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PETROGRAPHY AND THIN SECTION STUDY OF YANIK CULTURE'S POTTERY (KURA-ARAXES) AT TAPE KELAR, KUL TAPE AND TAPE GOURAB: CASE STUDY

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ABSTRACT

From the late fourth millennium to the early third millennium, an homogenous culture with common features emerged in a vast region, including the northern part of the Iranian plateau, the east and north-east of Turkey, Syria, and the Mediterranean coast. This culture is known with different names, such as the Transcaucasian, Kura-Araxes, Yannik, Karaz, and so on. One of its main features is the glossy, Incised and black pottery. There are many discussions about the origin and the causes of its spread. Various factors, especially immigration, trade, expansion, and imitation have been stated for the justification of this expansion. In this study, the Kura-Araxes pottery was studied in three regions, namely Tape Kelar at Kelardasht (North of Iran), Kul tape at Jolfa (Northwest of Iran), and Tape Gourab at Malayer (West of Iran). In this research, 30 pottery fragments of Kura-Aras culture were analysed by thin-section and petrography method for provenance studies. It is found that these pottery fragments were localized and consistent with the minerals and structures of the studied areas despite the diversification of soil and materials used in the production process.

KEYWORDS: pottery, Kura-Araxes, Kul Tape, Tape Kelar, Tape Gourab, petrography

1. INTRODUCTION

This pottery tradition is known with various native names, such as the Transcaucasus, Kura-Araxes, Yannik, Karaz, Khrebet Krak, and Shengavit in a wide area from the north of the Iranian plateau to the Levant region and from the north of the Caucasus, Dagestan, and Chechnya to the Chamchalim plain of Kermanshah (Alizadeh, 2010). Kiguradze and Sagona (2003) have described the features of this culture as follows: architecture with straight, semi-straight, circular walls made from clay or reed; fixed and portable hearth that are often anthropomorphic or zoomorphic form; varied types of hand-made burnished pottery with contrasting colors of black, gray, brown, and red, which are sometimes decorated; bony tools; horned animal figurines; and metal objects.

This culture apparently originates in the region between the two rivers of Kura and Araxes (Kohl, 2009) and, then, it was expanded to the adjacent regions during the second era of this culture (the Transcaucasus II) (Bernie and Lang, 2007). In Iran Seiafollah Kambakhshfard was the first archaeologist that paid attention to these potters, but these potters did not receive the attention of Iranian archaeologists that much (Alizadeh, 2010). However, this culture in Iran is known as this name due to Burney's extensive studies in Yanik Tape and the existence of a proper sequence in Yanik Tape from the Early and Middle Bronze Age; and the dissemination of the results.

Several theoretical approaches have been proposed regarding the development and extension method of the culture of Caucasus. Immigration, commerce, the dissemination of tools, and imitation by local producers are among some examples of these approaches (Batiuk 2005). Rothman's "ripples in a stream" approach that was proposed in relation to the reason for the similarity of the sites between the Early Bronze Age in the northern part of the Near East (the Early Transcaucasia culture). This suggests that large migrant groups were divided into the smaller groups, which had been separated from a larger population group and had still retained the cultural similarities of that larger group. Hence, some researchers regard the Caucasus culture in Iran, especially in the Zagros region, as a distinct example of prehistoric immigration (Rothman, 2003; Kohl, 2009). Another possibility is that many of the handmade tools of this culture found in Iran or elsewhere have been built at the main origin of this culture (the Caucasus) and, then, have been sent to other regions, while innovations could have also created these changes (Abay, 2005). Some researchers view certain forms of Caucasian pottery as representative of the trade of certain goods that were carried within these containers (Batiuk, 2013), although the intra-regional trade of these pieces of pottery had already been confirmed (Esse, 1991).

2. EARLIER PETROGRAPHIC STUDIES ON KURA-ARAXES POTTERY

Batiuk has studied the pottery of the Bayburt area in northeastern Turkey (Batiuk 2000). Batiuk also made a mention of specific non-local examples and came to the conclusion that each site has produced pottery structure with its own texture. This can reinforce the idea that the pottery has been a homemade product. Mason and Cooper (1999) studied the petrography of Bronze Age pottery at Godin Tepe, Sangalan Tepe, and Baba Ghasem Tepe, and specified that each of them has a distinct texture in such a way that even the grog inside the pottery containers were different from the pottery itself. It should be noted that the presence of grog in Bayburt's pottery is not as much as its existence in Godin and Kangavar's pottery, which had been mentioned by Mason and Cooper. Kibaroglu *et al*. (2011) studied the petrography and x-rays on Kura-Araxes pottery available on Sos Höyük site in northeastern Turkey and compared the findings with those of the other studies carried out on the neighboring sites. Then, they concluded that the pottery has been locally produced and were probably used in cases of home consumptions.

Iserlis (2009) examined the Kura-Araxes pottery of Beth Yarah which were representative of the major technological differences between Khirbet Krak potters and local potters who followed the southern Levant traditions, these differences began with the selection of raw materials, and continued until the pottery mixing, the technique of molding, decoration, and baking.

Iserlis and his colleagues (2010) published their research findings on the clay of Khirbet Krak pottery and two Kura-Araxes sites in Armenia (Aparan III and Karnut I). They concluded that all three sites had a completely local pottery industry and had also several common features that distinguish them from non-Kura-Araxes pottery.

In 2015, Iserlis and his colleagues identified three texture groups in Tsaghkasar area of Armenia, belonging to Kura-Araxes I, based on the relative frequency of minerals and evidence of deliberate manipulation and the mixture of raw materials. Clay resources were provided from the neighboring areas (even from the soil of Tsaghkasar mountain), and even on the site itself, but the interesting point is the use of volcanic ash in some vases and containers as a

supplement. In addition, it is known that it has been provided from outside the site. Schwartz et al. (2009) worked on the pottery of Malatya and Elazığ. Generally, the pottery in the region of Malatya and Elazığ was locally produced (see, Figs 1-4).

3. TAPE KELAR

Kelar Ancient Hill is located at latitude 36° 31' 42.69 ″, the longitude 51 11' 27.28 ″, and elevation 1100 m above sea level. Kelar is an almost oval hill with an area of about 6 hectares with an eastern-western expansion. Its height varies from 7 to 12 meters in different parts (Mousavi Kouhpar, 2008). The C-14 dating on the remnants of the Kelar showed that this site has been residential since the Chalcolithic (5000-3000 BC) and Yannik culture in this site dates back to 2880 BC (Heidarian, 2011: 248).

The area under study is geologically located in the central Alborz region. The rocks of the studied area include a diverse mix of different types of igneous rocks (intrusive igneous rocks, such as quartz monzonite, monosensitis, and monzonite), extrusive igneous rocks, such as basalt and ore, granite rocks and feldspathoid rocks (nepheline syenite), various types of sedimentary rocks, such as limestone, dolomite, coal limestone, sandstone, slit stone, shale, quartzite, and shale with sediments of the present era around rivers and canals (Fig.1, 1: 100,000).

