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An Archaeomineralogy of the Late Chalcolithic, Early Bronze, and Middle Bronze Pottery from Tapeh Kelar

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Abstract

Pottery is of particular importance in archaeology as an indicator of chronology, art, technology, and subsistence system of ancient populations. Pottery discloses contacts and exchanges between different regions. Kelar Hill (henceforth: Tapeh Kelar) of the Kelardasht region is a major prehistoric site in western Mazandaran. The site contains cultural evidences spanning the Late Chalcolithic (fourth millennium BCE) through the Islamic period. A most significant component of the site's sequence is a Kura-Araxes deposit. As the Kura-Araxes culture originated far from Tapeh Kelar (in South Caucasia), the primary concern of the present study revolves around the structure of the pottery from the site dating to the transition from the Late Chalcolithic to the Kura-Araxes period to spot the existing variations or discrepancies. The study also tries to answer the question whether or not the Kura-Araxes material represented exotic products at Tapeh Kelar. Some 25 sherds dating to the Late Chalcolithic, and Early–Middle Bronze Age were picked up for petrographic analysis to compare the mineralogical texture of the Late Chalcolithic and Middle Bronze Age ceramics with those of the Kura-Araxes material. The analyses suggest that the Kura-Araxes pieces from Tapeh Kelar were local products despite some disparities in their texture, which stemmed from the difference in raw material sources. Therefore, the presumption that the Kura-Araxes-type pottery first entered the site through exchange or trade before the related forms were copied by local potters is refuted.

Keywords: Tapeh Kelar, Petrography, Late Chalcolithic, Kura-Araxes, Geology.

ArticleType: Research Article

Introduction

Pottery represents a cultural material of paramount significance for archaeological inquiries. Getting the utmost data from related artifacts is done through archaeometric methods (Rice, 2015). Such data helps us understand the function and the provenance of pottery objects, revealing the hidden truths behind them. Interdisciplinary studies can expose the changes in techniques, sources of raw materials, and inclusions. In the fourth millennium BCE, a new tradition, known as the Kura-Araxes or Transcaucasian culture, emerged in South Caucasia and eastern Anatolia (Rothman, 2014). The defining characteristics of the culture included a unique burnished black pottery, architecture, fixed and portable fireplaces, small figurines, and standardized tools (Kigurzade & Sagona, 2003). At the beginning of the third millennium, the culture expanded to

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cover vast territories stretching from parts of the Iranian Zagros and Alborz regions (Motarjem, 2008; Khazaie Kouhpar, 2011; Kohl, 2009) up to the eastern Mediterranean littoral (Rothman, 2014; Batiuk 2005). This immense extent has resulted in several different regional designations for the culture (Alizadeh, 2010).

Scholars have invoked various hypotheses to explain the process of this spread, among them being migration (Rothman, 2003), exchange (Abay, 2005), cultural interactions (Smogorzewska, 2004), and reproduction of foreign styles by local or migrant artisans (Akkermans and Schewartz, 2003). Notwithstanding its inherent challenges and complication, studying prehistoric migrations has been the focus of scholarly inquiries. The advent of Processual Archaeology as a form of theory in modern archeology has led to a growing trend of participation of other specialists and disciplines, especially natural science and laboratory instruments, in the examination of archaeological materials with the ultimate goal of a better analysis of the obtained data.

Archaeometric studies of pottery vessels fall into the two general parts of chemical study, and mineralogy. As to the former methodology, one can refer to instrumental neutron activation (INAA), X-ray fluorescence (XRF), and inductive couple plasma spectrometry (ICP) used for elemental analysis (Quinn, 2013: 1).

Thus, the present paper studies a pottery sample from a key site with Bronze Age (Kura-Araxes) and Late Chalcolithic evidence in Mazandaran (Tapeh Kelar) to assess whether there are any remarkable changes between its pottery assemblage and other assemblages dating to the Late Chalcolithic to the Bronze Age (Kura-Araxes). A main objective is to find out if this pottery tradition was originated by local potters or was only copied by them after it had first found its way to the site through trade.

Tapeh Kelar

Tapeh Kelar is an archaeological site in western Mazandaran Province, near the city of Chalous (Figure. 1). Encompassing a total area of 6 hectares, it is an oval, east-west oriented mound. Rising between 7–12 m above the surrounding lands, it is situated at latitude 36˚31´42.69˝, longitude 51˚11´27.28˝, with an elevation above sea level of 1100 m (Mousavi Kouhpar *et al.* 2007).

The site was excavated in 1997 to demarcate its boundaries (Karimian, 1998). In 2006, Seyed Mehdi Mousavi Kouhpar and Rahmat Abbasnejad (2006) conducted there the first season of fieldwork, which would be followed by a second one under the direction of Mousavi Kouhpar (2008). Two trenches were excavated in the course of these excavations. The first, Trench I, was opened at the center of the mound, and Trench II was excavated in its western quarter. While none of the trenches were taken down to virgin soil, the recovered evidence traces the history of occupation at the site to as early as the Late Chalcolithic period, and suggests a sequence that uninterruptedly continued up to the Islamic period. On the basis of radiocarbon absolute dating, the Late Chalcolithic at the site dates to 3766 BCE, the Early Bronze to 2880 BCE., and the Middle Bronze Age to 2299 BCE (Table. 1).

The evidence pertaining to the Late Chalcolithic, Early Bronze (Kura-Araxes), and Middle Bronze periods come from Contexts 150 to 131. The Late Chalcolithic was represented in Context 150–146. Contexts 145–141 produced an intermingled pottery assemblage datable to the Late Chalcolithic and Early Bronze (Kura-Araxes) periods. Contexts 133-140 belonged to the Early Bronze Age, while Contexts 132-131 were associated with the Middle Bronze Age evidence (Heydarian, 2011: 195-205).

