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Araştırma/Research

Archaeometric Analysis of Early Bronze Age Dark Rimmed Orange Bowl Ware (DROB ware) from the Upper Khabur (NE-Syria) and the Upper Tigris Valley (SE-Anatolia)

[YUKARI HABUR VE YUKARI DİCLE HAVZASINDA BULUNAN ERKEN TUNÇ CAĞI "DARK RIMMED ORANGE BOWL WARE "(DROB WARE) SERAMİKLERİN ARKEOMETRİK ANALİZLERİ]

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Erken Tunç Çağı Seramikleri, Yukarı Dicle Havzası, Yukarı Habur Ha vzası, Arkeometrik Analiz, Seramik köken analizi.

Keywords

Early Bronze Age Pottery, Dark Rimmed Orange Bowl Ware, Upper Tigris Valley, Upper Khabur Valley, Archaeometric Analysis, Provenance Study.

ÖZET

Bu çalışmanın amacı, Güneydoğu Anadolu Bölgesi'ndeki Yukarı Dicle Havzasında ve Kuzey Suriye'deki Yukarı Habur Havzasında yapılan arkeolojik araştırmalarda ele geçen Erken Tunç dönemine ait Dark Rimmed Orange Bowl Ware (DROB-ware) mal grubunun, kimyasal ve petrografik analiz yöntemlerini kullanarak üretim yerinin belirlenmesidir. Bu amaçla, her iki bölgeden alınan DROB ware örneklerinin yanında, söz konusu seramiklerin üretiminde kullanılan muhtemel kil kaynak alanlarını tespit edebilmek için, her iki bölgeden çeşitli kil yataklarından örneklerde alınarak kimyasal ve petrografik analizleri yapılmıştır.

Arkeometrik analiz sonuçları, DROB ware'in Yukarı Dicle Havzasında, Bismil ve Batman arasında bulunan kil kaynaklarından üretildiğini, Yukarı Habur Havzasındaki höyüklerde bulunan örneklerin, bu bölgeye Yukarı Dicle Havzasından geldiğini göstermektedir.

ABSTRACT

The Early Bronze Age Dark Rimmed Orange Bowl Ware (DROB ware) uncovered at various archaeological sites in the Upper Khabur (NE-Syria) and the Upper Tigris Valley (SE-Anatolia) were examined using X-ray fluorescence spectroscopy and petrographic thin section methods to determine chemical and mineralogical characteristics of the ware, with a view to determining the production place of the ware. To obtain information on possible area of clay sources used in their production, local clay samples from the distribution area of DROB ware in the Upper Tigris and the Upper Khabur Valley were used as reference material.

The results of archaeometric analysis suggests that the DROB ware belongs to the Upper Tigris Early Bronze Age ceramic tradition, produced from the local clays available between the province Bismil and Batman in the Upper Tigris Valley (SE-Anatolia) and traded to the Upper Khabur Valley in NE-Syria.

1. Introduction

Dark Rimmed Orange Bowls Ware (hereafter DROB ware; Fig. 1) is a distinct ware type of the Early Bronze Age found at several sites in the Upper Khabur region in Northeastern Syria and in the Upper Tigris Valley in the Southeastern Anatolia (Fig. 2). According to Jazira chronology, DROB ware is dated to the Akkadian and post-Akkadian periods, c. 2250–2000 BCE.[1] It is characterized macroscopically by the use of fine clay and a precisely executed surface treatment. The outer surface is covered by a thin slip with a color ranging from pale brown to orange, though orange is the most common color (Fig. 1). On the rim, all vessels have a slip in the form of a wide, dark stripe, usually brown to black in color (Fig. 1). The dark slip at the vessel rim, usually outer side but sometimes covering with a narrower stripe into the inner part, is intentional and generally associated with a particular shape, namely a semi-circular bowl with a smooth or pointed rim; most are thick-walled (up to 6 mm), though there are also thin-walled (eggshell) examples.[2] A clear picture of the geographical distribution of DROB ware in the Upper Tigris is still lacking, though the salvage excavations and surveys conducted in the region in recent years shows that its occurrence is more pronounced in the Upper Tigris compared to the Upper Khabur region[3]. It is quite clear that DROB ware displays a north-south oriented distribution pattern between the Upper Tigris Valley and the Upper Khabur region over the Tur' Abdin mountains (Fig. 2). According to the present state of the research, Tell Melebiya and Tell Bderi seems to be the southernmost sites within the Upper Khabur region that show the presence of DROB ware (Fig. 2). [4]

In this paper, it is reported the results of the chemical and petrographic analysis carried out on thirty-six DROB ware sherds collected from the various sites in the Upper Khabur and in the Upper Tigris Valley (Fig. 2). An extensive collection of local clay samples (n = 79), initially collected as part of the SOAP project[5] were used in this study as reference materials for the provenance identification of the ware. The main aim of the study was to investigate the raw material source of DROB ware, and thus, to identify the production place of the ware. Further, the study also aimed to identify whether the ware was produced from a distinct clay source or used multi-clay sources. In addition, an attempt was also made to obtain some information on the production procedure of the ware, such as past preparation (levigation or temper) and firing temperature.

2. Samples

2.1. DROB ware samples

Thirty-six DROB ware sherds were selected for the chemical and petrographic analysis (Table 1). In the selection of the sherds, some macroscopic features such as the fineness of the ware (fine and coarse variants), wall thickness, and vessel shape were considered to assemble a representative sampling for the DROB Ware. The sample-set consists of examples unearthed at sites in the Upper Khabur region and in the Upper Tigris Valley: Tell Brak (n = 3), Tell Mozan (n =14), Tell Arbid (n = 1) located in Upper Khabur; and Salat Tepe (n = 9), Kavuşan (n = 4), Çayırlık Tepe (n = 2) and Susam Tepe (n = 2) located in the Upper Tigris Valley (Fig. 2). Most sherds come from archaeologically well-stratified deposits, while two samples, STP-1 and STP-2 from Salat Tepe, are from the surface collection (Table 1).

2. 2. Reference materials

A total of 79 clay samples from different spots in the Upper Tigris (n = 60) and Upper Khabur (n = 19) that have been initially collected as a part of the SOAP project[6] were considered in this study as reference materials for the comparison of the chemical and petrographic data of DROB ware (Fig.2). The samples from the Upper Tigris cover a large part of the clay deposits in the Valley; the majority come from the different terrace systems existing in the Upper Tigris, including the Batman River.[7] They were mainly collected from beneath the agricultural soil at the terrace profiles (T4, T3, and T2), where it is considered that they were not chemically contaminated by anthropogenic activity. In the Karacadağ basaltic area, the samples were collected from in-situ occurred

1 Bianchi 2012.

2 Bianchi 2012.

3 Bianchi 2012; Bianchi and Özfırat 2014

4 Bianchi 2012.

5 Kibaroğlu and Falb 2013.

6 Kibaroğlu and Falb 2013.

7 Doğan 2005.

clay deposits by manual drilling from the deep between 0.6-1.5 m. From the Upper Khabur region, a total of 19 local clay samples from various riverbeds (wadies), including four samples from Derik/Mardin region, were also included as reference materials (Fig. 2). A modern ceramic fragment (sample QP-215) and its raw clay (QM1) that was taken from the local pottery workshop in al-Qamišli was also added to the reference group. According to the potter's information, the raw clay for QP-215 and QM1 was collected from the clay-rich deposits close to the workshop.

Before the analysis, coarse clays with large inclusions were first levigated in the laboratory at the University of Tübingen (Germany) using distilled water to obtain a fine clay fraction. Subsequently, samples were manually homogenized and prepared into about 4x4x2 cm briquettes and then fired in an electric kiln at a temperature between 800–850 °C. A small part of clay briquettes was cut and ground into a fine powder using an agate mill and then submitted for chemical analysis.

3. Analytical Methods

3. 1. Wavelength dispersive X-ray fluorescence spectrometry (WDXRF)

The major (SiO_2, Ti_2O, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5) and trace element concentrations (Ba, Co, Cr, Ni, Rb, Sr, V, Y, Zn, Zr, Ce, La, Nd, Sm, and Yb) of the ceramic and reference samples were determined using a wavelength dispersive X-ray fluorescence spectrometer (Bruker AXS S4 Pioneer spectrometer, Rh X-ray tube, 4 kW) at the Institute of Geosciences, University of Tübingen (Germany) with 32 standardized samples. Analytical error and detection limits vary and depend on the element and uncertainties of sample composition. Uncertainties for all major elements are better than 1% (1SD) and for the trace elements are better than 5% (1SD).

Before grinding the ceramic samples to powder, a thin layer from internal and external surfaces of the sherds, which may have been chemically contaminated during the burial[8] was removed by a diamond-coated saw. The ceramic and clay powders were then oven-dried at a constant temperature of 105 °C for 24 hours. The measurement was performed on glassy fused beads. For that, 1.5 g (±0.003) of powder and 7.5 g (±0.003) of flux (Merck spectromelt A12, a mixture of 66% Li-tetraborate and 34% Li-metaborate) were mixed and subsequently fused at 1050 °C into a glassy fused bead to determine major and trace element concentrations. The loss-on-ignition (LOI) of the ceramic and clay samples was determined externally using 1g of powder. The measured element concentrations were recalculated by normalizing the sum of the non-volatile oxides to 100%. This procedure is required because a large part of the volatile components (LOI, mainly water and carbon dioxide) of the clays disappears during firing and is no longer present in the resulting ceramics.[9]

3.2. Petrographic thin section analysis

The petrographic analysis was carried out on thin sections from a total of 17 sherds from various sites in the Upper Khabur and the Upper Tigris valley. Thin sections were examined under a standard polarizing microscope at the Institute of Geosciences, University of Tübingen. Thin sections consist of fine and coarse variants and were from the different wall thicknesses found in both regions. This analysis was conducted to characterize the raw materials used in the DROB ware production and to identify the rock and mineral inclusions and other fabric features, to obtain information on the possible geographic location of the raw material source of the ware. Thin section analysis was also employed to identify, as far as possible, some technological aspects of production such as paste preparations and firing temperatures. A total of 24 reference samples, selected from different localities, including the Upper Tigris (n = 18) and Upper Khabur (n = 6), were also analyzed petrographically to compare their petrographic-mineralogical characteristics to those of DROB ware.