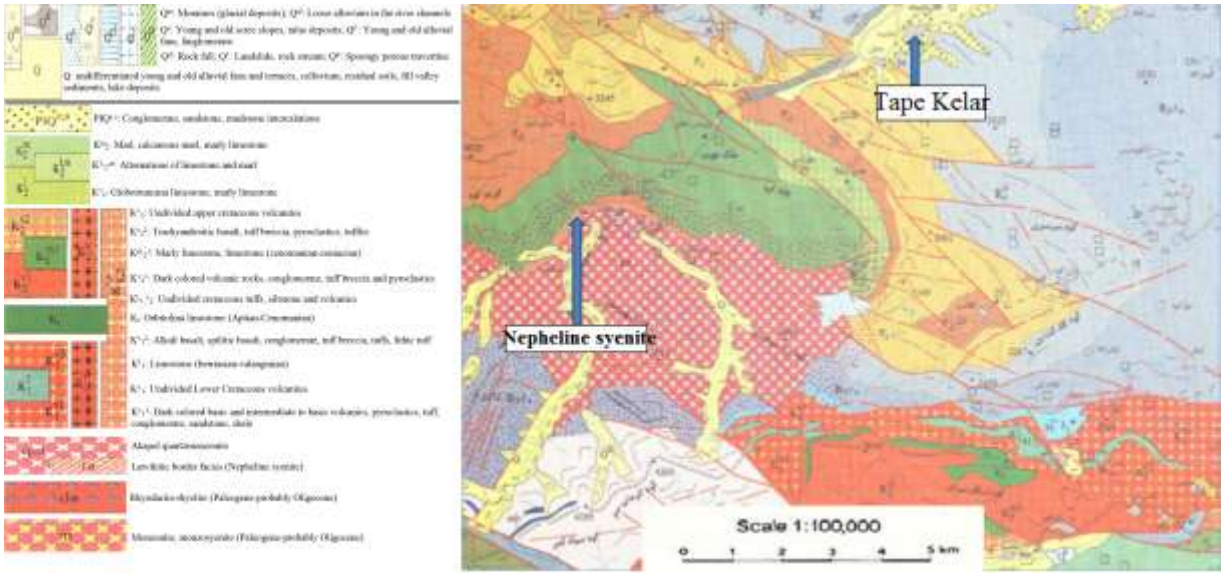

Figure 1. Geological Map of Kelardasht (in Marzan Abad Zone)

4. KUL TAPE

Kul Tape (E 45 ° 39 '43 "- N 38 ° 50' 19") is a hill with a height of 967 meters from the sea level and with an area of approximately 6 hectares and the height of 19 meters from the surface of the neighboring lands located inside the city of Hadishahr (Fig. 1). The Kul Tape site is located about 10 km to the south of Araxes River (Khatib Shahidi & Abedi, 2011). Based on carbon-14 dating conducted on this site, the history of this site dates back to 5000 BC until the Achaemenid dynasty. Accordingly, the history of the appearance of Kura-Araxes culture on this site goes back to 3600/3700 BC (Abedi *et al*. 2014).

The area under study, which is located to the northwest of the Alborz-Azarbaijan Territory, includes a general trend with the northwest-south to east direction, which is distinguishable in two sections of the flysch and platform based on the type of extrusive and facies rocks. The oldest stone units that is visible in the area of study pertains to the stone units of the Mesozoic period. These units are generally thin limestone, gray limestone, thick limestone, dolomitic rocks, and conglomerate deposits.

Conglomerate rocks, marl deposits, silty deposits with sandstone and marl, volcanic rocks, and pyroclastic rocks are found in most parts of the area under study. Andesite volcanic rocks are among the pyroclastic deposits of the Eocene period. This volcanic unit has extended over the Zunuz Chayi, Qareh Tapeh, Pir Isaac, and the north of Yamchi located in the southwest of the region. Plagioclase phenocrysts, pyroxene, and amphibole constitute the major minerals of this volcanic rock.

The above Eocene pyroclastic unit has been extended more in the south and southwest of the region, especially in the north of Yamchi to Pir Isaac, as well as in Sambron to Zunuz, and has a relatively significant expansion. The parts and rubbles of this unit are often made of andesine and dacite, and the tuffs are also observed in them. Ductile volcanic rocks of Oligocene are seen in the form of ductile domes in the region. These domes have caused

swelling of the adjacent lands, as well as the crushing and destruction of the natural process of older rocks by the creation of such mountains and hills as Kiamaki-Dagh Mountain, Qoleynj, and other peaks in the east and central parts of the country. Dacite rocks contain a porphyria texture with the background of microgranular and its Porphyries include: feldspar, biotite, amphibole, pyroxene, epidote, and zeolite. In addition, the hardening degree in the region of alluvial soils with a degree of silty to conglomerate can be found (Fig. 2).

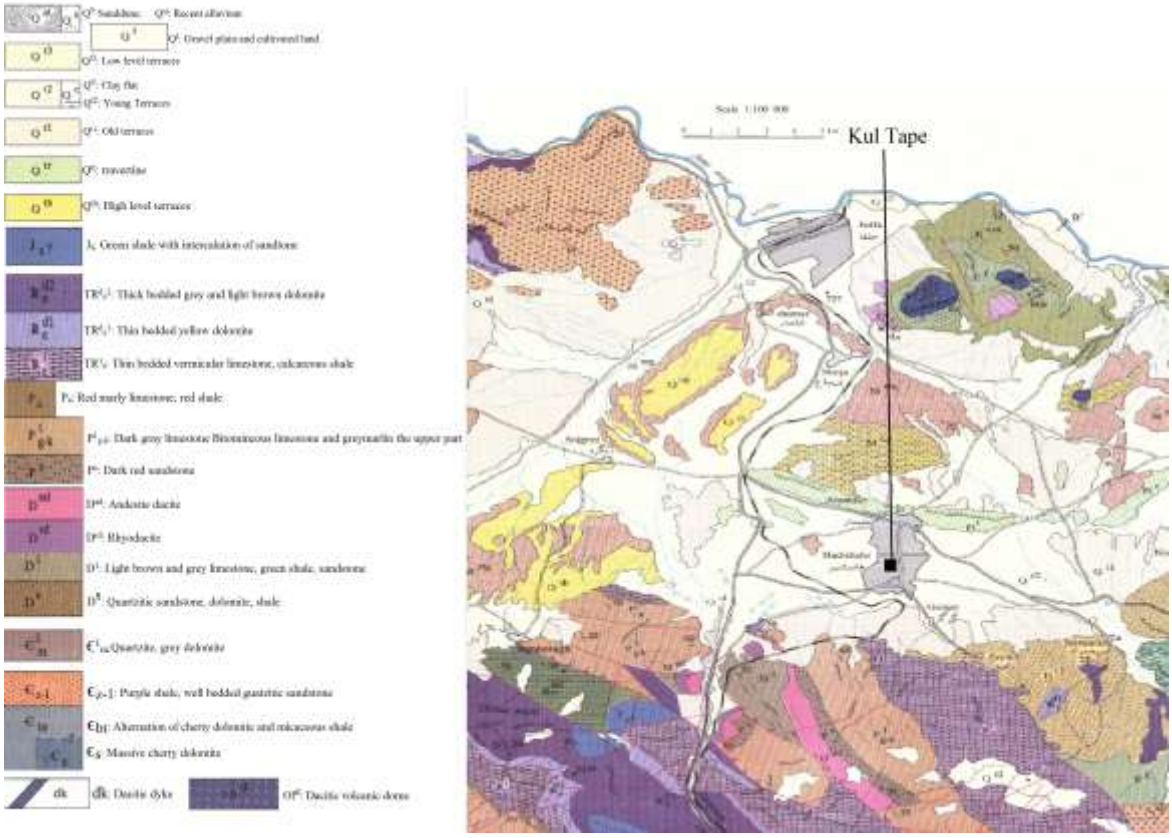

Figure 2. Geological Map of Jolfa (Based on Iranian Geology Org.)

5. TAPE GOURAB

Tape Gourab is located in the village of Gourab (Jourab), 12 km from Malayer city in Hamedan province, and is adjacent to Malayer's communication road to Hamadan. Its geographic coordinates are E 45 ° 52'00 "N 34 ° 13 '29" and the site height is 28 meters higher than the adjacent land and its height is 1823 meters above the free water level. Based on the stratigraphy of the site, 8 cultural periods, including the copper era, middle and new stone, the ancient Bronze Age, and the on Age until the Islamic era, have been identified. The deposits of Yanik culture are 5.8 meters long, which represents the continued history of this culture in this area as well as its high research value to recognize this culture in the western part of Iran. The history of this culture in Gourab dates back to 3028-2904 BC (Khaksar, Hemmati & Norouzi, 2014). The Malayer area is located in the Sanandaj-Sirjan zone from the Iran's structural geological point of view (Astuklin, 1968). This zone is, in fact, a part of the Central Iranian structure (Figs.3, 4).

Phyllite unit (J^{ph}): These rocks with the lower and middle Jurassic ages are known as the phyllites and slates of Malayer and Hamedan and have taken the highest volume of the outcrops in Malayer and its adjacent areas. The general color of this unit is dark gray to black. The microscopic studies have revealed that this rock is composed of quartz, minerals of filosilicate and feldspar. In addition, siltstone, sandstone, and fine crystalline quartz are also widely visible in some parts of this stone unit.

