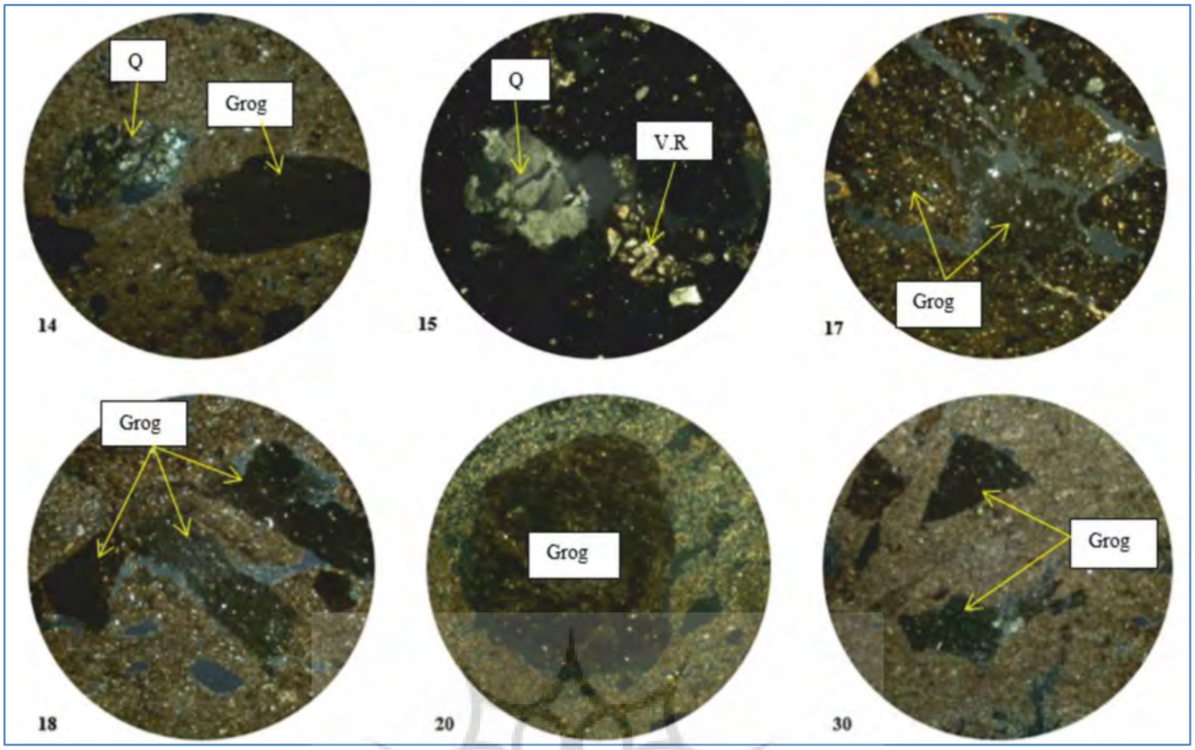

Fig. 6. Comparison of the Tepe Ghabristān samples

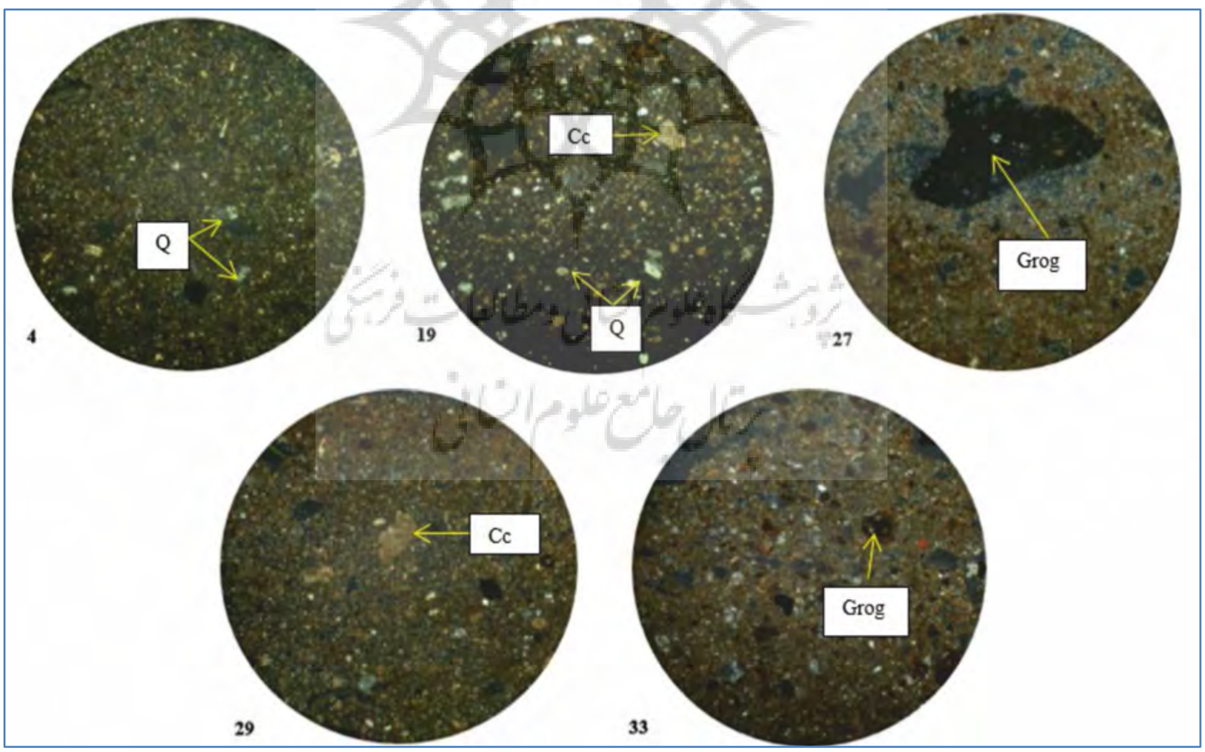

Fig. 7. Comparison of the Tepe Vizheh samples

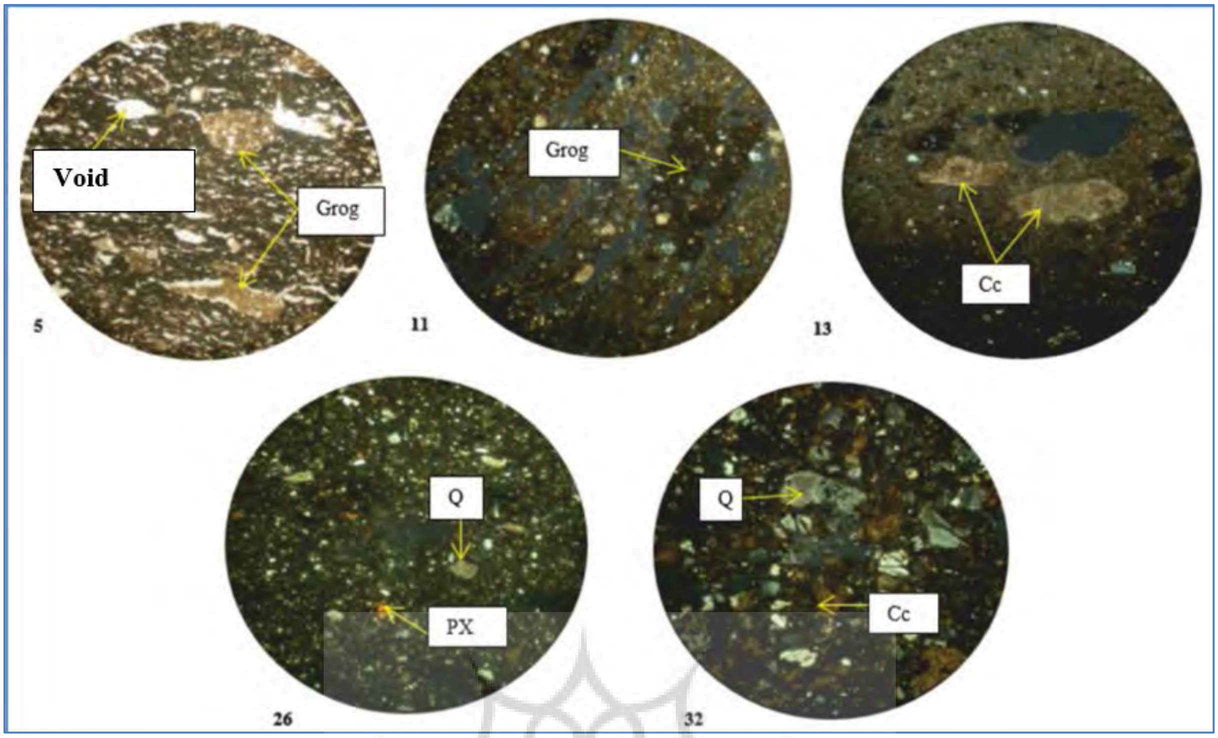

Fig. 8. Comparison of the Tepe Khāki samples

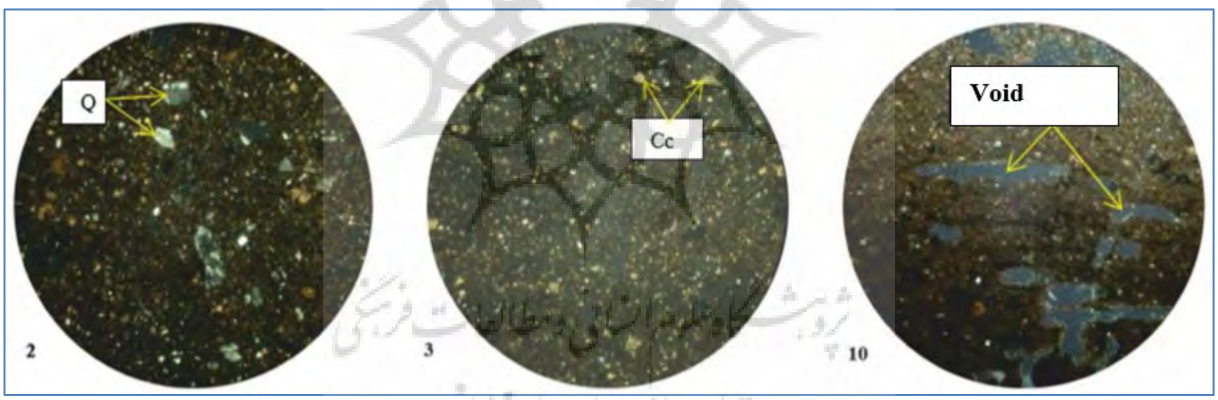

Fig. 9. Comparison of the Tepe Khodāei samples

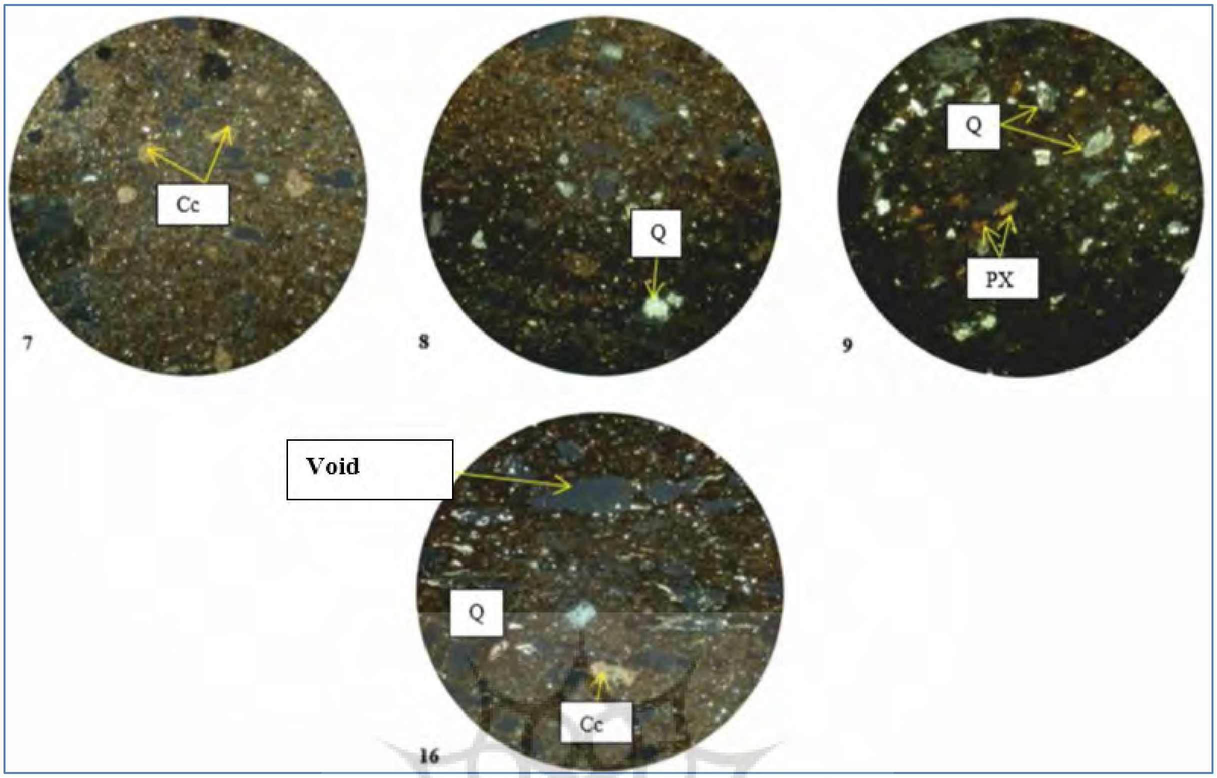

Fig. 10. Comparison of the Tepe Ali Baeig samples