Pottery sherds from these contexts split into five groups. Group 4 represent the Early and Middle Bronze Ages and Group 5 the Late Chalcolithic period. In light of the architectural remains, the sherds comprising Group 4 are divided between two subgroups. The first derives from Contexts 133–140, and the second from Contexts 131–133. The latter subgroup generally consists of gray, highly polished pottery dating to the Middle Bronze. The material in the former subgroup is made in a dark black or light gray paste, and has a polished surface marked by fine excisions. The Early Bronze Age (Kura-Araxes) deposits exposed in this trench are about 1 m thick. Drawing on radiocarbon determinations, Contexts 136 and 137 each date to 2880 BCE and 2830 BCE, respectively (Table. 1).

Contexts 141-145 make up Group 5, which is characterized by pieces made in a brown paste. The first context contained a large number of Kura-Araxes pottery. Carbon-14 dating assigns Context 144 to 3540 BCE.

The Middle Bronze Age material was recovered

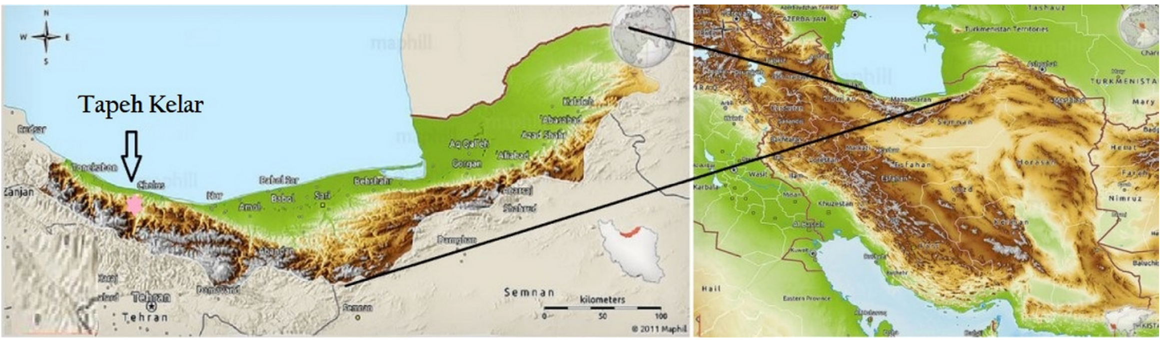

Figure. 1: *Map showing the location of Mazandaran Province and Tapeh Kelar (Illustrated by the authors based on maphil site).*

Table. 1: *Stratigraphy of Tapeh Kelar by Context number and C14 dating (Heyadrian, 2011: Table 5-1, with some modification)*

Context	Period	Absolut C14 Dating
132-131 (Trench 1)	Middle Bronze Age	OXA-18240 (3785±30 BP)
140-133 (Trench 1)	Early Bronze Age	OXA-18256 (4116±32 BP) OXA-18241 (4169±30 BP)
145-141 (Trench 1)	Late Chalcolithic	OXA-18213 (4872±33 BP)
150-146 (Trench 1)	Late Chalcolithic	OXA-18242 (4956±31 BP) OXA-23065 (5043±31 BP)

in Context 131. Measuring a thickness of about 50 cm, the context produced pottery, bones, a metal object, a stone tool (blade), and a piece of kiln waster.

The most important context regarding the transition from the Late Chalcolithic to the Kura-Araxes culture is Context 141, which was associated with a mixed pottery assemblage representing the both periods. The evidence from this context includes pottery sherds (n = 117), bone, and charcoal. The sherds split into two groups of gray and red. They display incised motifs cut into the polished surface. The Kura-Araxes and the Late Chalcolithic periods are represented by 20 sherds in the entire assemblage from this context (Heydarian, 2011: 195-208).

Methodology

As mentioned above, a sample of 25 sherds were singled out from the larger assemblage of the excavated small finds. The main objective of this study is to examine the possible changes in pottery techniques in the transition from the Late Chalcolithic to the Kura-Araxes period. A total of 10 Kura-Araxes sherds and a similar number of the Late Chalcolithic material were selected. In addition, 5 sherds dating to Middle Bronze Age were also included to supplement the Late Chalcolithic material as local pottery index (Figure. 2).

The sampled Middle Bronze Age sherds come from Contexts 131-132. A total of 155 pottery pieces from these contexts are dividable into two groups: gray, and red to brown. The Early Bronze Age and Late Chalcolithic pieces belong to Contexts 141-145. A total of 203 sherds dating to the involved two periods were recorded in these contexts, which represent a transitional phase.

The Late Chalcolithic material is a handmade pottery in a brown, red, or orange paste. The surface is shiny, and in cases painted geometric motifs were added.

The Early Bronze Age pottery is likewise handmade but shows a brown, black, or gray paste. The typically burnished surface occasionally bears incised geometric patterns (Table. 2).

For practical experiments, we used a James Swift & Son's polarizing binocular microscope at RCCCR-RICHT[1]. The prepared specimens measured 2 × 5 cm, and were covered in resin following thin sectioning.

[1] The Research Center for Conservation of Cultural Relics (RCCCR) is affiliated with Research Institute for Cultural Heritage and Tourism (RICHT).

Table. 2: *Specifications of the study sample*

Sample No.	Paste color	Interior decoration	Exterior decoration	Major Temper	Technique	period	Date
1	Light Brown	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
2	Light Brown	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
3	orange	Plain	Painted	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
4	Brown	Plain	Painted	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
5	Brown	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
6	grey	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
7	Brown	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
8	grey	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
9	red	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
10	buff	Plain	Plain	mineral	handmade	Late_Chalcolithic	Late_fourth millennium
1	Brown	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
2	Black	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
3	Brown	Plain	Plain	mineral	handmade	Early Bronze Age	Early third millennium
4	grey	burnished	excised	mineral	handmade	Early Bronze Age	Early third millennium
5	grey	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
6	Black	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
7	Brown	Plain	Plain	mineral	handmade	Early Bronze Age	Early third millennium
8	grey	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
9	Dark grey	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
10	grey	burnished	burnished	mineral	handmade	Early Bronze Age	Early third millennium
1	grey	burnished	excised	mineral	handmade	Middle Bronze Age	Middle third millennium
2	grey	burnished	excised	mineral	handmade	Middle Bronze Age	Middle third millennium
3	grey	burnished	burnished	mineral	handmade	Middle Bronze Age	Middle third millennium
4	grey	burnished	burnished	mineral	handmade	Middle Bronze Age	Middle third millennium
5	grey	burnished	burnished	mineral	handmade	Middle Bronze Age	Middle third millennium