J^{ms} and KS units: These two units of sandstones with the Jurassic age are the other units that are found in the region and are generally available in dark gray and dark green with the interlayers of slates and phyllites.

$K^{ml,s}$, K^{sd}, and K^{l}: These units are an alternate from a thin layer of marl limestone in cream color to sandstone lime, from thick limestone to a mass with thin middle layers of slate and dolomite that are visible within the area under survey.

Gabbro rock (gb): This unit is observable in the southern part of the region, and is dark in color and

has a coarse-grained texture. Its constituent minerals are plagioclase, amphibole, and biotite with feldspar alkaline.

Granite rock (gd) and (g): It has the highest expansion in the region, and it has been composed of a combination of granite, granodiorite, and monzodiorite to diorite. Its main minerals are feldspar alkaline, quartz, and amphibole. In addition to the exposure of the mentioned rock, the fragments metamorphic garnet schist along with alluvial deposits of the present age are also found in the region (Fig.3, 4).

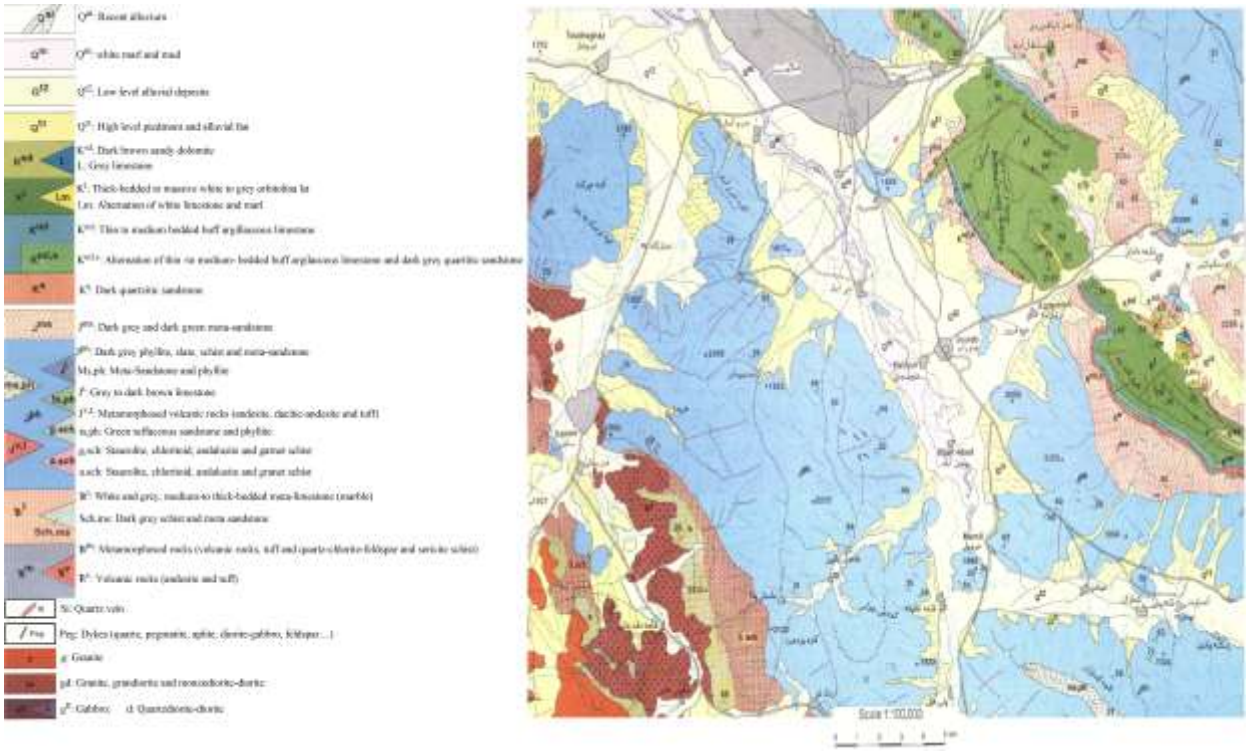

Figure 3. Geological Map of Malayer and Tape Gourab (based on Iranian Geological org)

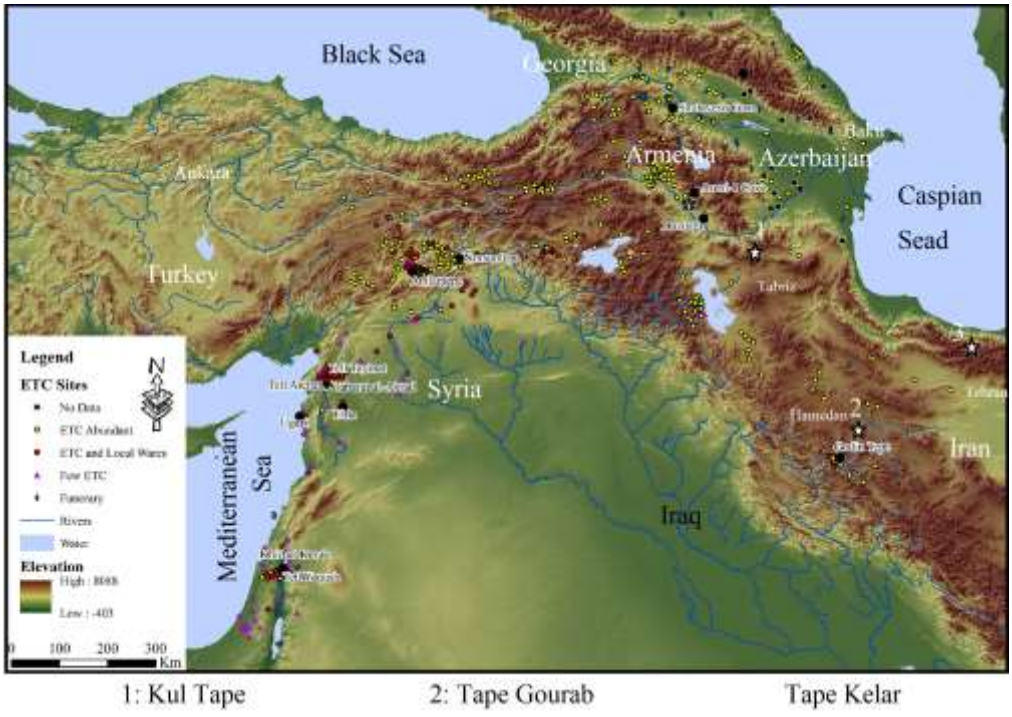

Figure 4. distribution of Kura-Araxes culture in Near East and under study sites 1- Kul Tape, 2- Tape Gourab, 3- Tape Kelar (after Batiuk, 2013)

6. PRESENT PETROGRAPHIC STUDY OF 30 SPECIMENS

In specimen selection, attempted to select the fine and high-quality potsherds, since the probability of finding imported specimens among the fine and high-quality specimens is more than among the rough and course specimens. In the meantime, the pottery under study was also selected from index types such as Nakhchivan lug and engraved potsherds. Ten specimens of pottery were collected from each site for study, a total of 30 (Figs.5-7). At this method a sample grinding to 0.03 mm, at this thickness the light can pass among the specimen; then the sample fixed onto a glass microscope slide. In next stage the samples studied by polarized light microscope. This instrument uses two types light, Plane polarized light (PPL) and crossed polar light (XPL). In which the light is polarized in to direction and interacts with the mineral specimens in the thin section, producing optical effects that can be used for their identification (Mason and Golombek, 2003; Sean Quinn 2013: 4).