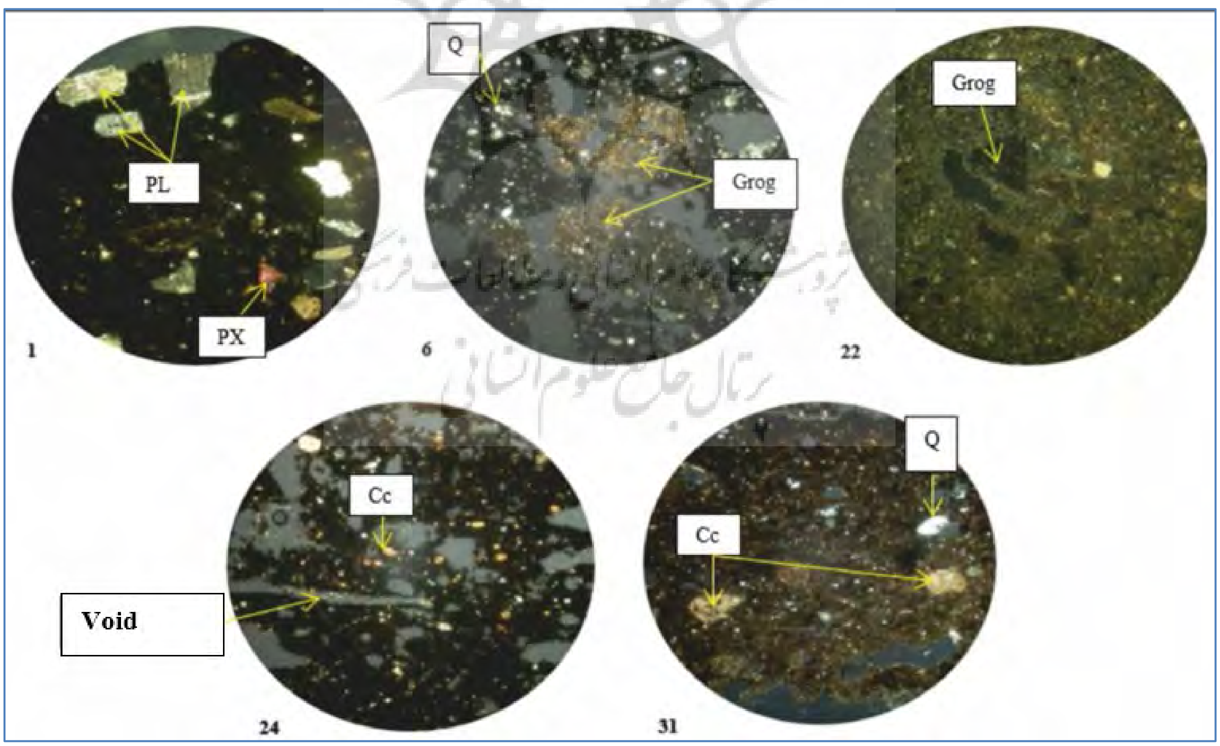

Fig. 11. Comparison of the Tepe Kalgāh Zamān samples

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مطالعه پتروگرافی سفال‌های عصر مفرغ قدیم سنقر، کرمانشاه

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چکیده: پتروگرافی سفال اغلب قادر است پاسخ‌گوی طیف وسیعی از سؤالات باستان‌شناسی، به‌ویژه در مورد ترکیبات، فرآیند ساخت، توزیع و یا تجارت سفال باشد. با این حال، سفال‌هایی که از یک محل جمع‌آوری