Figure. 2: *The analyzed sample. CH: Chalcolithic, EB: Early Bronze Age, MB: Middle Bronze Age (Illustrated by the authors).*

Results

Thin Section Description of the Late Chalcolithic Pottery

Specimen 2 stands out in the whole sample given its distinct composition, which includes a calcite component as inclusion. The inclusion recorded for Specimens 3 and 5 is feldspar of perthite and antiperthite. Perthite and antiperthite are mainly found in intrusive igneous rock of the alkaline type (Figure. 3). They serve as excellent indicators of the origin of raw materials. Specimens 8 and 9 include large chalcedony clasts that are totally absent in the rest of the sample (Figure. 4).

A calcite or carbonate-rich matrix in a pottery piece testifies to firing at temperatures below 800° (Montana, 2017: 88). Thus, Specimens 2, 3, 4, 5, 6, 7, 8, 9, and 10 (Figures. 5, 6 & 7) were fired below this degree, and only Specimen 1 (Figure. 8) was exposed to a higher kiln temperature. A volcanic rock component occurs in the 4 specimens of the Late Chalcolithic period (Table. 3). This figure changes significantly in the Early Bronze Age (Kura-Araxes) subassemblage.

Table. 3: *Summary of the mineral components detected in the Late Chalcolithic pottery from Tapeh Kelar*

N. Sample	Qz (Clean)	Qz (Cloudy)	Plg	Am & Py	Fe-oxides	Mica	Cc (Mic)	Cc (Sp)	P.Rock V.Rock	Silt Shale	chalcedony	Sand stone	Texture
Kelar-1	*	*	tr	*	*	*	-	-	*	-	-	-	porphyry
Kelar-2	*	*	tr	*	*	-	-	*	-	-	-	-	silty
Kelar-3	*	*	tr	*	*	*	*	-	-	-	-	-	porphyry
Kelar-4	*	-	tr	-	*	-	*	-	*	-	-	-	silty
Kelar-5	*	*	tr	*	*	-	-	*	*	*	-	*	porphyry
Kelar-6	*	*	-	*	-	-	-	*	-	-	-	-	silty
Kelar-7	*	*	-	*	*	-	-	-	-	-	-	-	silty
Kelar-8	*	*	*	-	*	-	-	*	*	*	*	-	porphyry
Kelar-9	*	*	*	-	*	-	-	-	-	*	*	-	silty
Kelar-10	*	*	*	*	*	-	*	-	-	-	-	-	porphyry

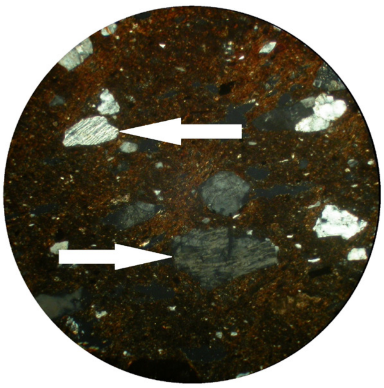

Figure. 3: *Specimen 3, X 40 magnification. Light XPL. Feldspar of perthite and antiperthite (RCCCR-RICHT).*

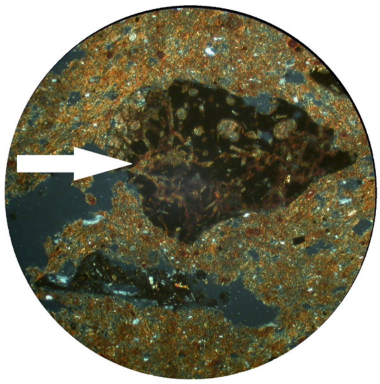

Figure. 4: *Specimen 8, X 40 magnification. Light XPL, large agate at center (RCCCR-RICHT).*

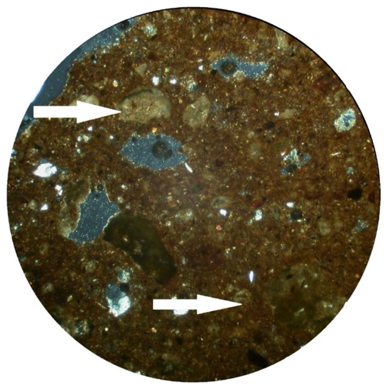

Figure. 5: *Specimen 2, X 40 magnification. Light XPL, heterogeneous porphyric texture, coarse-grained calcite in the paste (RCCCR-RICHT).*

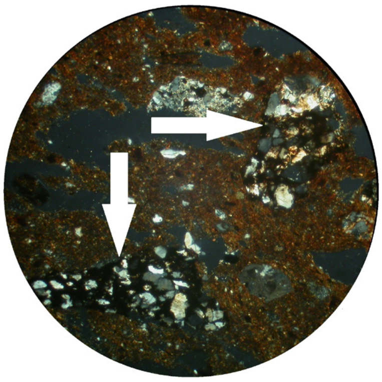

Figure. 6: *Specimen 5, X 40 magnification. Light XPL. Siltstone in paste (RCCCR-RICHT).*

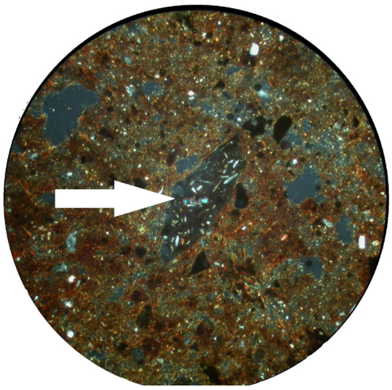

Figure. 7: *Specimen 4, X 40 magnification. Light XPL. Igneous rock at center (RCCCR-RICHT).*