4. Results

4. 1. Major and trace element characteristics of the DROB ware

The major and trace element concentrations of analyzed ceramic samples are given in Table 2. Sample AA-208 could not be analyzed chemically

8 Wilson 1978; Schwedt et al. 2004.

9 Ottenburgs et al. 1993.

because of insufficient material but analyzed using the petrographic method. The major and trace element concentrations of DROB ware show some characteristic compositional patterns. Overall, the samples are characterized by average values of moderate SiO_2 (56.1%), Al_2O_3 (15.7%), Na_2O (1.4%), K_2O (2.5%), and a relatively high MgO (5.2%) and Fe_2O_3 (7.8%) concentrations. CaO contents range from 6.1 to 19.1% indicate the use of moderate to high calcareous clays for the production of the vessels.

Major and trace element concentrations of the samples show some variations, particularly in major elements Al_2O_3, MgO, CaO, and trace elements Ba, Cr, Ni, and Ce, and less pronounced variations were also observed in SiO_2, Fe_2O_3, Co, Rb, Sr, V, and La. The other measured elements (Y, Zr, and Nd) show more or less homogenous patterns. In figure 3, the bivariate plot of selected major and trace element concentrations of ceramic samples is illustrated. The concentration of SiO_2, CaO, K_2O, Cr, Ni, and element ratios of Al_2O_3/Fe_2O_3 and Rb/Cr show different patterns that allow distinguishing the selected DROB samples into two main chemical groups. Sample AA-209, which is a typical DROB ware example, shows also a clear difference in major and trace elements composition from both main groups. As a whole, the first group, chemical group 1 (bivariate group 1), is characterized by higher SiO_2, Al_2O_3, K_2O, Rb, Zr, slightly higher Ba, Ni, Y, Sm, Yb, and lower CaO and Sr values, whereas the second group, chemical group 2 (bivariate group 2) contains higher CaO, slightly higher Sr, and lower SiO_2, Al_2O_3, and Zr values.

Principal components analysis (PCA) of the ceramic samples was calculated on the basis of the values of five major (SiO_2, Al_2O_3, Na_2O, K_2O) and four trace elements (Ba, Cr, Ni, and V). The calculation of principal components was performed by JMP Software (v.13). Prior to the computation, the variables (elements) were transformed using the standard estimation method of JMP software. Other measured elements (Table 2) were removed from the data set as they show either large scattering (TiO_2, Fe_2O_3, MgO, Co, Ni, Rb, Y, Zn, Ce, and Sm) within the samples, low detection (Yb), or possible post-depositional contamination (CaO, P_2O_5). The values of the first two principal components of the data (score plot) and loading plot are represented in Fig. 4a and b. The correlation of principal components, PC1 versus PC2, shows two main statistical groups within the ceramics data. These statistical groups largely, but not entirely, correspond with the chemical groups based on bivariate comparisons. The first group, chemical groups 1 (statistical group 1), consists of the samples collected from Tell Mozan (6), located in the Khabur Region, and Salat Tepe (6), Kavuşan (4) and Susam Tepe (1), located in the Upper Tigris Valley. The second group, chemical group 2, also consist of sherds collected from the sites in the Upper Khabur region: from Tell Mozan (7), Tell Brak (2), Tell Arbid (1), and from the sites in the Upper Tigris Valley; from Salat Tepe (1), Kavuşan (1) and Susam Tepe (2). Furthermore, groups of the statistical analysis contain DROB examples with different macroscopic features such as fine or coarse fabric and bowl shapes, so there is no correspondence between the statistical/chemical groups and the macroscopic features of the examples belonging to each group.

The plot of the variable loadings, as displayed in Fig 4b, shows that statistical group 1 is mainly characterized by high concentrations of Al_2O_3, slightly high K_2O and Ba, and lower Na_2O, Cr, and Ni, whereas statistical group 2 shows reverse concertation values in these elements. There are few samples (e.g., AA-238, LN-10. AA-61, and AA-05) that are slightly separated from the main two groups as shown in Fig. 4a. This is apparently a result of slightly high SiO_2 and Na_2O and lower V for AA-238 LN-10 and AA-61 as well as higher K_2O values for AA-205. Since they show more or less similar compositional patterns in most elements as observed in bivariate comparisons, they can be interpreted as subgroups of statistical group 1 rather than a separate clay source. As shown by the bivariate plot above, PCA also demonstrates that sample AA-2009 is clearly divided from other groups. This is not illustrated in the score plot as it plots out of the diagram area. As observed in bivariate and statistical analysis, DROB ware analyzed in this study are compositional inhomogeneous, and this can be particularly well-observed in elements Al_2O_3, Fe_2O_3, Ba, Co, Cr, Ni, Rb, and La values. This inhomogeneous pattern may be the result of either natural concentration variation of the clay deposits or caused by paste preparation

processes, for example by purification, but not verified in this study.

The results of the chemical analysis demonstrated above suggest that DROB ware excavated at the sites in the Upper Khabur and the Upper Tigris Valley belong to the same production tradition. The different compositional groups (statistical groups 1 and 2) point to the use of at least two different clay deposits for their production. The case of sample AA-209, which shows very different major and trace element compositions from both main groups, suggests the existence of a further chemical group and use of other clay sources for DROB ware production.

4. 2. Petrographic analysis of selected DROB ware samples

The DROB ware samples selected for the petrographic analysis show that they were made of fine clays with inclusions varying from silt to coarse sand-size (about 0.05–1mm) in volume percentage from 3 to 20% (e.g., see Fig. 5c and d). The main inclusions are quartz and muscovite as well as calcite and chert fragments in minor quantities that are present in different quantities in selected sherds. Single inclusion of feldspar, volcanic rock, and hornblende was also observed in a few samples. Quartz grains, as the predominant inclusion type, consist of well-sorted, angular, fine, sand-sized grains. Two quartz types were distinguished: monocrystalline and polycrystalline quartz with typical undulate extinction. The latter indicates its metamorphic origin. In some cases, the polycrystalline quartz shows intergrowths with muscovite, which also indicates its metamorphic origin. Muscovite inclusions, also abundant in the ware, are characterized by needle-like fragments with typical cleavage, low relief, and yellow-red or blue colors under polarized light. In some sherds, muscovite fragments show orientations parallel to the ceramic surface, which may indicate that the DROB ware was wheel-made. Further inclusion in minor quantities (1–3%) is opaque grains with deep red color and high relief.

From a broad view, the selected DROB samples contain more or less similar types of inclusions; however, based on the grain size and general fabric features, they can be subdivided into two broad fabric groups. The first group, petrographic group A (PG-A), shows fine, partly very-fine fabric (e.g., AA-201), with main quartz and muscovite inclusions (Fig. 5a-c). The grains are well-sorted and show serial distribution (Fig. 5). PG-A sherds comprise both fine and coarse variants of DROB vessels that are from both the Upper Khabur and the Upper Tigris Valley (Table 1). The second petrographic group, PG-B, is characterized by larger inclusions in higher quantities compared to PG-A (Fig. 5d-f). It also contains a slightly higher abundance of feldspar (1–2%) and carbonate fragments. Likewise, PG-B comprises of DROB examples with fine and coarse paste variants that were collected from the sites in the Upper Khabur and Upper Tigris Valley (Table 1).

Comparing the chemical and petrographic results, it is seen that the groupings in each show no clear correspondence to each other. For example, statistical group 1 consists of samples belonging to petrographic groups A and B, as is the same with statistical group 2 (Table 1). This suggests, on one hand, local inhomogeneity of the raw clays, containing slightly different amounts of inclusions that are possibly an effect of the sedimentation processes. On the other hand, this may also be a result of the purification process of the raw clay by potters. The finesse of the clay pastes and the absence of large single grains (bimodal grain size distribution) can be seen as an indication of purification processes (levigation) of the raw clay prior to the production.

In brief, the chemical and petrographic analyses of the DROB ware represented above yield that DROB sherds excavated in the Upper Khabur and in the Upper Tigris Valley belong to the same group of production from the same region. They were produced from different clay sources, using different processing (e.g., levigation). However, compositional linking, particularly petrographic results, and also chemistry suggest that the raw clay sources used for the production should be located within the same depositional environment, belonging to the similar hinterland geology and geographic location, as discussed below.

4. 3. Provenance identification of the DROB ware

4. 3. 1. Comparison of chemical analysis

The main inclusions of the DROB ware, particularly muscovite and quartz (monocrystalline and polycrystalline types) as well as the moderate calcareous nature of the DROB ware, points to that the raw clay was derived mainly from quartz and muscovite rich, partly from calcareous rocks; thus, such rocks are exposed within the catchment area of the clay deposits. But both inclusions types are common in sediments and did not permit the ability to identify the clay source area of the DROB ware, specifically whether they are of the Upper Khabur or the Upper Tigris Valley origins. Therefore, the use of reference clay samples collected within the distribution area of the DROB ware became necessary.

The major and trace element concentration of the clay samples collected from various spots in the Upper Tigris and the Upper Khabur regions were compared using bivariate plots and multivariate statistical methods to examine the compositional similarities or dissimilarity of the DROB ware samples to the local clays and thus assign the ware to a distinct region. In figure 6, the bivariate plots of selected elements (SiO_2, Al_2O_3, CaO, Na_2O, Zr and V), demonstrate that the clays from both regions show compositional variation but still allow a separation of the clays from the Upper Khabur and the Upper Tigris Valley. They form two broadly defined chemical groups, though for some elements (e.g., TiO_2, MgO, and Nd, not shown) both groups show overlap. The clays from the Upper Tigris and the Upper Khabur region can be distinguished from each other in terms of the major elements SiO_2, Al_2O_3, CaO, Fe_2O_3, Na_2O, and trace elements Ni, V, and La, though the groups are not separated from each other. The Upper Tigris clays, considered in this study, are characterized by an average higher concentration of SiO_2 (56.6%), Al_2O_3(15.5%), Fe_2O_3 (6.9%), Na_2O (1.3%), Ni (190.8 ppm), V (151.2 ppm), and La (24.1 ppm) and lower CaO (12.6%) and Sr (222.1 ppm) compared to the Upper Khabur clays analyzed in this study. A comparison of these results to the DROB ware in bivariate plots as illustrated in figure 6 revealed that the DROB Wares show a closer compositional similarity to the Upper Tigris clays than to the Upper Khabur region, both in the major and trace elements. A similar result was achieved also by using multivariate statistical analysis as presented below.