Figure 5. pottery samples of Kul Tape

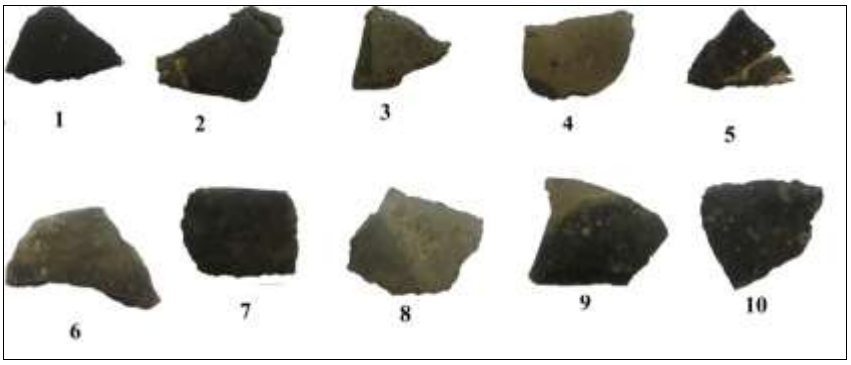

Figure 6. Pottery samples of Tape Gourab

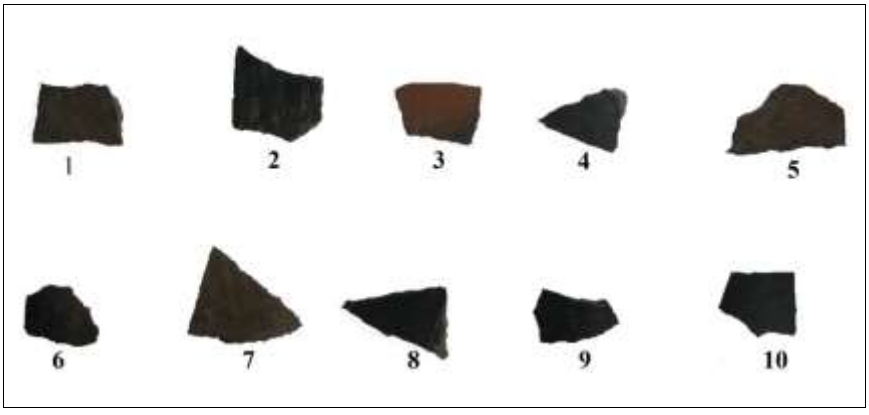

Figure 7. Pottery samples of Tape Kelar

For the microscopic study of pottery, we grind the sample to 0.03 mm and then for mineral identification James Swift's polarized binocular microscope was used. The magnifications used in this study are 4x and 10x. For ease of access to the results of petrography, the results of the review are presented in the tables.

Table 1. Reported Minerals from Kul Tape Potteries

Number of Sample	Qz(Clean)	Qz(Cloudy)	Plg	Am&Py	Fe-oxid	Mic	Cc(Mic)	P.Rock V.Rock	grog	Texture
Kultape-1	*	*	*	-	*	-	*	-	-	Silty
Kultape-2	*	*	*	*	*	*	*	tr	*	Silty
Kultape-3	*	*	*	*	*	-	-	*	-	porphyry
Kultape-4	*	*	*	*	*	-	*	*	*	porphyry
Kultape-5	*	*	*	-	*	*	*	tr	*	Silty
Kultape-6	*	*	*	*	*	-	*	-	*	Silty
Kultape-7	*	*	-	-	*	-	*	-	*	Silty
Kultape-8	*	*	-	*	*	-	*	-	-	Silty
Kultape-9	*	*	*	*	*	-	*	-	*	Silty
Kultape-10	*	*	*	*	*	-	*	*	-	porphyry

Table 2. Reported Minerals from Tape Gourab Potteries

Numberof Sample	Qz(Clean)	Qz(Cloudy)	Plg	Am& Py	Fe-oxid	Mic	Cc(Mic)	Cc(Sp)	M-Rock	P.Rock V.Rock	Sand&Silt Ston	grog	Texture
Gourab-1	*	*	tr	*	*	*	*	tr	*	-	*	*	porphyry
Gourab -2	*	*	*	*	*	*	*	-	*	-	*	*	porphyry
Gourab -3	*	*	*	*	*	*	*	-	*	*	*	-	megaporphyry
Gourab -4	*	*	tr	*	*	*	*	-	*	-	*	*	porphyry
Gourab -5	*	*	*	*	*	*	*	-	*	-	*	*	porphyry
Gourab -6	*	*	*	-	*	*	*	*	-	-	*	*	Silty
Gourab -7	*	*	*	*	*	*	*	-	*	-	*	*	porphyry
Gourab -8	*	*	*	*	*	*	*	-	*	-	-	tr	Silty
Gourab -9	*	*	*	*	*	*	*	-	*	-	*	*	Silty
Gourab - 10	*	*	*	*	*	*	*	-	*	-	*	*	porphyry

Table 3. Reported Minerals from Tape Kelar Potteries

Number of Sample	Qz (Clean)	Qz (Cloudy)	Plg	Am & Py	Fe-oxid	Mic	Cc(Mic)	Cc(Sp)	P.Rock V.Rock	Silt Shale	chalcedony	Texture
Kelar-1	*	*	tr	*	*	-	-	-	*	-	-	porphyry
Kelar -2	*	*	tr	-	*	*	-	*	*	-	*	porphyry
Kelar -3	*	*	tr	*	*	-	-	*	*	-	-	porphyry
Kelar -4	*	*	tr	*	*	-	-	-	-	-	-	Silty
Kelar -5	*	*	tr	*	*	*	-	*	*	-		porphyry
Kelar -6	*	*	tr	*	*	-	-	*	*	-	*	porphyry
Kelar -7	*	*	tr	-	*	-	-	-	*	-	*	porphyry
Kelar -8	*	*	tr	*	*	-	tr	-	*	-	-	porphyry
Kelar -9	*	*	*	*	*	-	-	-	-	tr	-	porphyry
Kelar -10	*	*	tr	-	*	-	*	*	*	-	-	porphyry

7. MICROSCOPIC STUDY OF SPECIMENS

The pottery under study are of two general structures, namely isotropy[1] and anisotropy[2] in terms of paste.

7.1. Kul Tape Specimens

As it can be observed in Table 1, quartz, plagioclase, amphibole and pyroxene, iron oxide, calcite, and igneous rock fragments are observed in all the mineral specimens. The specimens numbered 5 and 10 have the anisotropic background and the rest of the specimens have an isotopic background. In terms of fabric or petrophobic, as it can be seen in Table 1, two groups can be detected. A group of pottery that has a silty texture and is subdivided into two subsets of fine-grained crystalline silicate and heterogeneous and coarse-grained crystalline silicate. The other group of pottery is of porphyria fabric. As shown in the table, quartz, plagioclase, amphibole, iron oxide, and glycine calcite are present in all specimens. Of course, it should be noted that the frequency of each of these components varies from specimen to specimen.

Specimen No. 1 (Kultape-1): This specimen is completely different in structure from the other specimens. It has a very tiny, homogeneous, and isotropic background wherein the mineral parts of calcite, quartz, plagioclase, and iron oxide are observed in the form of porphyry (coarse-grained) and in scattered states. In this specimen, the quartz mineral is present in two forms of phenocrysts and polycrystalline (Fig. 8). The size of the constituents does not exceed 0.5mm. It is noteworthy that the presence of the remnants of primary coarse-grained calcite in this specimen is lost due to heat and only a margin of them remains (Fig. 9).

Specimens numbered 2, 5, and 8: These specimens are almost identical. Mineral calcite is abundantly found in the textures of these silty specimens. This mineral exists with coarse grains to fine grains and in combination with the background (Fig. 10). Among the other constituents of these specimens, one can refer to quartz, plagioclase, and amphibole with grog fragments (Fig. 11). The available quartz is in the form of phenocrysted and polycrystalline, and this mineral has an angled and semi-rounded margin. The size of the constituents in these specimens does not go beyond 0.5mm.

Kultape-3, 4, 10 constitutes another category of pottery specimens. These specimens are of porphyry texture (Fig. 12), and have a heterogeneous background. In these specimens, there are a large number of extrusive and intrusive igneous rocks (Fig. 13) with quartz, plagioclase, and pyroxene minerals (Fig. 14), amphibole, calcite (Fig. 15), and grog and iron oxide fragments. The size of the coarse-grained fragments is over 1mm. In the specimen numbered 10, the amount of plagioclase mineral is more than the other constituents.