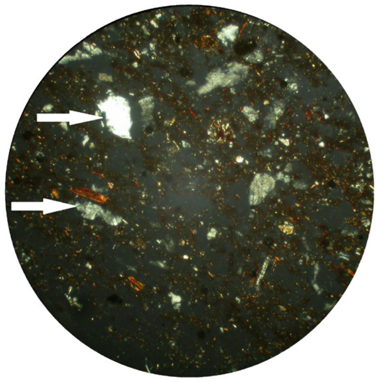

Figure. 8: *Specimen 1, X 40 magnification. Light XPL, heterogeneous porphyric texture, quartz and mica (RCCCR-RICHT).*

Thin Section Description of the Kura-Araxes Pottery

In the Kura-Araxes subassemblage, two texture types are distinguishable: one with a porphyric texture, and the second with a silty texture (Table. 4). Specimen 4, characterized by a silty texture, is structurally different from the others (Figure. 9). In this specimen, the particles measure below 0.5 mm, averaging between 20-30 mm. Unlike the other pieces, the main mineral is quartz, which is generally in phenocryst. This mineral comprises something around %20 of the total mass of the specimen. Apart from quartz, amphibole and mica (biotite and muscovite) microcrystals are also attested. The specimen lacks any volcanic rocks and calcite components. In other specimens, large clasts of igneous rocks exist in the form of large crystals. For instance, Specimen 1 has intrusive igneous rocks in its matrix (Figure. 10), and in Specimen 7 extrusive igneous rocks were added intentionally (Figure. 11).

As another case of peculiarity, Specimen 3 displays a dichromatic color scheme: it is red on one side and gray on the other. This specimen has a porphyry texture, and contains igneous rock along with quartz and calcite in the form of phenocrysts (Figures. 12 & 13). Also detected are pyroxene, plagioclase, and iron oxide. It is noteworthy that the big crystals mostly occur in the red part. The field has a relatively harmonious composition. The darker side, however, shows a sort of stream texture, most probably a result of firing at a high temperature.

In addition, igneous rocks and quartz used as fillers occur in most cases. In some other cases,

Table. 4: *Summary of the mineral components detected in the Kura-Araxes pottery from Tape Kelar.*

N. Sample	Qz (Clean)	Qz (Cloudy)	Plg	Am & Py	Fe-oxides	Mica	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

such as Specimens 2, 5, 6 and 7, chalcedony was used as temper (Figure. 14). Specimens 6 and 7 are remarkable in that they contain nepheline (Figure. 15), and thus stand out in the sample. Searching for the sources of nepheline will enable us to determine whether the original vessels were locally manufactured. Nepheline is a feldspathoidal mineral, formed when silica is missing in the magma. Nepheline (Na, K) AlSiO4 is colorless in polarized light and is seen as dark in XPL. The nepheline was detected along with the remains of igneous rocks in Specimens 6 and 7. Another structurally different instance from the rest of the sample is Specimen 9, which lacks any igneous rock components, and instead contains phenocryst plagioclase found as a minor element in other samples (Figures. 16 & 17). Large pieces of quartz polycrystalline and a bit of siltstone are the other ingredients of this specimen. Importantly, Specimens 1, 4, and 7 lacked in calcite that was present in the entire sample. However, the interesting point is that in most cases calcite exists as big crystals (calcite sparite), and its microcrystal was detected only in Specimens 8 and 10 (Figures. 18 & 19).

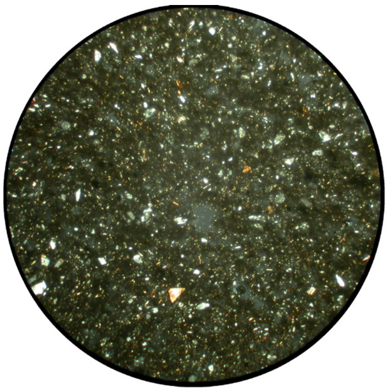

Figure. 9: *Specimen 4, X 40 magnification. Light XPL, silty paste with numerous pieces of small quartz (RCCCR-RICHT).*

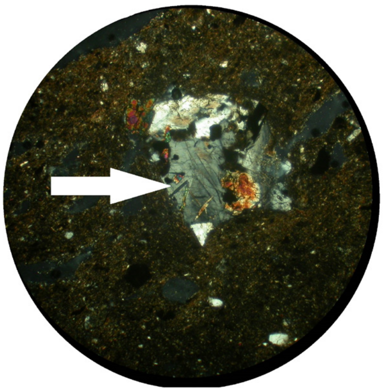

Figure. 10: *Specimen 1, X 40 magnification. XPL Light, large piece of intrusive volcanic stone is visible (RCCCR-RICHT).*

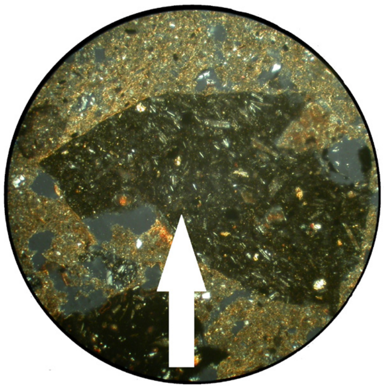

Figure. 11: *Specimen 7, X 40 magnification. Light XPL, Large volcanic stones are visible in photo (RCCCR-RICHT).*

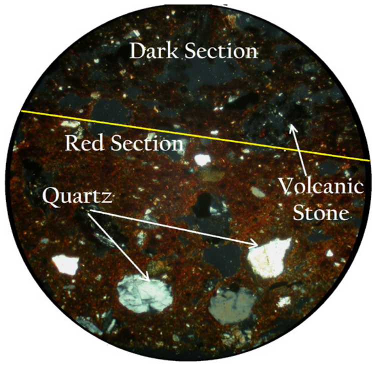

Figure. 12: *Specimen 3. X 40 magnification. Light XPL, Porphyry texture, large quartz and volcanic stone are seen (RCCCR-RICHT).*