To test the results of bivariate plots and to refine compositional group patterns of the clay samples from the Upper Tigris Valley and Upper Khabur region, and accordingly to indicate their similarity or dissimilarity to DROB Ware, the entire compositional data were calculated using principal component analysis (PCA). PCA was calculated on the base of four major elements (SiO_2, Al_2O_3, Fe_2O_3, and Na_2O) and five trace elements (Ba, Cr, Ni, V, Y, La) that are considered in this study as suitable for achieving the aims of the analysis. The major elements CaO and P_2O_5 were removed from the data set as their initial concentrations can be modified in the post-depositional environment.[10] The elements of TiO_2, MgO, Co, Rb, and Ce were also removed from the data set as they show either large scattering within the whole data set or due to low detection (Yb). Concentrations of Zn, Nd, and Sm, which showed unusual concentration shift that may be a result of measurement error, were also removed from the data.

The results of the first two principal components (PC 1 and PC 2), accounting for the 54,5% of the total variance, are shown in a scatterplot in figure 7a and the loading plot of the selected variables in figure 7b. The PCA allows to separate the clays from the Upper Tigris and from the Upper Khabur region, clustered into two main groups which mostly correspond with the sampling regions of the Upper Tigris and the Upper Khabur. However, the groups' separation is not sharp; there is overlapping but still broadly defined groups for both regions. The loading of selected elements as shown in figure 7b indicates that SiO_2, Al_2O_3, Na_2O, Ba and V dominate the Upper Tigris clays, while La is the most dominant parameters in the Upper Khabur clays. In the scatter plot of the first two PCs, the DROB ware shows closer compositional similarity to the Upper Tigris clays compared to those from the Upper Khabur region and suggests that the Upper Tigris Valley is most probable source area of the raw

10 Freestone et al. 1985; Schwedt et al. 2004.

material, thus the production place of DROB Ware. However, due to the compositional similarity of the clay samples collected in the various spots within the Upper Tigris Valley (Fig. 2), it is not possible to assign the DROB ware to a more precise geographical location or clay source area.

Taking into account of the results of the chemical analysis using bivariate and multivariate statistical evaluation, the possible clay sources for the DROB ware may be located between the province Bismil and Batman in the Upper Tigris Valley (Fig. 2). This result is also supported by petrographic analysis as presented below.

4. 4. 3. Comparison of the petrographic analysis

A total of 23 thin sections were prepared from the reference clays from both regions, including thirteen from the Upper Tigris Valley, two from Derik/Mardin (southern slope of Tur'Abdin), and three samples from the Upper Khabur region. The clays from the Upper Tigris Valley contain mainly quartz and muscovite in varying quantities (Fig. 8a-c). Further inclusions are carbonate, biotite, plagioclase, chert, and reddish opaque minerals in minor quantities. Quartz grains were angular in shape; the large grains show polycrystalline structure and undulate extinction, which points to a metamorphic origin such as gneiss or slate. Such rocks are exposed on the Eastern Taurus mountains to the north of the Upper Tigris in so-called Bitlis-Pütürge metamorphics. This may also explain the presence of muscovite inclusions in the Upper Tigris clays. Petrography of the Upper Tigris clays show also the iron-rich nature of the clays that is represented by the reddish color of the clay paste under oxidizing firing atmosphere. In contrast, the clay samples from the Upper Khabur area (Fig. 8d-f) show different fabric features. Thin sections from four samples (HN2S, VS1-VS-2 and GM1) show a marly clay matrix and are characterized by low quartz and a high quantity of carbonate inclusions, as also attested by their high CaO values mentioned above. No muscovite was observed in the Upper Khabur clays.

Comparing the petrographic characteristics of the DROB ware with those of the clay reference samples, it is evident that the DROB ware show closer petrographic similarity to the Upper Tigris clay than the Upper Khabur clays, which supports the results of the elemental analysis discussed above, and reinforce the Upper Tigris origin of DROB ware.

5. Discussion and conclusions

Archaeometric analysis carried out on DROB ware samples (n = 36) collected from the various sites in the Upper Khabur and the Upper Tigris Valley reveal valuable information contributing to a better understanding of the cultural and trade relations of two Early Bronze Age communities in the Upper Khabur (Northeastern Syria) and the Upper Tigris Valley (Southeastern Anatolia). DROB ware unearthed in the Upper Khabur and the Upper Tigris Valley were produced from raw materials of the same source area, characterized by moderate to high calcareous nature with moderate to high iron oxide content, which is possibly the reason for their reddish color when fired under oxidation conditions. DROB ware found in both regions show no differences either in their chemical and petrographic-mineralogical compositions, suggesting that they all belonged to the same production tradition and originated from the same geographic area.

Combining the results of both analytical methods and the comparison of the results to the clay reference groups from both regions indicate that the DROB ware was manufactured from the clay sources available in the Upper Tigris Valley. In this study, two main clay sources with local variations in their element contents exploited for DROB ware production were distinguished. Moreover, as shown by sample AA-209, there are further deposits that were also used for DROB production. However, it is difficult to assign the location of the clay sources more precisely within the Upper Tigris Valley from their chemical and petrographic characteristics. This is due to the compositional similarities of the clays in the Valley, which may be attributed to the similar hinterland surface geology of the catchment and the sedimentation conditions of the clay deposits. In the Upper Tigris Valley, there are several fluvial terraces[11] containing rich clay deposits with high plasticity. For DROB ware, potters may have exploited various raw clays deposited in the terraces available in a large area between the

11 Doğan 2005.

province of Bismil and the Batman River.

Petrographic analysis gives some further information on the production technique of the ware. Orientation of the needle-like muscovite fragments parallel to the ceramic surface observed in thin sections (e.g., clearly visible at the samples AA-212) suggest that the DROB ware was wheel-made. The presence of calcite and absence of any vitrification, as well as the general optic appearance of the clay matrix, are suggestive of a firing temperature lower than 850°C.[12]

The presence of the materials produced in the Upper Tigris, in this case DROB ware, indicates an interregional exchange network existing between the Upper Tigris Valley and the Upper Khabur. The presence of North Mesopotamians in the Upper Tigris is already attested by archaeological records, for example by the victory stela of Akkadian king Naram-Sin discovered in Pir Hüyesin (dated to c. 2250 BCE), located to the northeast of Diyarbakir (Fig. 2). [13] Kelly-Buccellati[14] has argued that the regions north and south of the Tur 'Abdin Mountains were in commercial contact, based mainly on the trade of copper, a highly sought-after material in the whole Syro-Mesopotamian region in the third millennium BC. The north-south oriented distribution pattern of DROB ware, as a narrow strip over the Tur' Abdin, is indicative of a communication route of the Tigridian and North Mesopotamian communities in the Bronze Age. Accordingly, it can be proposed that the DROB ware was traded through the Tur' Abdin.

The first appearance of DROB ware in the Upper Khabur is dated to the Early Jazira 3a-3b period (c. 2500 BCE), intensified in period EJZ 4-5, c. 2220 BCE,[15] and after that, disappeared from the region. Its disappearance in the Upper Khabur overlaps chronologically with the crisis of Northern Mesopotamian urbanism, which is characterized by drastic change in the urban system in Northern Mesopotamia. This event, as known also 4.2 ka event[16] was the subject of various works and has been controversially discussed.[17] The disappearance of DROB ware in the Upper Khabur may be related, directly or indirectly, to this urban crisis, which led to interruption of the exchange system existing between the Upper Tigris and the Upper Khabur region. However, this interpretation is based on the very limited data represented in this study, and further evidence is required to substantiate the potential relation between the disappearance of the DROB ware in the Upper Khabur region and the urban crisis in Northern Mesopotamia.

12 Cultrone et al. 2001.

13 See Ökse 2011; Bianchi 2012.

14 Kelly-Buccellati 1990; see also Buccellati and Kelly-Buccellati 1999.

15 Bianchi and Özfırat 2014.

16 Weiss et al.1993.

17 See e.g., Weiss et al. 1993; Kuzucuoğlu and Marro 2007; Wossink 2009; Weiss 2000; Pfälzner 2012; Ur 2015.

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Chemical group 1					Chemicalagroup 2				
Sample	Region	Site	Site Inventory Number	Pet.Group	Sample	Region	Site	Site Invt. number	Pet.Group
AA-174	Upper Khabur	Tall Mozan	A06q0394	PG-B	AA-058	Upper Khabur	Tall Mozan	MZ01C2–q2285–2	–
AA-201	Upper Khabur	Tell Moazn	MZ01C2-q2055-11	PG-A	AA-063	Upper Khabur	Tall Mozan	MZ01C2–q2188–94	–
AA-207	Upper Khabur	Tall Mozan	A05q0934-p01	–	AA-064	Upper Khabur	Tall Mozan	MZ01C2–q0635–13	–
AA-212	Upper Khabur	Tell Mozan	A06q0394-p01	PG-B	AA-204	Upper Khabur	Tall Mozan	MZ01C2-q2263-39	–
AA-213	Upper Khabur	Tell Mozan	A06q0394	–	AA-205	Upper Khabur	Tell Mozan	A01q0134-p03	PG-A
AA-061	Upper Khabur	Tall Mozan	MZ01C2–q1422–61	–	AA-206	Upper Khabur	Tall Mozan	A05q0939-p01	–
AA-05	Upper Khabur	Tell Brak	FS 1854	–	AA-210	Upper Khabur	Tell Mozan	A06q677-p22	–
AA-228	Upper Tigris	Kavuşan	AAU.279	–	AA-06	Upper Khabur	Tell Brak	DH 54	PG-A
AA-230	Upper Tigris	Kavuşan	AOJ1943	PG-A	AA-07	Upper Khabur	Tell Brak	FS 304	PG-A
AA-231	Upper Tigris	Kavuşan	ABE	PG-A	AA-226	Upper Khabur	Tell Arbid	ARB-01-S-37/55-69-1	PG-B
AA-250	Upper Tigris	Kavuşan	no invt. number	–	AA-229	Upper Tigris	Kavuşan	AN01778	PG-B
LN-6	Upper Tigris	Salat Tepe	K13-96-S (10)	–	AA-241	Upper Tigris	Susam Tepe	ST 5	–
LN-9	Upper Tigris	Salat Tepe	K13-141-S (9)	–	AA-242	Upper Tigris	Susam Tepe	ST 109	–
LN-10	Upper Tigris	Salat Tepe	K13-141-S (1)	–	LN-1	Upper Tigris	Salat Tepe	K13-0100(10)	–
ST-1	Upper Tigris	Salat Tepe	H12/003651	–					
ST-2	Upper Tigris	Salat Tepe	L13/0236	–	Chemical group 3				
STP 1	Upper Tigris	Salat Tepe	surface collection	PG-A	Sample	Region	Site	Site Inventory Number	
STP-2	Upper Tigris	Salat Tepe	surface collection	PG-A	AA-209	Upper Khabur	Tell Mozan	A05q0481-p01	
AA-238	Upper Tigris	Çayırlık	GT 58	PG-B	No chemical analysis				
AA-240	Upper Tigris	Çayırlık	ST 85	PG-A	AA-208(a)	Upper Khabur	Tell Mozan	A05q0200	PG-B