Two specimens (Kultape-6, 7): These two specimens are of coarse-grained silty textures. In these two specimens, the coarse crystalline components (porphyry) are mainly silty and grog (Figs. 16 and 17). It is notable that there exists a very limited amount of plagioclase mineral the two specimens while its highly found in other specimens.

[1] Isotropy: It is a state in which no change in the color of the microscope is created and the pottery remains completely dark with a complete rotation of the microscope.

[2] Anisotropy: It is a state where the background of the pottery will get dark four times and will get light four times with the complete 360-degree rotation of the microscopic table.

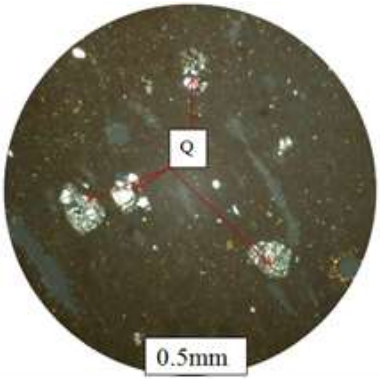

Figure 8. Sample No. 1 Kul Tepe. Light XPL, Silty Texture, quartz in phenocryst and polycrystalline form. Homogeneous clay and isotropic background, empty space seen as stretched and dark.

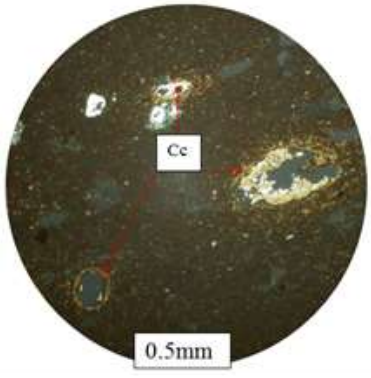

Figure 9. Sample No. 1 Kul Tepe. Light XPL, residue of burned calcite.

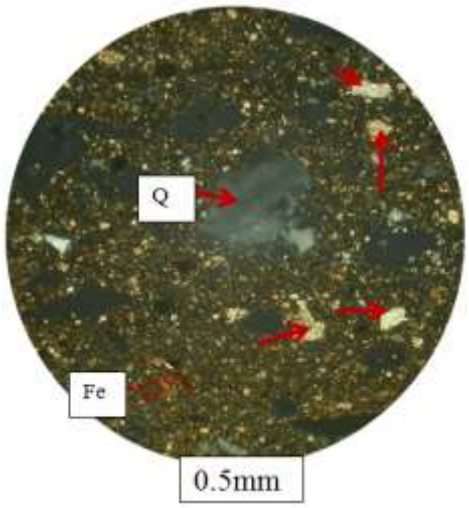

Figure 10. Sample No. 2 Kul Tepe. Light XPL, light minerals are calcite that seen in micro crystal form.at center of picture quartz is in grey color.

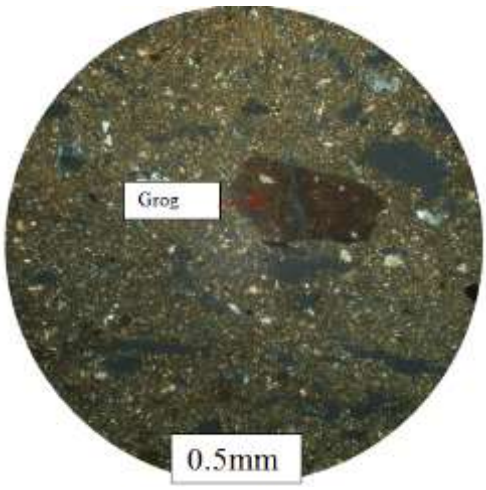

Figure 11. Sample No. 5 Kul Tepe. Light XPL, silt mineral (Grog) is in dark at center, background is combination of silt and tiny carbonates.

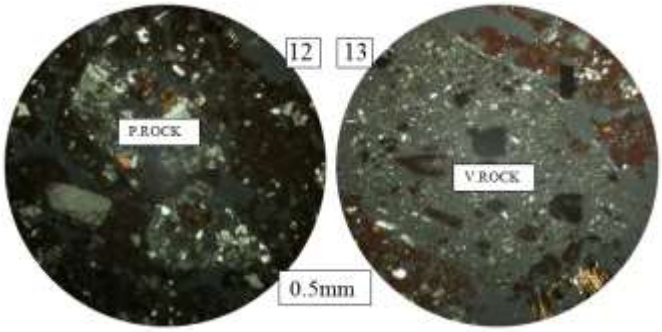

Figure 12. Sample No. 3 Kul Tepe. Light XPL, Residue plutonic rocks with tiny quartz in center of picture.

Figure 13. Sample No. 3 Kul Tepe. Light XPL, volcanic rocks in center, Fe are seen in dark.

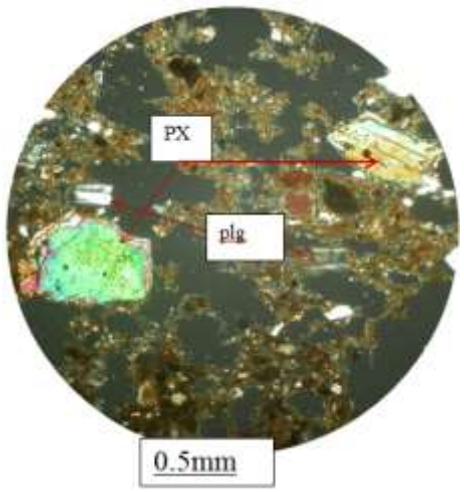

Figure 14. Sample No. 10 Kul Tepe. Light XPL, Pyroxene, Plagioclase and Iron oxide.

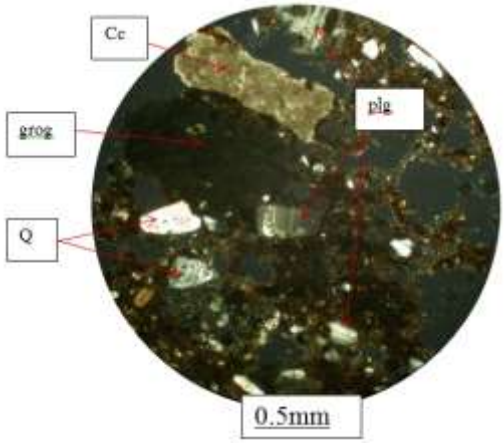

Figure 15. Sample No. 10 Kul Tepe. Light XPL, Grog, Quartz and Plagioclase.

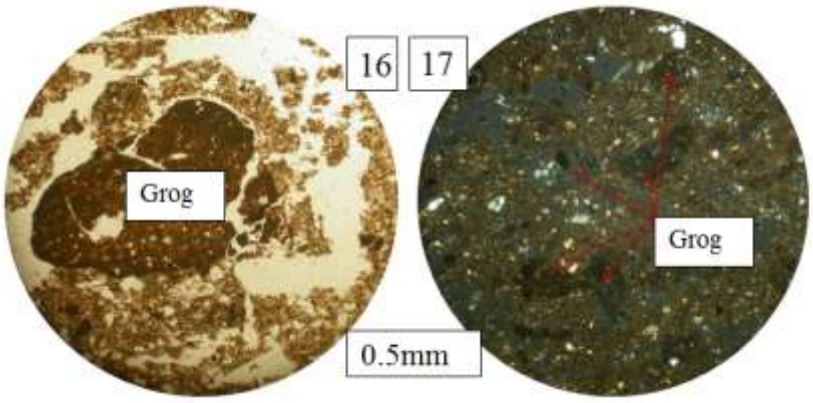

Figure 16. Sample No. 7 Kul Tape. Light ppl, grog at center and empty space are in light color.

Figure 17. Sample No. 6 Kul Tape. Light XPL, silty (grog) fragments in dark color with tiny quartz in light color.