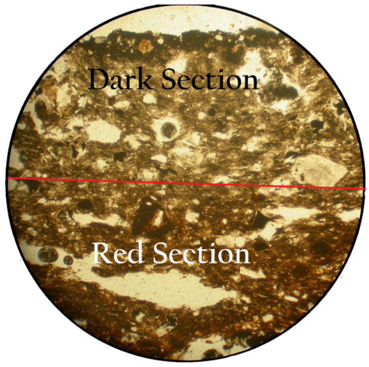

Figure. 13: *Specimen 3. X 40 magnification. Light XPL, in dark section a melted state that is because of high temperate is visible (RCCCR-RICHT).*

Thin Section Description of the Middle Bronze Pottery of Tape Kelar

This subasemblage is represented in the sample by 5 specimens, all of which are dark and have a dark paste. Two types of silty and porphyry textures were discernible (Figure. 20). No indications of grog existed (Table. 5). The presence of calcite again shows that the respective vessels were fired

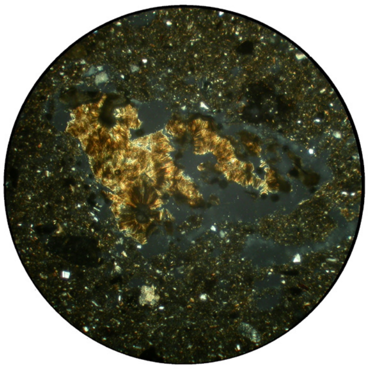

Figure. 14: *Specimen 7. X 40 magnification. Light XPL, porphyry texture, large chalcedony at center (RCCCR-RICHT).*

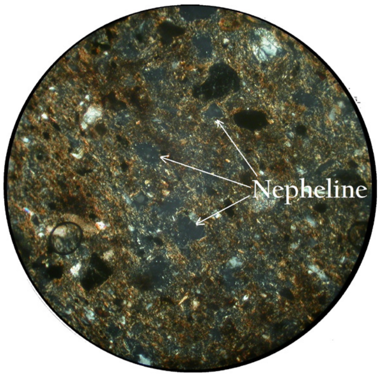

Figure. 15: *Specimen 6. X 40 magnification. Light XPL, residue of nepheline (RCCCR-RICHT).*

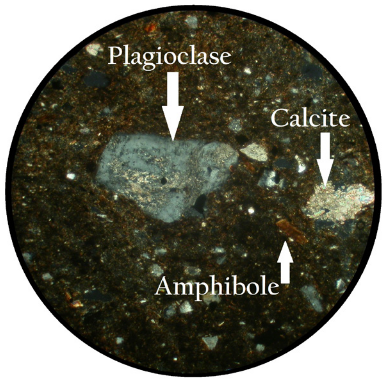

Figure. 16: *Specimen 9. X 40 magnification. Light XPL, large eltrated plagioclase at center with calcite and amphibole (RCCCR-RICHT).*

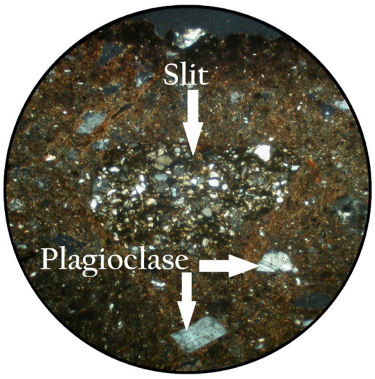

Figure. 17: *Specimen 9. X 40 magnification. Light XPL, slit and plagioclase (RCCCR-RICHT).*

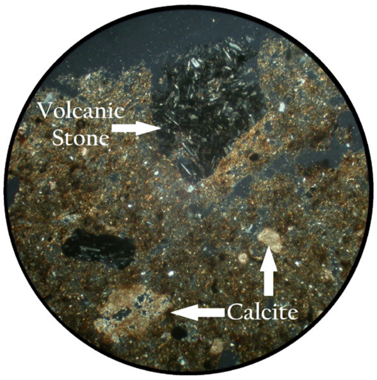

Figure. 18: *Specimen 10. X 40 magnification. XPL Light, porphyry texture, residue of calcite and volcanic stone (RCCCR-RICHT).*

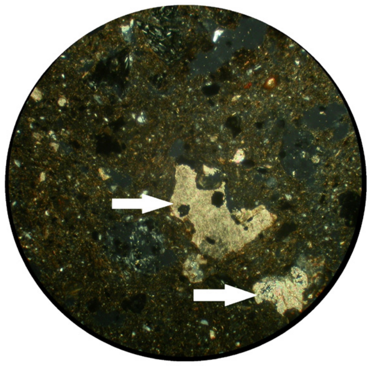

Figure. 19: *Specimen 5. X 40 magnification. XPL Light, piece of large calcite (RCCCR-RICHT).*

at temperatures below 800°. The same observation was made for the late Chalcolithic and Early Bronze material from Tapeh Kelar, indicating that temperature level at pottery kilns had not changed significantly during this elongated span of time. An agate content occurred in Specimen 3. Its presence, albeit in a smaller number of concomitant specimens compared to the Early Bronze Age material, proves that the raw material for the production of the pertinent vessels was procured from the same sources. Specimen 3 contained intrusive igneous rocks (Figure. 21) of basic type (diorite or gabbro). Specimen 2 revealed carbonate margins with bits of siltstone used as temper (Figure. 22). In Specimen 5, the margins were darker than the center (Figure. 23). It might have resulted from exposition to a high temperature at king.