Table 1. Chemical and petrographic groups of the analyzed DROB ware samples from both regions, and their site inventory numbers. A full description and documentation are given in Bianchi (2012) and Yaşın-Meier (2015). *Sample AA-2008 could not be analyzed chemically due to small amount of available material.

Chemical group 1																									
Sample	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Ba	Co	Cr	Ni	Rb	Sr	V	Y	Zn	Zr	Ce	La	Nd	Sm	Yb	SUM
AA-174	60,4	0,9	16,8	7,3	0,11	4,4	6,1	1,1	2,5	0,2	515	31	200	275	82	161	162	32	84	188	64	24	27	4,5	2,6	99,8
AA-201	56,3	1,0	16,8	8,7	0,14	5,5	6,7	1,5	3,0	0,2	504	32	241	223	86	221	157	36	111	171	63	25	35	4,2	3,1	99,8
AA-207	55,6	0,8	15,3	6,9	0,11	4,3	13,5	0,9	2,2	0,2	387	27	227	181	68	163	139	34	89	166	57	22	33	4,8	2,8	99,9
AA-212	60,2	0,9	16,5	7,6	0,12	4,3	6,3	1,2	2,5	0,2	558	27	212	176	82	164	155	34	89	190	68	29	31	6,5	2,8	99,8
AA-213	59,9	0,9	16,7	7,6	0,12	4,4	6,4	1,1	2,6	0,3	588	23	243	182	83	166	163	35	87	197	71	21	26	6,5	2,9	99,8
AA-228	55,5	0,9	16,9	8,4	0,15	5,8	7,7	1,3	2,9	0,2	605	35	223	227	90	230	162	35	122	164	77	27	29	6,7	3,0	99,8
AA-230	55,9	0,9	16,3	7,7	0,12	5,1	9,7	0,9	3,0	0,2	663	25	214	186	85	145	146	35	100	183	68	25	32	6,3	2,9	99,8
AA-231	57,4	1,0	16,7	8,3	0,14	5,1	6,6	1,5	2,8	0,3	563	33	258	235	88	168	160	37	111	186	69	28	37	6,7	3,2	99,8
AA-240	56,0	0,9	17,6	8,3	0,12	5,5	7,3	0,7	3,1	0,2	711	28	192	187	97	142	153	32	109	153	77	26	34	6,2	2,8	99,8
AA 250	52,2	1,0	16,2	8,5	0,15	6,1	10,6	1,3	3,5	0,4	595	0,1	144	182	92	315	179	24	92	174	273	44	110	0,1	2,1	99,8
ST-1	56,8	0,9	16,2	7,2	0,11	4,3	10,4	1,1	2,5	0,3	499	0,1	152	172	67	173	166	30	40	159	222	21	15	6,5	3,2	99,9
ST-2	56,1	0,8	16,6	7,2	0,11	4,8	10,8	1,0	2,3	0,3	483	0,1	125	158	61	194	150	24	42	118	164	23	17	7,5	2,5	99,9
STP 1	54,3	1,0	15,3	7,6	0,13	5,2	11,9	1,3	2,8	0,4	554	0,1	256	220	67	354	142	0	77	142	206	30	106	0,1	0,1	99,9
STP-2	56,1	1,0	16,5	7,7	0,14	4,5	10,0	1,1	2,5	0,3	582	0,1	140	139	73	216	142	18	64	177	237	34	119	2,7	1,3	99,8
LN-6	56,1	0,9	17,9	8,3	0,12	5,3	6,7	1,2	3,1	0,2	870	7,8	179	169	88	227	171	29	85	153	125	22	22	3,0	3,2	99,8
LN-9	55,8	0,8	16,1	6,9	0,11	4,3	12,0	1,1	2,5	0,2	524	5,3	152	146	68	212	145	28	49	146	131	16	18	4,7	2,9	99,9
AA-05	52,6	0,9	15,3	8,4	0,13	6,8	11,1	1,1	3,1	0,2	488	33	312	228	77	859	160	27	130	151	64	47	18	5,0	2,1	99,8
LN-10	60,6	0,8	15,5	6,7	0,12	3,8	7,5	2,1	2,4	0,2	538	14	181	183	76	181	143	30	62	192	138	20	26	5,6	3,0	99,8
AA-61	55,8	0,8	15,0	7,0	0,14	4,9	12,9	1,3	1,8	0,2	391	27	211	153	49	313	141	26	79	122	43	20	23	4,9	2,0	99,9
AA-238	63,2	0,9	14,4	6,5	0,13	3,8	6,9	1,5	2,3	0,3	476	26	269	172	71	179	137	37	83	246	66	24	30	5,6	3,1	99,9
Mean	*56,8*	*0,9*	*16,2*	*7,6*	*0,1*	*4,9*	*9,0*	*1,2*	*2,7*	*0,3*	*555*	*19*	*207*	*190*	*77*	*239*	*154*	*29*	*85*	*169*	*114*	*26*	*39*	*4,9*	*2,6*	*99,8*
SD	*2,7*	*0,1*	*0,9*	*0,7*	*0,0*	*0,8*	*2,5*	*0,3*	*0,4*	*0,1*	*107,8*	*13,5*	*49,3*	*34,4*	*11,9*	*157,4*	*11,7*	*8,5*	*25,0*	*28,8*	*70,0*	*7,7*	*31,8*	*2,1*	*0,8*	0,02
Chemical grousp 2																										
DROB ware	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Ba	Co	Cr	Ni	Rb	Sr	V	Y	Zn	Zr	Ce	La	Nd	Sm	Yb	SUM
AA-06	56,7	1,0	15,8	8,7	0,2	5,9	7,2	1,8	2,3	0,3	311	40	428	317	62	266	156	32	112	160	49	18	31	5,1	2,8	99,8
AA-07	52,4	0,9	14,4	8,7	0,1	8,0	10,9	1,3	2,9	0,2	324	38	385	339	70	391	155	29	111	143	55	31	27	3,7	2,3	99,8
AA-58	55,8	1,0	14,7	7,5	0,1	4,7	11,8	2,0	1,9	0,3	341	31	368	253	56	254	154	33	87	174	56	21	28	4,7	2,7	99,8
AA-63	56,0	1,0	15,2	8,2	0,1	5,1	10,2	1,7	2,2	0,3	314	34	369	277	58	249	157	34	94	167	57	57	30	4,3	2,8	99,8
AA-64	56,0	0,9	14,8	7,5	0,1	4,8	11,8	1,7	2,0	0,3	367	30	340	250	58	240	154	33	90	163	52	25	26	5,2	2,7	99,9
AA-204	53,9	1,0	15,0	8,1	0,1	5,2	12,5	1,5	2,2	0,2	314	31	349	246	58	281	156	34	103	162	57	23	32	3,7	2,7	99,9
AA205	54,0	1,0	14,5	8,1	0,2	5,6	12,7	1,6	2,0	0,2	430	33	396	238	54	355	161	31	99	153	51	31	31	4,1	2,6	99,9
AA206	54,8	1,0	15,2	8,5	0,2	5,2	11,2	1,4	2,3	0,3	365	34	360	220	63	249	158	31	96	110	57	38	29	4,3	2,9	99,8
AA-210	54,7	1,0	15,1	7,9	0,1	5,0	12,3	1,3	2,1	0,3	336	0,1	353	268	51	246	160	10	63	155	168	28	100	0,1	0,1	99,9
AA-226	57,2	0,9	14,5	7,7	0,1	4,7	10,5	1,9	2,0	0,2	297	30	421	238	56	233	146	33	82	172	51	19	24	4,2	2,7	99,8
AA-229	57,0	1,0	14,6	7,5	0,2	5,2	10,5	1,7	2,0	0,2	356	35	394	249	54	251	147	32	90	166	49	19	24	3,3	2,6	99,9
AA-241	56,2	1,0	15,4	8,1	0,1	5,0	10,3	1,5	2,0	0,2	447	33	367	273	58	238	155	33	93	169	53	30	28	4,3	2,6	99,8
AA-242	56,0	1,0	15,6	8,7	0,2	6,2	8,0	1,7	2,2	0,3	403	39	422	333	62	253	163	34	105	160	62	22	23	5,3	2,7	99,8
LN-1	57,3	1,0	15,9	8,5	0,2	5,6	7,0	1,9	2,3	0,2	326	22	399	302	62	232	156	28	74	151	122	20	26	2,3	2,8	99,8
Mean	*55,6*	*1,0*	*15,1*	*8,1*	*0,1*	*5,4*	*10,5*	*1,6*	*2,2*	*0,2*	*352*	*31*	*382*	*272*	*59*	*267*	*156*	*30*	*93*	*157*	*67*	*27*	*33*	*3,9*	*2,5*	99,8
SD	*1,4*	*0,0*	*0,5*	*0,4*	*0,0*	*0,9*	*1,9*	*0,2*	*0,2*	*0,0*	*46,0*	*9,8*	*28,6*	*37,3*	*4,9*	*47,1*	*4,7*	*6,2*	*13,6*	*16,1*	*34,4*	*10,5*	*19,5*	*1,4*	*0,7*	0,0
Chemical group 3																										
DROB ware	**SiO2**	**TiO2**	**Al2O3**	**Fe2O3**	**MnO**	**MgO**	**CaO**	**Na2O**	**K2O**	**P2O5**	**Ba**	**Co**	**Cr**	**Ni**	**Rb**	**Sr**	**V**	**Y**	**Zn**	**Zr**	**Ce**	**La**	**Nd**	**Sm**	**Yb**	SUM
AA-209	47,6	0,9	13,8	8,0	0,2	7,4	19,1	0,4	2,2	0,3	1263	45	710	332	33	376	196	29	118	163	48	22	28	5,1	2,2	99,8

Table 2. The major and trace element concentrations of DROB ware sherds from the Upper Tigris Valley and the Upper Khabur region. Concentration values are given in Wt. % for major and trace elements in ppm. (Mean: average concentration values of group, SD standard deviation).