7.2. Gourab Specimens

The *specimens numbered 1-5-6-7-9-10* have an anisotropic background and the specimens numbered 2-3-4-8 have an isotopic background. In terms of fabric or petrophobic, the specimens can be classified into three groups of specimens with megaporphyry (very coarse grains), porphyry (coarse grains), and silty or fine-grained fabrics. As it can be observed in Table 2, there are quartz, plagioclase, amphibole, iron oxide, mica, and calcite in all the specimens. Of course, it should be noted that the frequency of each of these components varies from specimen to specimen. The most abundant constituent of these potters is the quartz mineral that varies between 10 and 15 percent. This mineral is generally fine-grained, it does not exceed 0.5mm in terms of size, it has an angled margin up to a half-round one, and its phenocryst variety is more abundant than the polycrystalline quartz (Figs. 20 and 21).

The rocky fragments in the pottery are metamorphosed fragments (slate and phyllite) (Figs. 18 and 25), sandstone (Fig. 19), siltstone, igneous rocks, and grog clays (Figs. 23 and 27) in most specimens. Specimen 3 (Gourab-3) is the only specimen in which the remnants of intrusive igneous rocks (amphibole granite) along with altered and healthy feldspar phenocrysts can be observed (Figs. 21 and 22). This specimen contains a megaporphyry coarse-grained fabric. The size of its constituents reaches up to 4mm. In specimen 7, grog fragments are much more abundant than the other specimens. These fragments are often seen in dark color or in the same color as the background. The dark type of these ferments is impregnated with iron oxide and is probably of an extrusive origin relative to the background (Fig. 23); and the clay and silicate fragments that are homogeneous with the background are of the intrusive origin (Fig. 27).

There is calcite in all the specimens (Fig. 20). This is an initial calcite and coarse-grained (Esparite) cal-

cite crystal is also seen in the *two specimens numbered 1 and 6* (Fig. 28). In the study of pottery, the initial mineral calcite is used as a thermal indicator. This mineral disappears in the temperature range of 800-850 degrees Celsius, and given the fact that there is calcite in all specimens, the baking temperature of the pottery is definitely less than 800 degrees Celsius.

In *specimen No. 8 (Gourab-8),* the interesting point is that there is a low amount of filler fragments (temper) and the secondary process of alteration and formation of secondary yellow zeolite have occurred widespread (Fig. 26). Ina addition, this is the only specimen in which Garnet was observed (Fig. 27).

In *specimens 2-4-6,* the margin has a lighter color than its central part, and it contains a two-colored background. Due to the uniformity of the composition of the two parts, the main reason is the oxidation conditions, the high heat, the higher amount of oxygen in the margin of the pottery during baking compared to the interior part of the pottery (Fig. 24).

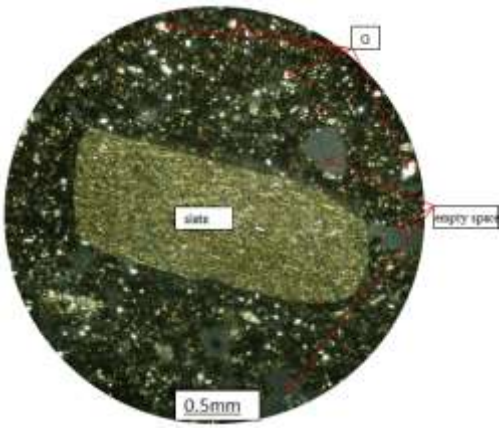

Figure 18. Sample No. 2 Tape Gourab. Light XPL, porphyry texture, slit stone fragment at center, anisotropic theme and quartz mineral in light color are seen in theme. epty space is in dark.

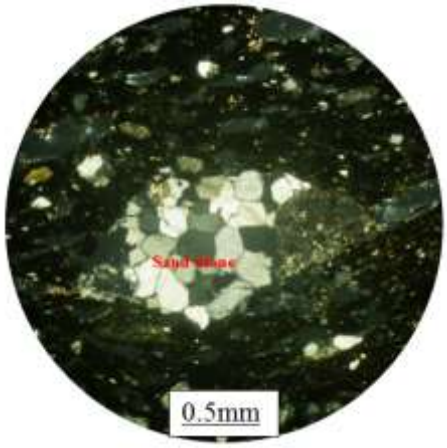

Figure 19. Sample No. 3 Tape Gourab. Light XPL, Sand stone at center. Theme is anisotropic, quartz is in light color with amphibole.

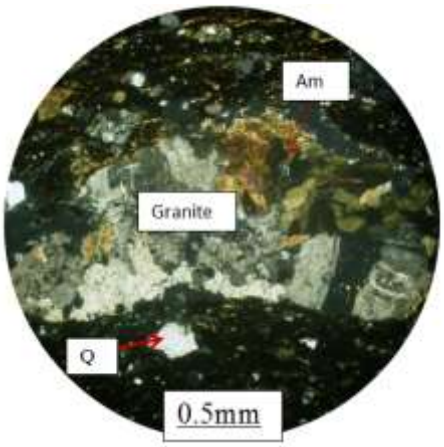

Figure 20. Sample No. 3 Tape Gourab. Light XPL, large fragment of calcite at center of picture and quartz is above.

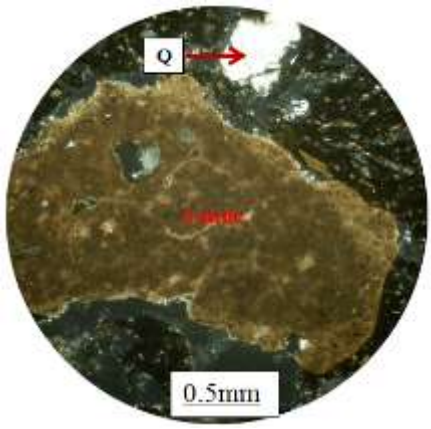

Figure 21. Sample No. 3 Tape Gourab. Light XPL, fragment of granite at center, feldspar amphibole and quartz are visible.

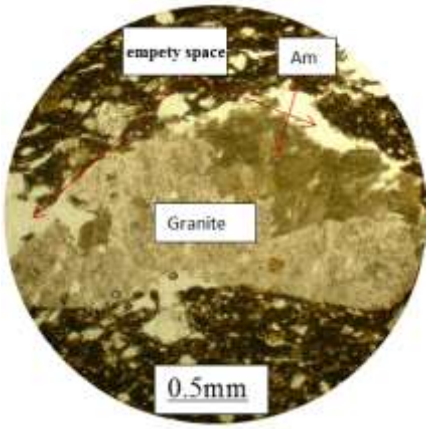

Figure 22. Sample No. 3 Tape Gourab. Light XPL, silty (grog) fragments in dark color with tiny quartz in light color.

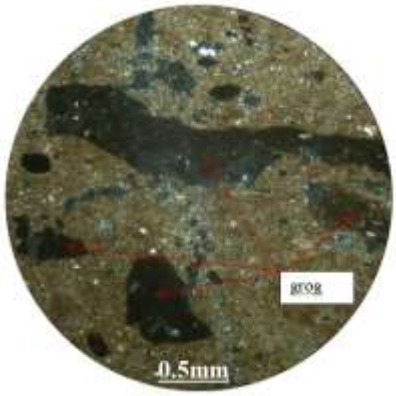

Figure 23. Sample No. 9 Tape Gourab. Light XPL, silty (grog) fragments in dark color, theme is fine and isotropic and homogenous.

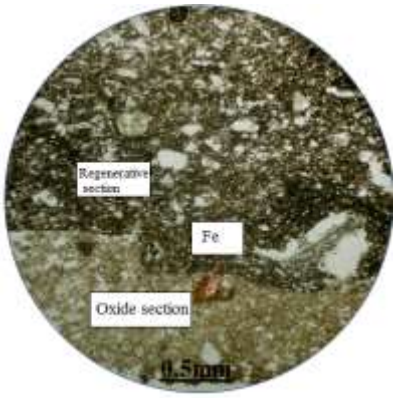

Figure 24. Sample No. 2 Tape Gourab. Light PPL, texture is completely Heterogeneous. Oxide section is in light color and Regenerative section is in dark light. Most time it is because of oxygen rate change or temperate of Kline. Iron oxide is in red color.