Table. 5: *Summary of the mineral components detected in the Middle Bronze Age from Tape Kelar.*

N. Sample	Qz (Clean)	Qz (Cloudy)	Plg	Am & Py	Fe-oxides	Mica	Cc (Mic)	Cc (Sp)	P.Rock V.Rock	Silt Shale	chalcedony	Texture
Kelar-1	*	*	*	*	*	*	-	-	*	-	-	porphyry
Kelar-2	*	*	-	-	*	-	-	*	-	*	-	silty
Kelar-3	*	*	*	*	*	-	*	-	*	-	*	porphyry
Kelar-4	*	*	*	*	-	-	*	-	-	-	-	silty
Kelar-5	*	*	*	*	-	-	*	-	-	-	-	silty

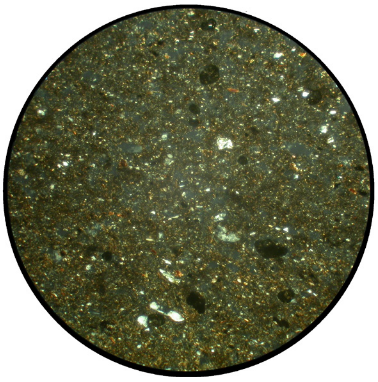

Figure. 20: *Specimen 4, X 40 magnification. Light XPL, silty paste with quartz pieces (RCCCR-RICHT).*

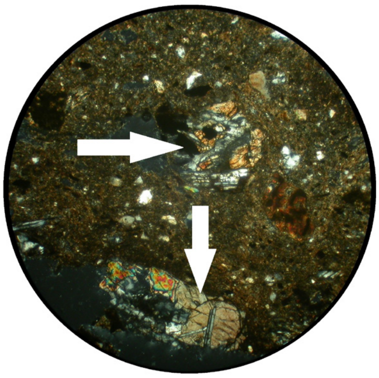

Figure. 21: *Specimen 3, X 40 magnification. Light XPL, porphyry paste with Intrusive igneous rocks of basic (RCCCR-RICHT).*

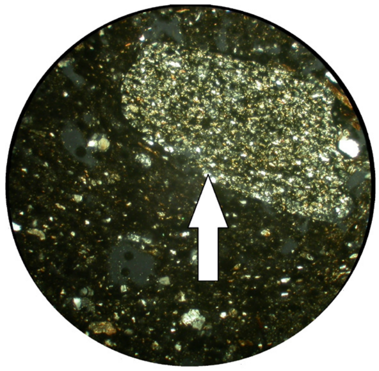

Figure. 22: *Specimen 2, X 40 magnification. Light XPL, silty paste with slit (RCCCR-RICHT).*

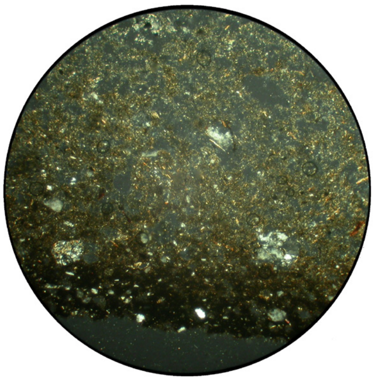

Figure. 23: *Specimen 5, X 40 magnification. Light XPL, silty paste and different color at bottom (RCCCR-RICHT).*

Discussion

Tapeh Kelar is geographically in the Central Alborz. In the Kelardasht region are found various compositions of igneous rocks (intrusive igneous rocks such as quartz, monzonite, and extrusive igneous rocks such as basalt andesite), pyroclastic igneous rocks, feldspathoid (nepheline), various forms of sedimentary rocks such as limestone, dolomite, coal limestone, sandstone, slit stone, shale, and quartzite along with present-day sediments (Figure. 24). These latter sediments occur in riverine areas and waterways (Organization of Geological Survey of Iran, Marzan Abad Map scale 1: 100 000).

There have been reported from Kelardasht a granitoid mass (SW of Kelardasht) as well as plagioclase, amphibole, feldspar (Esmaeily *et al.* 2007), elements which are detectable in the sample under study. In southern Kelardasht, in the granitoid mass of Alam Kuh, pyroxenes, garnet, amphibole, sphene, sericite, and chlorite are present (Vahdati, 1976; Hajalilou *et al.* 2013). While no mention of chalcedony in southwestern quarter of Kelardasht is made in the geological map of the Kelardasht and the work by Esmaeily and his colleagues (note however that their research did not cover the whole minerals available in the region), its existence has reported in the nearby area of Baladeh Noor (A'laie Bakhsh *et al.* 2013; A'laie Bakhsh & Sham'anian 2015) about 40 km from Kelardasht as the crow flies. Also, in a study on Nikooyeh region of Ghazvin in the Central Alborz, the presence of chalcedony in the soil's texture has been reported (Aghajani *et al.* 2016). Accordingly, the mineral's presence in the geological zone of Kelardasht is prospective. Nepheline is rare in Iran, and therefore the required nepheline for the production of alumina and other items is imported from other countries. From the 1960s onwards, some sources of nepheline began to be identified, e.g. in Kaleybar, Razgah, Bozqush, and Azarshahr in northwest Iran as well as in Soltan Meidan in northern Shahrud County and the Central Alborz. Nonetheless, since the Kura-Araxes culture did not reach the Shahrud region, the nepheline deposits in this region has nothing to do with the present study. To better understand the differences between pottery inclusions in different regions, it is better to compare some published reports.

Batiuk studied a sample from the Bayburt region in northeastern Turkey (Batiuk, 2000). He selected 20 sites, from each of which he singled out a single specimen. The ensuing publication reports the existence of specific non-local elements such as felsic volcanic, plagioclase, amphiboles, epidote, grog, olivine, limestone, quartz, biotite, and muscovite (Batiuk, 2000).