Sample	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	NaO	K2O	P2O5	Ba	Co	Cr	Ni	Rb	Sr	V	Y	Zn	Zr	Ce	La	Nd	Sm	Yb	SUM
T106	57,1	0,9	15,1	9,0	0,13	6,2	7,0	2,41	1,8	0,19	298	45,0	646	287	49	204	163	30	96	151	157	18	0	22	3	99,8
TFB	56,1	0,9	14,9	8,1	0,13	5,4	10,4	1,95	1,8	0,16	285	31,0	435	234	56	201	156	28	96	106	50	36	14	22	3	99,8
YY-1	54,7	0,9	15,0	7,6	0,18	5,3	13,2	1,21	1,6	0,16	385	32,0	227	120	51	224	159	28	116	96	32	29	0	18	3	99,8
YY-2	57,5	0,9	15,3	7,9	0,14	5,6	9,3	0,94	2,1	0,20	401	25,0	270	163	75	174	186	30	122	123	68	34	17	28	3	99,9
T432	52,7	0,9	14,00	7,3	0,14	4,5	17,2	1,44	1,4	0,16	268	21,0	603	305	48	246	158	21	71	145	96	18	0	34	2	99,8
TD-B	56,9	1,0	14,1	7,7	0,12	5,3	10,8	2,29	1,5	0,14	263	8,40	812	309	44	171	159	33	53	183	154	17	0	25	3	99,8
T471	61,5	1,1	15,1	7,9	0,14	4,6	5,1	2,53	1,7	0,17	275	24,0	1039	306	50	164	170	27	58	226	120	24	0	40	3	99,8
T470	56,1	1,0	17,9	9,2	0,15	6,7	6,5	0,59	1,7	0,15	309	27,0	217	207	54	187	213	20	88	117	94	14	0	34	2	99,9
T466	53,5	1,1	16,1	8,4	0,15	4,2	14,5	0,45	1,4	0,12	414	23,0	315	226	59	178	180	28	71	177	121	13	0	47	3	99,9
T467	63,0	1,1	17,2	8,5	0,17	4,7	2,1	1,35	1,6	0,16	257	36,0	532	309	55	118	167	24	71	184	109	19	0	43	3	99,9
T465	54,3	1,0	14,3	7,4	0,14	5,1	14,2	1,57	1,6	0,17	316	17,0	591	268	50	235	159	21	70	166	108	18	0	42	2	99,8
UT1B	39,4	0,7	9,18	4,9	0,10	6,1	37,1	0,66	1,3	0,41	208	4,00	305	102	38	387	111	33	56	155	104	23	0	29	3	99,9
UCT-1	43,1	0,8	10,6	5,7	0,11	5,5	31,5	0,82	1,4	0,36	246	17,0	346	96	45	332	120	28	86	107	51	33	0	26	2	99,8
UCT2	52,6	0,9	14,4	7,2	0,14	4,7	17,5	0,58	1,7	0,22	367	24,0	254	160	72	203	138	34	117	121	55	38	17	30	3	99,9
T399	57,8	1,0	15,2	7,5	0,18	4,1	11,3	0,80	1,7	0,19	333	21,0	406	241	67	162	159	29	70	209	141	21	16	50	3	99,8
T400	59,8	1,1	16,4	8,0	0,18	4,5	6,9	0,90	1,8	0,20	333	24,0	407	266	72	122	172	29	79	201	118	22	15	46	3	99,8
TGT20	55,3	1,0	15,6	7,5	0,13	4,4	13,7	0,56	1,4	0,14	379	16,0	390	229	65	227	163	28	66	198	133	25	15	53	3	99,8
T458	50,6	1,0	14,2	6,8	0,14	6,8	17,5	0,63	1,8	0,21	359	12,0	308	245	68	202	162	29	72	208	140	28	15	60	3	99,7
GRC5	51,9	0,8	14,4	7,9	0,15	5,3	16,5	0,90	1,7	0,25	301	35,0	253	202	58	377	156	26	116	95	45	54	0	25	2	99,9
GRC2	55,2	0,9	14,9	8,4	0,16	5,1	12,1	1,07	1,6	0,31	345	35,0	503	191	66	247	131	30	126	120	50	38	18	38	3	99,9
GRC4	53,0	1,0	15,9	10,6	0,19	8,0	7,4	1,64	1,9	0,19	353	78,0	591	364	64	190	171	30	166	99	51	36	18	27	3	99,8
T456	53,8	0,8	14,9	6,9	0,14	4,8	16,1	0,93	1,3	0,12	356	12,0	240	149	45	313	168	19	54	137	95	20	0	41	2	99,8
T462	56,9	1,0	14,2	7,5	0,14	5,1	10,8	2,33	1,7	0,18	318	20,0	650	195	49	273	159	23	56	208	117	18	0	44	2	99,8
T463	54,4	0,9	14,9	7,1	0,14	4,4	14,8	0,66	2,3	0,20	349	8,0	308	218	80	196	145	27	75	227	139	22	0	56	3	99,8
T464	53,7	0,9	14,9	7,2	0,14	4,4	15,5	0,64	2,3	0,19	353	5,0	299	199	80	212	152	24	71	188	135	26	0	49	2	99,8
T405	54,1	0,8	13	5,9	0,11	4,0	17,8	0,79	3,1	0,26	342	0,0	206	157	63	217	151	21	56	165	141	20	0	42	2	99,8
T461	52,1	0,8	15,5	7,1	0,13	5,1	16,7	0,45	1,7	0,13	367	10,0	252	201	70	297	158	22	66	155	127	24	0	44	2	99,8
SLT1	56,7	0,9	13,6	7,1	0,13	5,0	11,9	2,07	2,3	0,17	278	8,0	401	253	49	252	158	30	63	168	64	22	0	21	2	99,9
SLT2	62,5	1,0	12,2	6,7	0,09	3,8	9,4	2,24	1,6	0,20	296	6,0	888	197	45	195	148	37	54	348	74	20	19	28	3	99,7
T401	54,1	0,9	17,3	8,0	0,14	5,1	11,9	0,23	2,0	0,16	372	12,0	214	245	88	180	160	29	81	168	128	27	15	52	3	99,8
TGT22	61,7	0,7	14,4	5,7	0,09	4,1	9,8	1,42	1,8	0,18	388	0,0	133	106	56	155	133	20	37	168	100	18	0	37	2	99,9
T455	55,1	1,0	13,9	7,1	0,14	5,3	13,9	1,78	1,5	0,15	289	22,0	612	257	47	277	156	21	65	169	115	17	0	39	2	99,8
T459	57,8	0,8	13,9	6,0	0,12	4,2	14,2	1,35	1,5	0,13	391	5,0	205	121	48	260	147	19	42	161	89	19	0	32	2	99,9
T460	59,9	0,9	14,2	5,9	0,12	3,6	12,2	1,19	1,7	0,14	450	8,0	216	141	61	296	140	26	47	221	144	24	0	50	2	99,9
SLT3	62,2	0,8	14,8	6,2	0,10	3,7	7,9	1,95	2,0	0,19	393	0,0	162	147	64	153	129	30	49	179	71	25	0	20	2	99,8
SLT4	68,8	0,7	13,8	5,2	0,09	3,0	3,8	2,37	1,9	0,14	450	0,0	140	118	56	136	120	26	30	169	61	16	0	21	2	99,8
T410	56,5	0,9	16,2	7,4	0,14	4,6	11,4	0,52	2,1	0,18	425	8,0	239	224	86	182	154	28	75	188	135	24	16	44	3	99,9
MUT2	55,4	0,9	14,9	7,0	0,13	5,2	13,5	1,05	1,8	0,17	357	1,0	219	178	60	217	152	27	65	164	79	25	0	40	2	99,9
MUT3	56,8	0,8	13,6	6,4	0,13	4,8	14,2	1,21	1,7	0,19	327	0,0	227	159	53	205	156	31	58	162	72	20	0	16	3	99,8
MUT4	54,0	0,8	12,7	6,2	0,12	4,7	18,0	1,31	1,7	0,42	304	0,0	225	134	46	309	142	23	60	138	67	17	0	38	2	99,9
T452	55,1	0,9	15,3	7,6	0,15	5,8	11,2	1,79	1,8	0,19	371	19,0	370	258	57	283	169	24	71	170	119	28	0	43	2	99,8
T453	55,3	0,9	15,1	7,4	0,15	5,5	11,6	1,56	2,0	0,20	328	18,0	364	245	55	246	170	23	65	163	107	23	0	43	2	99,8
T454	54,5	0,9	15,4	7,7	0,15	5,5	12,1	1,53	1,9	0,18	389	18,0	338	252	59	263	172	22	71	158	102	21	0	47	2	99,8
DRK1	55,0	0,8	14,7	6,7	0,14	4,5	15,7	0,90	1,3	0,13	345	11,0	231	146	50	358	152	21	53	145	97	21	0	46	2	99,9
T600	65,7	0,9	13,4	5,4	0,13	2,8	7,9	1,80	1,8	0,14	440	4,0	183	152	61	146	127	27	41	220	134	20	0	52	3	99,9
T602	45,4	0,6	12,6	5,3	0,09	3,3	30,2	0,83	1,4	0,11	439	51,0	113	88	47	208	121	21	38	145	108	14	0	46	1	99,9
T414	61,0	0,9	16,2	7,2	0,09	4,1	6,0	1,42	2,7	0,19	444	7,0	162	164	86	122	156	29	72	183	154	21	0	56	3	99,8
TN-21	55,8	0,9	14,6	6,7	0,13	4,7	14,3	0,81	1,8	0,14	403	7,0	230	186	69	234	145	27	60	207	141	23	0	56	2	99,8
BTM1	54,4	0,8	15,2	6,9	0,16	5,3	13,9	1,23	1,8	0,15	198	12,0	254	159	47	283	200	19	57	106	91	24	0	32	2	99,9
BTM11	61,9	0,7	14,1	5,9	0,10	4,2	9,2	1,69	1,9	0,14	267	3,0	198	135	60	224	140	18	47	141	105	25	0	38	2	99,8
BTM10	50,1	0,7	13,7	6,3	0,13	4,1	21,9	1,14	1,7	0,13	447	0,0	128	102	54	247	182	22	48	134	113	25	0	47	2	99,9
BTM3	53,2	0,7	13,6	6,1	0,31	4,8	17,8	1,30	1,8	0,13	671	11,0	188	133	54	397	173	15	53	122	122	25	0	38	1	99,8
BTM9	62,7	0,7	14,1	5,4	0,10	3,5	9,6	1,75	1,9	0,13	514	0,0	122	100	62	248	118	21	32	188	123	27	0	37	2	99,8
BTM4	61,0	0,9	14,2	6,1	0,09	2,9	12,0	1,09	1,5	0,15	383	3,0	198	152	59	160	122	28	57	206	129	23	0	48	3	99,9
BTM5	72,9	0,9	13,5	5,5	0,15	1,9	1,6	1,71	1,7	0,09	369	3,0	269	158	59	108	113	24	36	213	134	22	0	49	3	99,8
BTM7	67,4	1,0	15,7	7,0	0,14	2,9	2,4	1,16	2,0	0,15	410	10,0	288	200	81	94	144	34	60	257	154	19	18	48	4	99,8
BTM8	67,6	0,8	15,8	6,6	0,12	3,4	1,4	1,71	2,3	0,13	461	10,0	187	183	78	86	134	25	60	193	119	21	0	43	3	99,9
HSK-1	50,7	0,9	13,8	7,3	0,14	6,2	17,4	1,10	2,1	0,25	419	21,0	260	174	78	321	120	30	116	127	65	39	16	38	3	99,9
HSK-2B	63,7	0,8	13,2	6,1	0,10	4,1	7,1	2,57	1,9	0,17	382	19,0	332	106	64	199	112	28	101	188	42	30	0	24	2	99,8
HSK-3	60,1	0,9	13,5	6,7	0,12	4,8	9,5	2,22	1,9	0,20	388	23,0	360	129	65	228	121	33	95	186	54	35	17	32	3	99,9
DER1	39,5	0,7	10,4	5,2	0,09	6,9	34,0	0,81	2,0	0,45	298	0,0	68	77	58	144	74	16	65	136	170	19	0	99	0	100,0
DER2	39,7	0,7	10,8	5,3	0,10	7,1	33,1	0,80	2,1	0,44	305	0,0	65	82	58	144	75	11	69	133	186	17	0	104	0	100,1
DER3	37,6	0,6	8,78	4,2	0,08	5,3	40,2	0,95	1,9	0,38	277	0,0	37	38	46	124	56	13	43	120	151	6	0	90	0	100,0
DER4	37,3	0,6	9,63	4,8	0,10	8,3	36,2	0,79	1,9	0,38	284	0,0	73	75	51	132	71	14	59	132	164	13	0	103	0	100,0
HN2B	49,5	0,8	13,5	6,6	0,12	5,3	21,6	0,38	1,7	0,16	334	0,0	209	201	68,4	441	132	29	63	166	183	29	0	34	3	99,7
VS1	50,5	0,9	13,5	6,8	0,13	5,0	20,5	0,44	1,8	0,18	351	0,0	287	210	68,7	344	139	32	65	201	193	25	15	23	3	99,8
VS2B	51,9	0,9	13,6	6,7	0,12	5,0	19,1	0,48	1,9	0,21	358	0,0	257	215	68,9	342	143	33	66	194	174	29	0	23	3	99,9
RAD-1	47,8	1,0	11,5	6,7	0,12	5,8	24,4	0,50	1,9	0,20	311	21,0	353	169	60,7	337	125	30	89	145	51	39	20	35	3	99,9
GEL-1	38,0	0,6	9,8	5,1	0,08	5,3	39,6	0,26	1,1	0,13	239	15,0	222	136	46	390	98	21	68	89	0	54	0	34	2	99,9
ASLO-1	51,3	0,9	12,6	6,4	0,12	5,0	20,9	0,50	1,8	0,23	333	19,0	284	155	69,9	414	114	31	93	139	65	52	18	38	3	99,8
HSB-III-B2	49,6	0,8	12,9	6,3	0,08	4,9	22,5	0,46	1,9	0,32	353	18,0	257	157	72	535	110	29	100	154	65	62	17	36	3	99,8
KAL-6	40,6	0,7	10,3	5,4	0,09	7,3	33,4	0,45	1,4	0,17	267	16,0	243	130	54,7	393	101	29	72	125	63	58	0	28	2	99,8
JERM-3	39,4	0,7	11,1	5,5	0,05	7,8	33,6	0,35	1,3	0,14	249	13,0	221	131	57,1	222	105	29	84	84	68	47	18	28	3	99,9
FAR-7	54,2	1,0	15,1	8,1	0,14	4,9	13,5	0,68	1,9	0,24	404	30,0	259	203	80,4	432	154	36	108	158	75	67	21	34	3	99,7
KHR-6	50,0	0,9	13,6	7,1	0,12	5,5	20,1	0,47	1,8	0,20	323	24,0	299	199	75,9	325	129	31	96	140	68	49	19	30	3	99,8
WR-38	54,4	0,9	14,4	7,7	0,13	5,9	13,5	0,53	2,2	0,23	361	27,0	330	245	79,1	244	134	30	106	117	51	52	19	27	3	99,8
AY-37	55,0	0,7	10,9	5,2	0,12	3,9	20,9	1,28	1,6	0,17	323	17,0	573	148	55	371	104	26	66	121	42	46	0	25	2	99,8
QM1	49,1	0,8	13,9	6,9	0,11	5,5	21,3	0,32	1,8	0,15	327	0,0	214	228	70,4	224	142	33	63	168	162	16	15	32	3	99,8
QP215	50,2	0,8	11,6	5,9	0,11	4,6	24,4	0,61	1,4	0,20	269	21,0	354	166	54,3	187	124	29	119	99	54	28	20	28	3	99,8