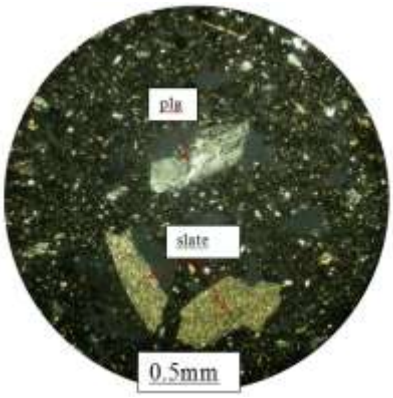

Figure 25. Sample No. 2 Tape Gourab. Light XPL, Plagioclase is in grey color at center, in lower part of picture two fragment of Phyllite or slit are visible.

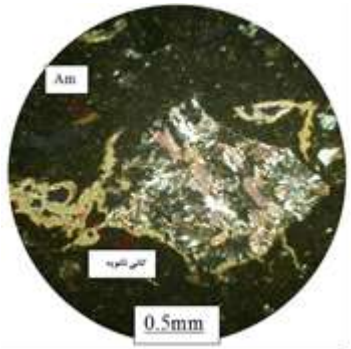

Figure 26. Sample No. 8 Tape Gourab. Light XPL, yellow mineral is because of Alteration. This mineral shaped for heating, humidity, or other situation underground.

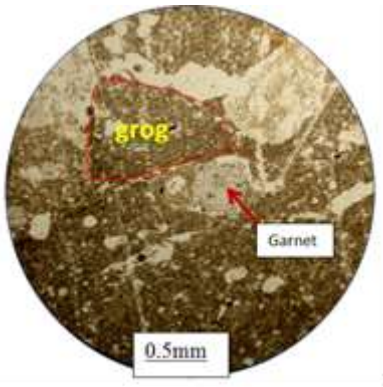

Figure 27. Sample No. 8 Tape Gourab. Light PPL, garnet and grog.

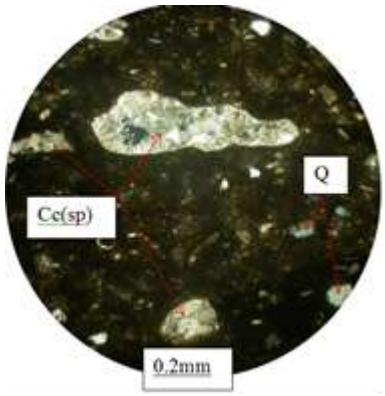

Figure 28. Sample No. 6 Tape Gourab. Light XPL, large crystal calcite in light yellow and quartz fragments.

7.3. Kelar Specimens

In a general overview, it is possible to classify the pottery under study from the texture or fabric perspective to two main categories, the specimens with a porphyry texture and the specimen with a silty texture. Specimen number 4, which has a silty texture, differs from the other specimens in terms of structure. In this specimen, the size of the constituents is smaller than 0.5 millimeters, and the average size is between 20-30 microns (Fig. 29).

Contrary to the other specimens, the main constituent of this specimen is quartz mineral, which is generally seen as phenocerite while the polycrystalline type is also seen in it. This mineral accounts for about 20% of the total volume of the specimen. In addition to quartz, other minerals, such as amphibole and mica (biotite and mesquite) also exist in the specimen in the form of fine-grained crystalline and with clay background. This specimen does not contain volcanic rocks and calcite. In other specimens, igneous rocks are coarse-grained. For example, in specimen 1, fragments of intrusive igneous rocks can be found in the pottery (Fig. 30).

In the same way, extrusive igneous rock fragments have been used as fillers (Fig. 31). Regarding other differences in pottery, specimen number 3 can be referred to. This pottery is two-colored, i.e. it is red on one side and gray on the other side. The pottery contains a porphyry texture, and the igneous rocks along with quartz and calcite are seen as coarse-grained crystals (Fig. 32). In addition to the above constituents, such minerals as pyroxene, plagioclase, and iron oxide also exist in the specimen. It should be noted that most of the coarse-grained crystal parts of the pottery specimen are placed in the red-colored side. The background is relatively homogeneous while a fluid texture is observed in the dark side and the high heat is likely to produce this state (Fig. 33).

In addition to igneous rock fragments and quartz that have been used as fillers and tampere in most specimens, calcareous stone elements (agate) have been used as fillers in a number of other specimens, such as Nos. 5, 6, 7, and 2 (Fig. 34). A very interesting point about specimens 6 and 7 is the presence of a mineral called nephalin in these specimens that distinguishes them from the other specimens. Given the presence of this type of rock in the south of the region, it can be an indication of the native nature of the pottery under study.

Nephalin is a feldspar mineral, which is in the magma in the case of the lack of silica. Nephlein is formed with the formula (Na, K) $AlSiO_4$ and is seen in the colorless polarized light and in dark XPL light. This mineral, along with the remains of igneous rocks, can be seen in specimens 6 and 7 (Fig. 35).

Specimen No. 9 differs from the other specimens in terms of composition. In this specimen, there are not any igneous rock fragments; instead, coarse-grained fragments of crystalline plagioclase, which exist in the rest of the specimens in a small amount (Fig. 36). In addition, polycrystalline quartz coarse-grained fragments along with a fragment of silt stone are the other constituents of the specimen (Fig. 37).

Regarding the existence of calcite, it should also be noted that specimens 1, 4, and 7 lack calcite, but there is calcite in other specimens. However, the interesting thing is that the existing calcite is observed in the form of coarse-grained crystalline (sparse calcite) in the specimens, and its fine-grained variety is available only in specimens 8 and 10.

Figure 29. Sample No. 4 Tape Kelar. XPL Light, silty texture, large number of quartz in light color

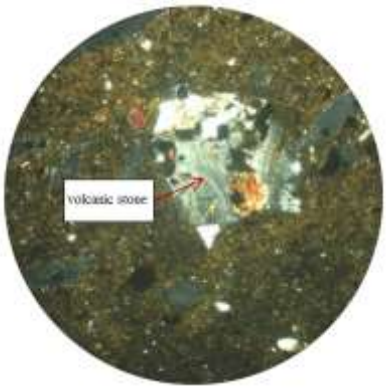

Figure 30. Sample No. 1 Tape Kelar. XPL Light, large fragment of intrusive volcanic stone is visible used as temper.

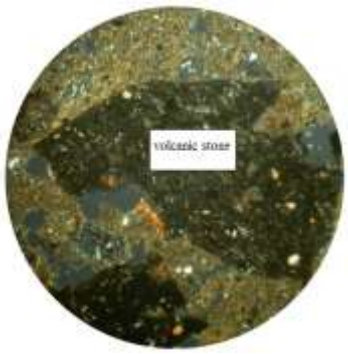

Figure 31. Sample No. 7 Tape Kelar. Light XPL, porphyry texture, several large volcanic stone are visible in theme.

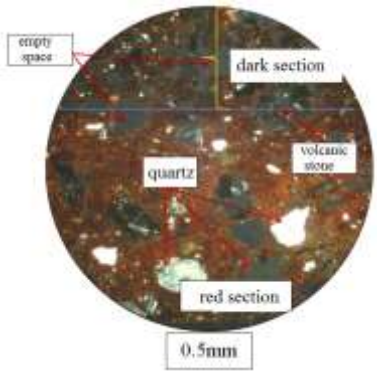

Figure 32. Sample No. 3 Tape Kelar. Light XPL, Porphyry texture, large quartz and volcanic mineral are seen. At picture two red and dark sections is obvious.

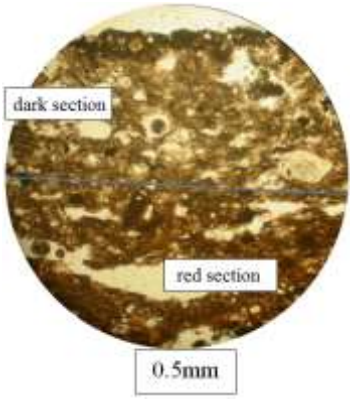

Figure 33. Sample No. 3 Tape Kelar. Light XPL, in dark section a Stream state that is because of high temperate are visible.