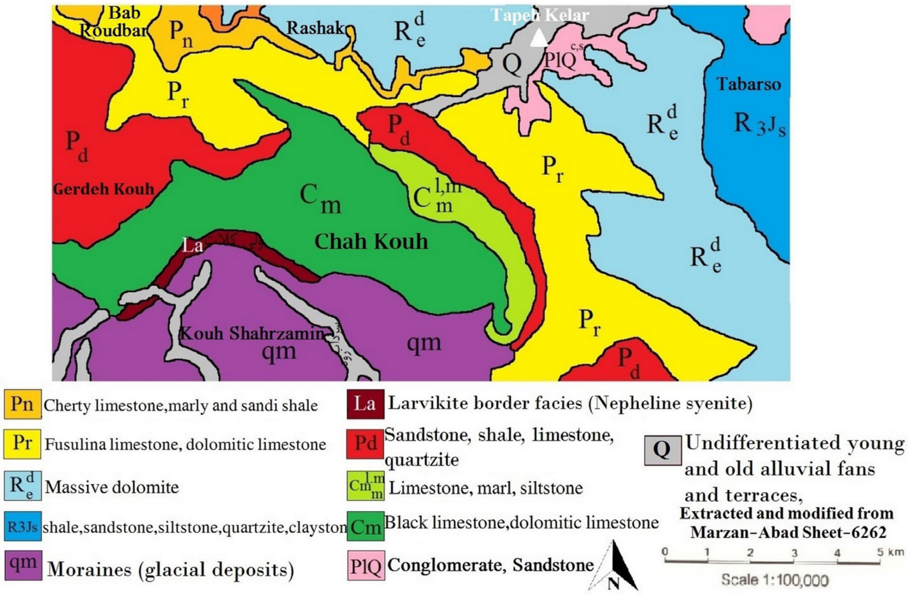

Figure. 24: *Geological map of the study area (Kelardasht), (photo by authors based on the geological map 1: 100 000 Marzan Abad, Organization of Geological Survey of Iran)*

In a 2011 study by Kibaraoglu et al. at Sus Hyuk site, the following inclusions were reported to be present in the ceramics' texture: andesite, volcanic glass, basalt, micritic limestone, quartz, plagioclase, pyroxene, and olivine.

Another study was conducted in 2015 on the Kura-Araxes pottery at Tsaghkasar, a site in Armenia considered one of the possible birthplaces of the Kura-Araxes culture (Iserlis *et al.* 2015) The studied pieces reportedly included sanidine, plagioclase, quartz, orthopyroxene, clinopyroxene, dacite, tuff, obsidian, volcanic ash, pumice, grog, organic material, and bone.

In 2009, Iserlis studied the Kura-Araxes specimens from the site of Bet Yerah, reporting the presence of such inclusions as calcite, straw, grog, crushed basalt, soil balls, and carbonatic sand.

Another study examined samples from Bet Yerah as well as two sites from the Republic of Armenia. In the specimens from Bet Yerah, chalk, basalt, calcite, quartz, plagioclase, olivine, and chert were observed. Inclusions reported from Karnut I are plagioclase, dacite, pumice, trachytic tuff, basanite, andesite, apatite, orthoclase, quartz, feldespathoids, amphiboles, grog, organic temper, rhyolite, volcanic ash, obsidian, and olivine.

And finally, specimens from Aparan III was found to contain quartz, tuff, plagioclase, biotite, calcareous grains, volcanic glass, grog, basalt, obsidian, anorthoclase, volcanic ash, pumice, andesite, hornblende, dacite, and apatite (Iserlis *et al.* 2010).

Mason and Cooper were first scholars to carry out a pertinent study on an Iranian assemblage, deriving from Godin Tepe. They reported the following inclusions: quartz, shale, mica, muscovite-quartz shist, feldespars, pyroxenes, fossiliferous micrites, grog, sandstone, siltstone, and argillite.

In another study, Khazie Kouhpar analyzed the Kura-Araxes pottery of Tepe Gurab, Malayer as part of a doctoral dissertation, which describes the Gurab material as containing the inclusions outlined in Table. 6. Notwithstanding the obvious differences and variations between the inclusions in different regions, an abrupt and remarkable change in the texture of the pottery during the transition from the Late Chalcolithic to the Early Bronze Age is readily discernible (differences are illustrated in Figure. 25).

The frequency of inclusions in most of the analyzed specimens in our sample varies between 5 to 20%. The frequency is less in some cases (samples dating to the EBA). In addition, in some instances from the EBA, xenolith occurs among the detected inclusions (Specimens no. 2, 7 & 8).

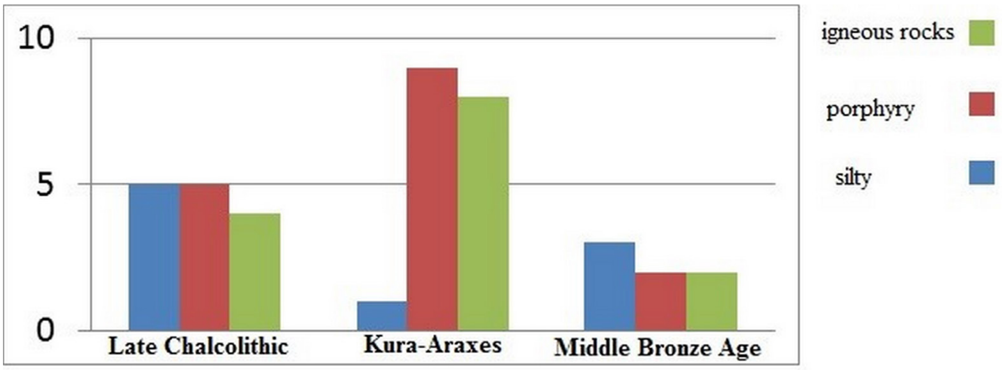

Figure. 25: *Changes in the texture of the pottery from Tapeh Kelar (Illustrated by the authors).*

Table. 6: *Inclusions of the pottery from Kura-Araxes sites in Iran and other regions.*

1- quartz, 2- plagioclase, 3- amphibol and pyroxin, 4- Fe-oxid, 5-mica, 6- calcite (Mic), 7- calcote (Sp), 8- P.rock V.rock, 9- sand & siltstone, 10-schist, 11- muscovite, 12- limestone, 13- basalt, 14- shale, 15- biotite, 16- chalk, 17- argillite, 18- basanite, 19- hornblende, 20- andesite, 21- epidote, 22- fossil, 23- orthoclase, 24- chalk, 25- sanidine, 26- apatite, 27- tuff , 28- pumice , 29- dacite , 30- organic temper, 31- anorthoclase, 32- olivine , 33- chert , 34- obsidian, 35- volcanic glass, 36- volcanic ash, 37- rhyplite, 38- felsic volcanic, 39- nepheline, 40- grog.