Table 3. The major and trace element concentrations of clay samples from the Upper Tigris Valley and the Upper Khabur region. Concentration values are given in Wt. % for major and trace elements in ppm.

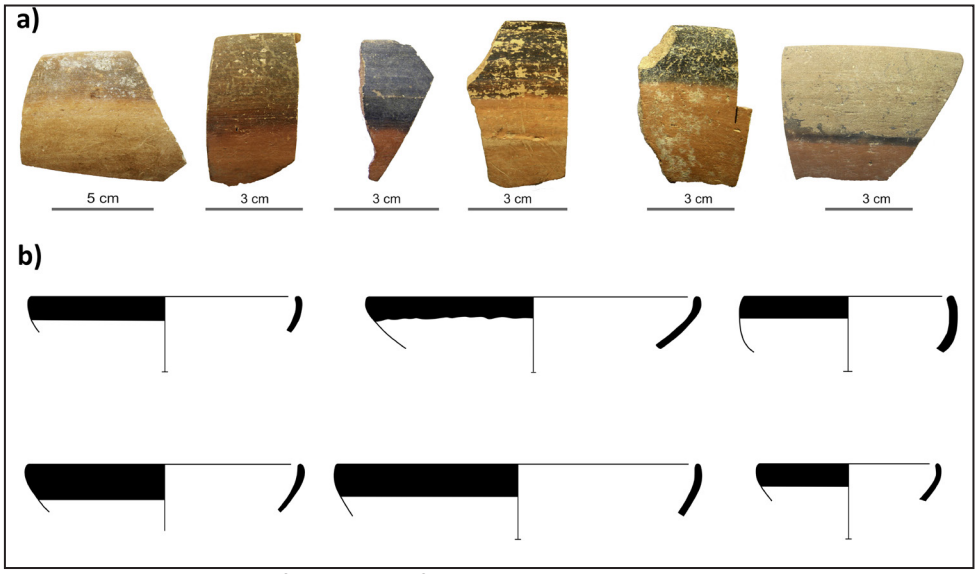


Fig. 1. a) Example sherds of DROB ware from the Upper Tigris and the Upper Khabur region, b) illustration of typical DROB ware (after Bianchi 2012).