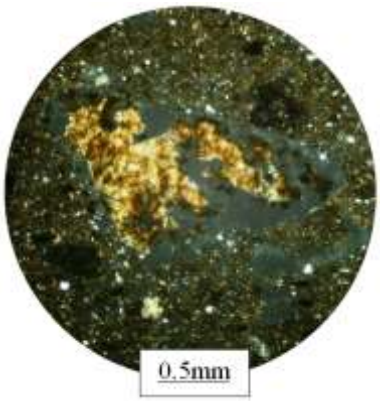

Figure 34. Sample No. 7 Tape Kelar. Light XPL, porphyry texture, large chalcedony at center.

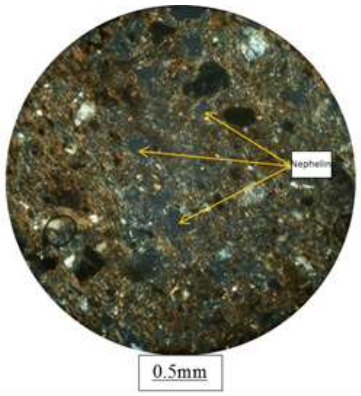

Figure 35. Sample No. 6 Tape Kelar. Light XPL, residue of Nepheline in background.

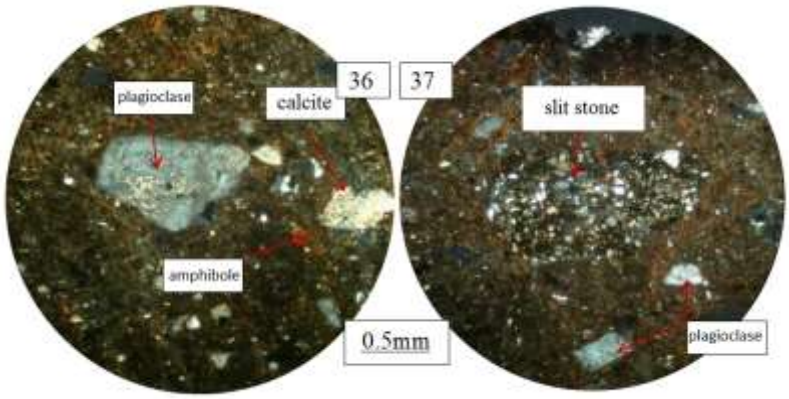

Figure 36. Sample No. 9 Tape Kelar. Light XPL, large eltrated plagioclase at center alongside calcite and amphibole.

Figure 37. Sample No. 9 Tape Kelar. Light XPL, fragment of slit and plagioclase

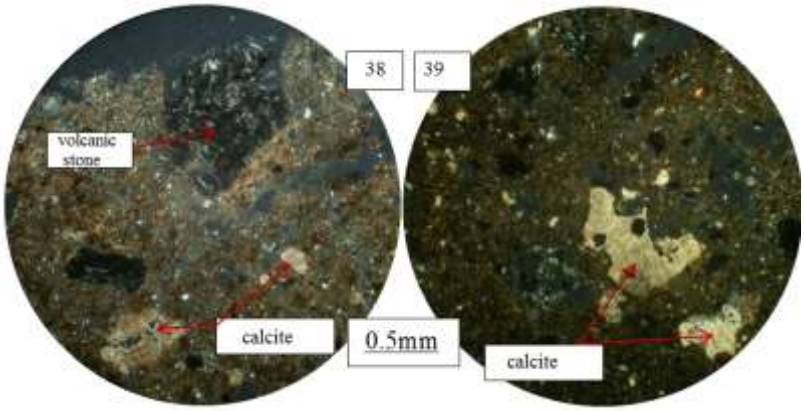

Figure 38. Sample No. 10 Tape Kelar. Light XPL, porphyry texture, residue of calcite and volcanic stones.

Figure 39. Sample No. 5 Tape Kelar. Light XPL, piece of large calcite that is available in crystal calcareous stones of Kelardasht region.

8. DISCUSSION

8.1. Kul Tape

In the Kul Tape specimens, considering the geology of the region, the Felicity sedimentary basin, volcanic rocks and pyroclastic rocks, limestone rocks and kaolin deposits (clay) in the region have been produced from the alteration of granite rocks. Considering this statement, it can be certainly argued that there is a local origin for this pottery because fragments of volcanic and pyroclastic rocks can be seen without limitation in all of these specimens. In specimens that contain calcite, these minerals are found in coarse-grained and fine-grained crystalline forms with clay backgrounds. The presence of this mineral in the composition of the pottery shows that the pottery's baking degree has not exceeded 800 degrees Celsius.

The quartz existing in these specimens is fines-grained, contains an angled and semi-rounded margin, and can be seen in both phenocrysts and polycrystalline forms. Due to the geological conditions of the region, plagioclase mineral content is abundant in specimens of clay. Another important point is the presence of volcanic glasses and crescent shaped and circular pieces, which can be seen in the specimens belonging to the Bronze Age. This volcanic glasses exist in the pottery due to high baking temperatures and as a result of partial melting (imperfect melting) in the pottery. Due to the rapid exit of the specimen from the furnace, there is not enough time for these pieces to be crystallized and remain glass-like with crested and circular pieces. In this site, like Tape Gourab, Godin Tape, Sangalan Tape, and Baba Ghasem Tape; grog has been used as the Tampere. The local production of pottery of this area is confirmed by the absence of volcanic ash in the geochemical fabric of the Caucasus region as well as in the pottery of that area and also by the texture of the area.

8.2. Tape Gourab

In the case of Gourab specimens, due to the geology of the area and the presence of slate and phyllite rocks, granite, garnet schist, sandstone, celadestone, and limestone in the region, as well as the presence of the remains of these rocks in the specimens of pottery, it can be argued that this pottery is of a local and domestic origin. In addition, due to the presence of calcite in all specimens, the temperature of the baking pottery has not exceeded 800 degrees Celsius. Specimen No. 3, is different from the other specimens in terms of the time of production and the origin of the compound (the presence of intrusive igneous particles) and has a non-native origin. Moreover, the presence of rock fragments in specimens numbered 8 and 9 is less than that in the other specimens under study, but there are higher amounts of the added clay and silicate (grog) parts in them.

8.3. Tape Kelar

In terms of the pottery of Kelar Hill, it is possible to reach the local origin of this pottery in general by considering the geology of the region and the existence of various types of intrusive and extrusive igneous rocks, the types of limestone and sandstone shale, siltstones, coal limestone, and intrusive igneous rock of nephleen sinite in the region as well as considering the presence of the remains of these rocks in the pottery.

However, apart from the locality issue, there are striking differences in terms of texture, composition, etc. in the pottery under study. In a number of pieces of pottery, various fragments of igneous rocks have been used as fillers or tempers, whereas the other

specimens do not contain igneous rock fragments. Some specimens contain parts of Chalcedon in their background. In terms of fabric or texture, two silty and porphyry or coarse-grained textures are found in the pottery. In the specimens that contain calcite, this mineral is found both in coarse-grained and fine-grained formats. The presence of this mineral in the composition of the pottery shows that the pottery's baking degree has not exceeded 800 degrees Celsius. In the specimens without calcite, the baking temperature of the pottery is more than 800 degrees.

9. CONCLUSION

From the obtained results, it can be concluded that the results of previous studies in other regions are also confirmed that the pottery used in all the current three regions were indigenous and local. The lack of volcanic ash in the specimens of Kul Tape caused the soil of Caucasus region to be distinguished. This soil contains this ash and has been reported to exist in the pottery studied by other researchers. In Gourab, only the specimen numbered 3 has a distinct texture and it has entered the region from another region due to the presence of volcanic rocks in its texture and this is indicative of a kind of communication and exchange with a distant region (with the northern parts of Zagros?). In Kelardasht specimens, based on the difference in the textures and minerals of the pottery, as well as the distinction in the pottery temperature, it is possible to identify several workshops or locations for the supply of the distinctive raw materials. However, Kelar pottery is also of a local production and the location in the south of Kelar Hill has been the supplier of soils of most of the pottery off this hill in the Bronze Age.

The final statement is that the causes of the emergence of this culture in these three regions should be sought in the items other than the exchange and trade of pottery from distant areas and even the presence of imitation, although there is evidence of the probability of pottery exchanges in short distances regarding the specimens under study.

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