Site Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Bybort	+	+	+			+					+	+			+						+											+						+		+
Sos hyouk	+	+	+									+	+							+												+				+				
Tsaghkasar	+	+	+																						+		+	+	+	+				+		+				+
Karnut I	+	+	+															+		+			+			+	+	+	+	+		+		+		+	+			+
Aparan III	+	+											+		+				+	+						+	+	+	+		+			+	+	+				+
Tapeh Kelar	+	+	+	+	tr	tr	tr	+	+							+																							+	+
Gourab	+	tr	+	+	+	+	tr	tr	+																															+
Godin Tapeh	+		+		+				+	+	+			+			+					+																		+
Bet Yerah	+	+				+	+						+			+																+	+							+

The observed inclusions are dividable into two classes in appearance: equidimensional (eq) and elongate (el), among which elongated variety is more common. Based on Whitbread' approach, the inclusions in most of the studied thin sections fall in the el & eq group.

In terms of appearance and roundness or angularity of sedimentary-detrital grains, the inclusions tend to belong to the sub-angular (sa) category. A smaller percentage of these inclusions are also visible as almost sub-rounded (sr). Therefore, it seems that these sedimentary grains have traveled a shorter distance from their primary source.

The inclusions vary from poorly/very poorly sorted in specimens with a porphyry texture to moderately sorted in those with a silty texture. The boundary between coarse-grained and medium-grained inclusions in these sections is obvious. Also, the optical density of these sections is higher than that of the matrix. Nevertheless, this boundary is diffused and integrated with the fine-grained inclusions. The optical density of inclusions in these sections is evaluated as weak compared to the matrix (Table. 7).

The clay matrix accounts for the largest part in the studied sections. The voids in these sections are mostly in the form of long channels with parallel walls. Some voids are also visible in the planar shape. Generally, voids can be described as large voids and irregular medium voids. The predominant inclusions are mostly sandstone and slate and, to a lesser extent, iron ores and calcite.

Table. *7: Inclusions description according to Whitbread system.*

Sample No	Boundaries	Degree of sorting	Roundness/Angularity	Shape (eq or el)	Dominant shape	Estimation of percentage
L.Ch-1	Diffuse	Very Poorly Sorted	Sub-Angular	Elongate & equant	Anhedral	5-10% (Few)
L.Ch-2	Diffuse	Poorly Sorted	Sub-Angular	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-3	Diffuse	Very Poorly Sorted	Sub-Angular	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-4	Diffuse	Poorly Sorted	Sub-Angular	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-5	Diffuse	Very Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-6	Diffuse	Well Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	15-30% (Common)
L.Ch-7	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	15-30% (Common)
L.Ch-8	Diffuse	Very Poorly Sorted	Sub-Angular	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-9	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-15% (Few)
L.Ch-10	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	30-50% (Frequent)
E.B.A-1	Diffuse	Very Poorly Sorted	Sub-Angular >>Sub-Rounded	Equant & Elongate	Anhedral	5-10% (Few)
E.B.A-2	Diffuse	Very Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
E.B.A-3	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
E.B.A-4	Diffuse	Well Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	30-50% (Frequent)
E.B.A-5	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Equant & Elongate	Anhedral	5-10% (Few)
E.B.A-6	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
E.B.A-7	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
E.B.A-8	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
E.B.A-9	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	15-30% (Common)
E.B.A-10	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Elongate	Anhedral	5-10% (Few)
M.B.A-1	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-15% (Few)
M.B.A-2	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
M.B.A-3	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	5-10% (Few)
M.B.A-4	Diffuse	Poorly Sorted	Sub-Angular >>Sub-Rounded	Elongate & equant	Anhedral	15-30% (Common)
M.B.A-5	Diffuse	Moderately Sorted	Sub-Angular >>Sub-Rounded	Equant & Elongate	Anhedral	30-50% (Frequent)

Conclusions

Based on the geology of the Kelardasht region and the existence of various inner and exterior igneous rocks, various types of limestone and shale, sandstone, slit stone, charcoal limestone, intrusive igneous rocks, nepheline syenite in the region, and given the occurrence of these elements as inclusions in the studied sample, one can argue for the local origin of this pottery assemblage from Tapeh Kelar. Except for their local manufacture, the studied specimens showed differences in texture, composition, etc. In a number of the Early Bronze Age sherds, various igneous rocks were used as temper. However, the latter's absence from the remaining specimens reflects different clay sources. Some examples contained a chalcedony content.

Two texture types, namely silty and porphyric or phenocryst, were attested. In specimens containing calcite, these exist in the form of phenocryst and microcrystal. The presence of this mineral suggests that the temperatures at which the relevant vessels were fired were below 800°. In specimens lacking calcite, the kiln temperature exceeded 800°. On the whole, the texture of the sherds is indicative of noticeable changes between the Late Chalcolithic Age to the Early Bronze Age (Kura-Araxes period) in that out of 10 Late Chalcolithic specimens 6 contain porphyric, while calcite is present in the remaining 4. In the Early Bronze Age (Kura-Araxes) subassemblage, 9 out of 10 specimens show a porphyric texture. In the Middle Bronze Age, only two of the five specimens are porphyric.

While talking about migration based on archaeological finds is highly challenging, the pattern of Kura-Araxes culture's spread and its emergence at the localities that witnessed a decline in population and the collapse of centrality in the Late Chalcolithic, reconstructed settlement patterns in the western part of this culture in the Levant as well as its supplanting of the native traditions at some archaeological sites of the Levant all combine to suggest that migration might have been an important factor in the tremendous changes that occurred in pottery and other cultural materials during the transition from the Late Chalcolithic to the Early Bronze Age (Kura-Araxes).

Comparison of the inclusions and lithography of the pottery texture in different geographical areas in a wide range shows major differences, attesting to the fact that the Kura Araxes pottery was made locally and perhaps in domestic contexts, because if this pottery type was manufactured at one or more workshops in its birthplace in Caucasia, there would not be such differences and variations in its texture. However, this presumption needs to be tested with larger samples and complementary approaches in the future. While it is possible to embark on the topic of migration via studying the genetic changes in a site or region, such studies will need to wait until appropriate evidence is available.

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