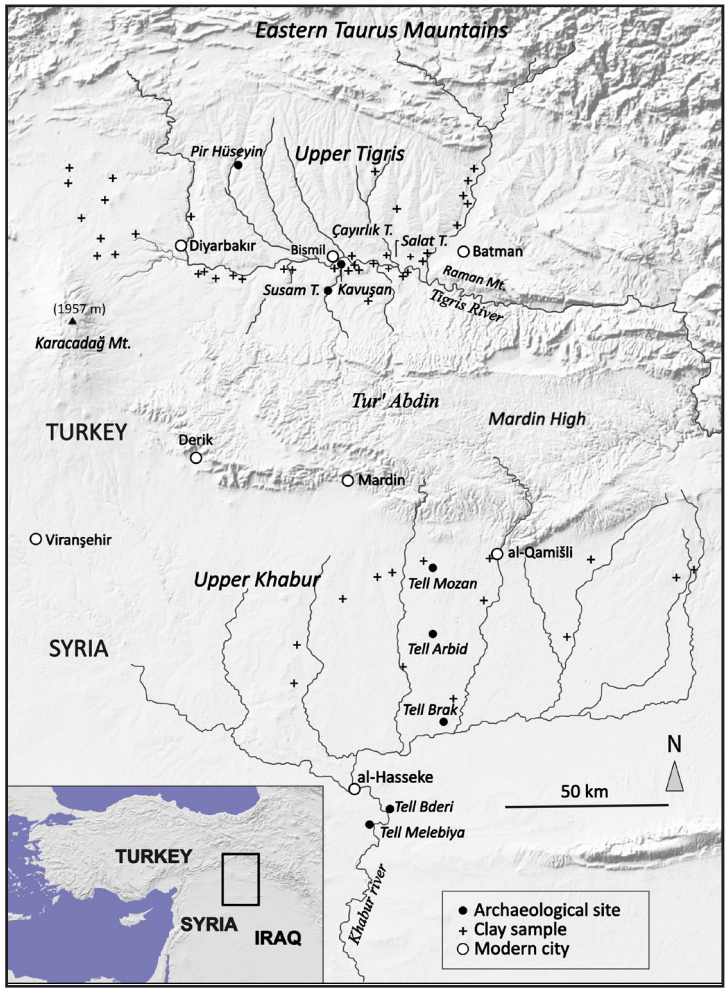


Fig. 2.
Topographic map of study area and distribution area of DROB ware in the Upper Khabur and the Upper Tigris. The map shows also archaeological sites and locations mentioned in the text, as well as location of reference clay samples used in the study.

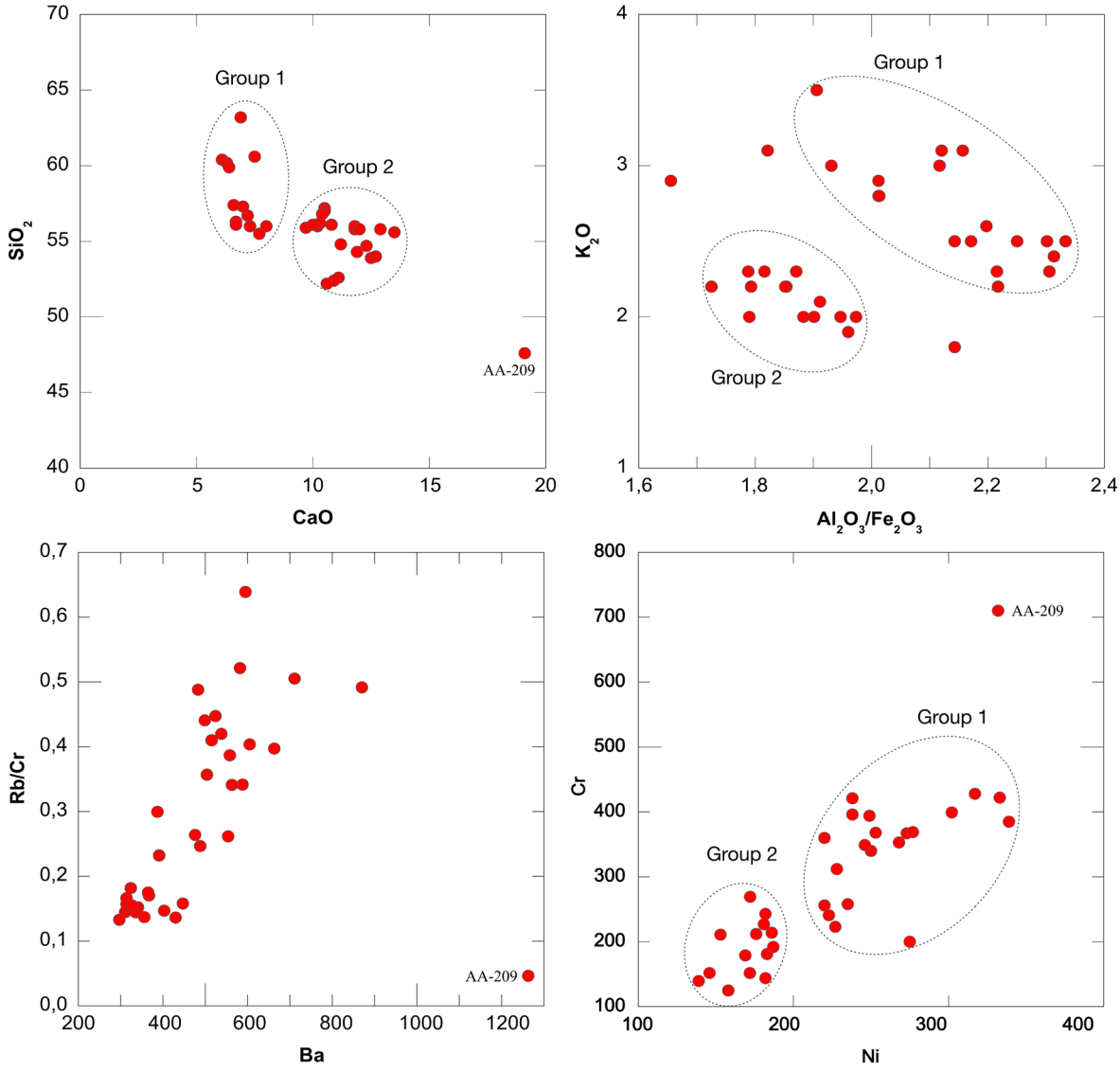


Fig. 3. Scatterplots of SiO_2 vs. CaO, K_2O vs. Al_2O_3/Fe_2O_3, Rb/Cr vs. Ba and Cr vs. Ni of DROB ware from the Upper Tigris and Upper Khabur region.

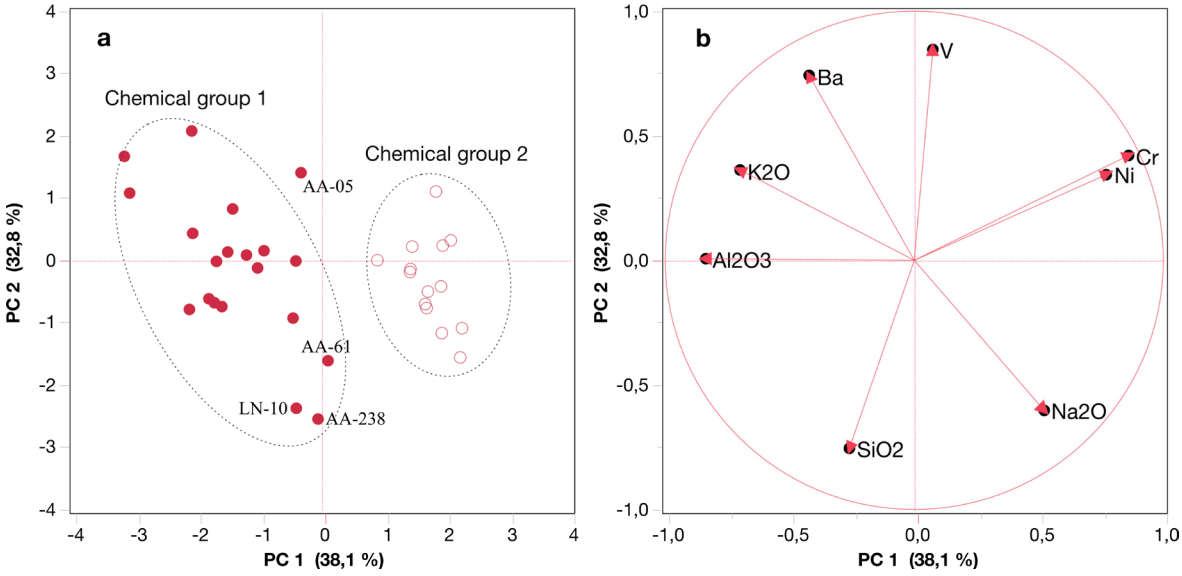


Fig. 4. a) Showing the scatter plot of the first two principal components (PC1 and PC2) and b) loading plots of analyzed DROB ware from the Upper Tigris Valley and the Upper Khabur region.

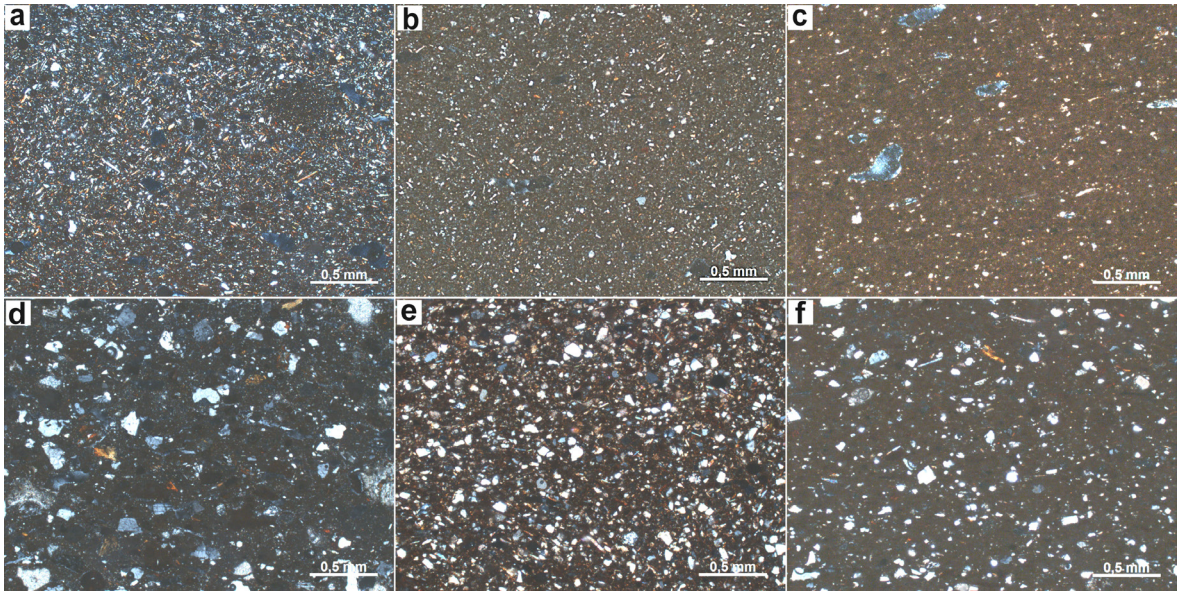


Fig. 5. Thin-section photomicrographs of DROB ware from the Upper Tigris and Upper Khabur, representing two different petrographic groups: petrographic group A and B. a: samples AA-240, b: AA-7 and c: AA-201 belong to the petrographic group A, showing fine fabric features with predominant fine quartz and needle-like muscovite inclusions, d: samples AA-226, e: AA-238 and f: AA-174 belong to the petrographic group B, showing moderate large fabric features with quartz and muscovite inclusions (All photomicrographs were taken with cross-polarized light, 5X).