شده‌اند، عمدتاً می‌توانند از نظر شیمی یا ترکیبات متفاوت باشند درحالی‌که با چشم غیرمسلح یکسان به‌نظر می‌رسند. همان‌طورکه در تمام تحقیقات باستان‌شناسی، جنبه‌های نظری وجود دارد، چارچوب نظری برای تفسیر نتایج تحقیقات پتروگرافی سفال بسیار ضروری است. این مقاله با رویکرد پتروگرافی به بررسی فرآیند تولید سفال کورا-ارس یا عصر مفرغ قدیم در دشت سنقر می‌پردازد؛ شناخت ارتباطات و راهبردهای تبادل بین جوامع بومی و برخی حوزه‌های فرهنگی در اوایل عصر برنز (آغاز هزاره چهارم پیش از میلاد) در این منطقه بسیار ارزشمند است. داده‌های ریخت‌شناسی همراه با ترکیبات کانی‌شناسی سفال‌ها برای تعیین عناصر اصلی قطعات سفال استفاده شد. براساس نتایج به‌دست آمده، می‌توان پیشنهاد کرد که همه قطعات در یک گروه قرار دارند و تولیدات محلی قوی را نشان می‌دهند. فناوری ساخت سفال نشان‌دهنده الگوهای مشابهی از ترکیب مواد در طول عصر مفرغ قدیم یا کورا-ارس در تمام محوطه‌های بررسی شده در دشت سنقر است.

واژه‌های کلیدی: پتروگرافی؛ سفال؛ منشاءیابی، عصر مفرغ قدیم.