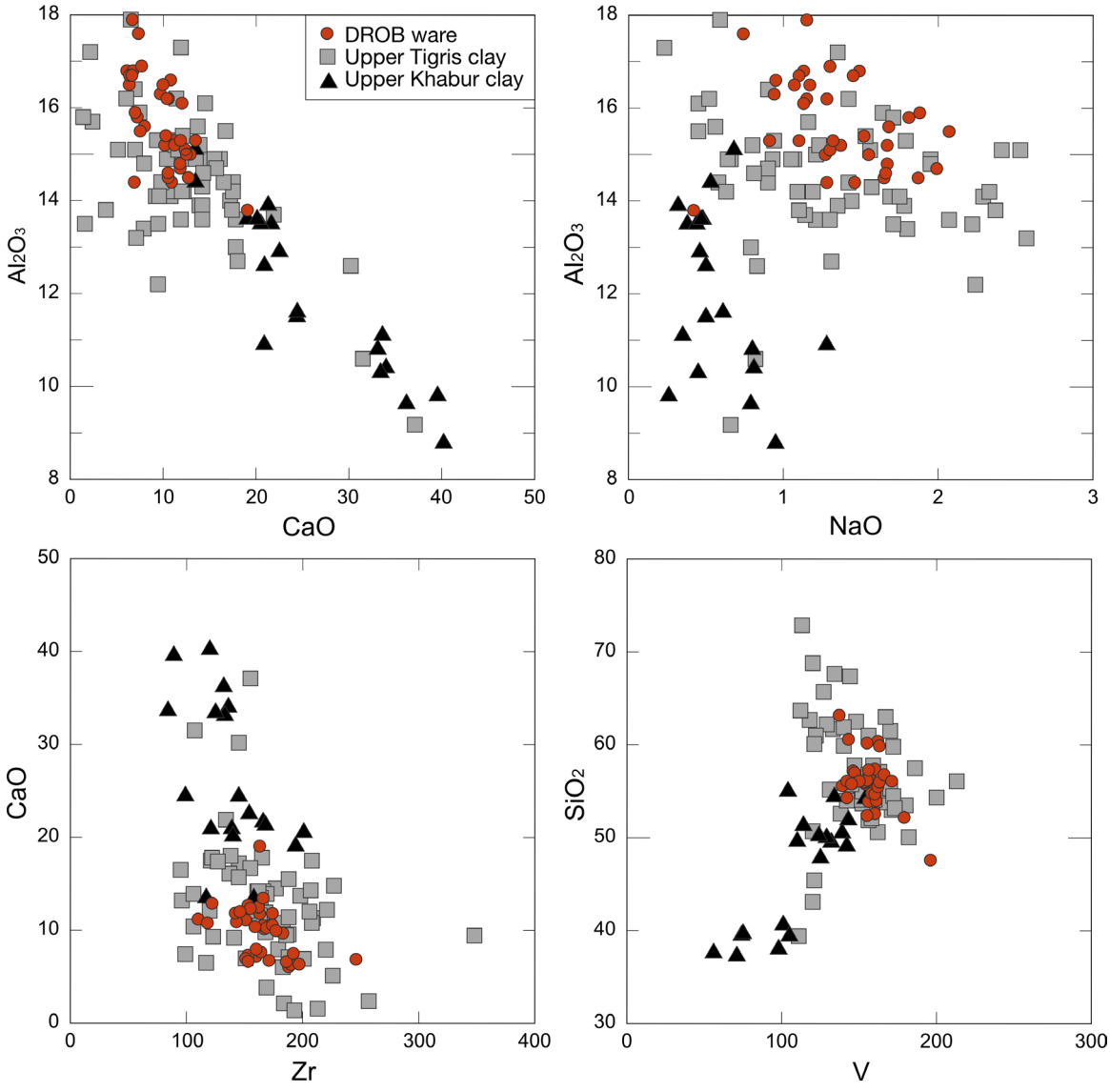


Fig. 6. Scatterplots of CaO vs. Al2O3, Na2O vs. Al2O3, Zr vs. CaO and V vs. SiO2 of the DROB ware and clay samples from the Upper Khabur and Upper Tigris Valley, showing compositional similarity of DROB ware to the clay sample from the Upper Tigris.

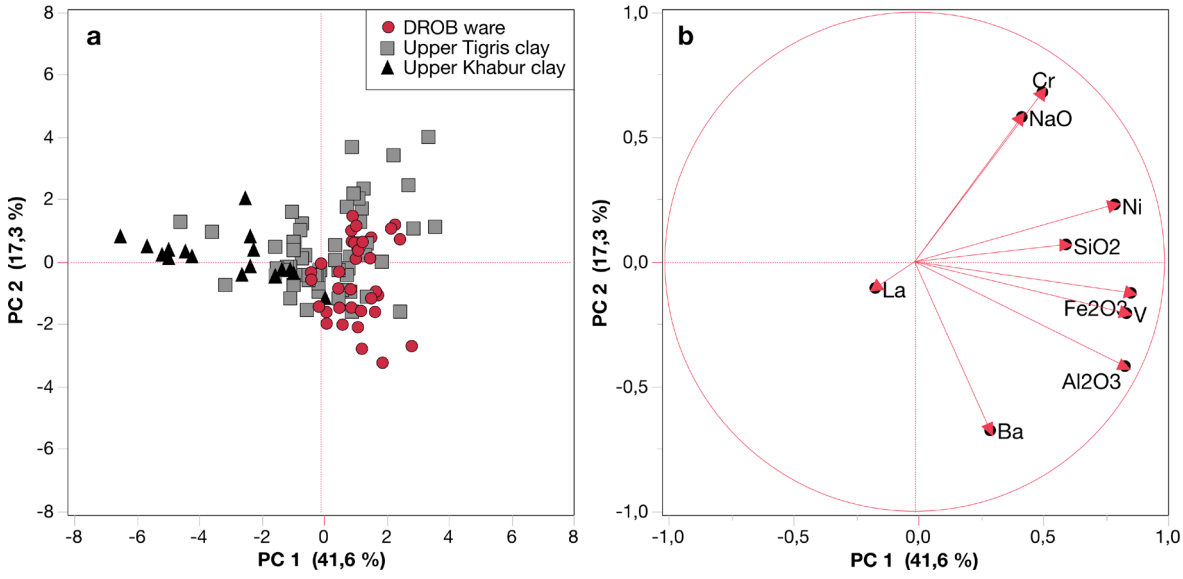


Fig. 7. a) Showing the scatter plot of first two principal components (PC1 and PC2) and loading plots (b) of analyzed DROB ware and reference clay samples from the Upper Tigris Valley and the Upper Khabur region.

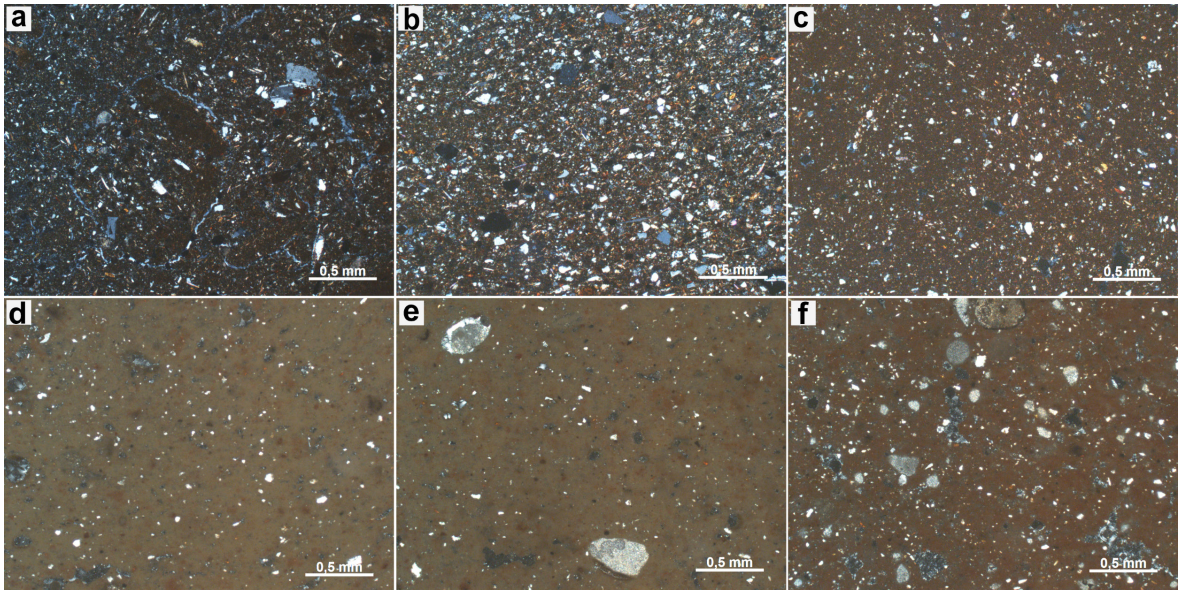


Fig. 8. Thin-section photomicrographs of selected reference clay samples from the Upper Tigris (a, b, c) and Upper Khabur (d, e, f), with different petrographic features. Clay samples from the Upper Tigris show predominate quartz inclusions and needle-like muscovite, whereas the clays from the Upper Khabur contain carbonate inclusions in high quantity and low quantity quartz (All photomicrographs were taken with cross-polarized light, 5X) .