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MERSİN
2017

*Vefat Eden Meslektaşlarımızı*
*Saygı ile Anıyoruz…*

**Prof. Dr. Güven ARSEBÜK**

**Prof. Dr. Arzu ÖZTÜRK**

**Dr.-Ing. Martin BACHMANN**

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# MERSİN ÜNİVERSİTESİ
# KILIKIA ARKEOLOJİSİNİ ARAŞTIRMA MERKEZİ
# BİLİMSEL SÜRELİ YAYINI 'OLBA'

**Kapsam**

Olba süreli yayını Mayıs ayında olmak üzere yılda bir kez basılır. Yayınlanması istenilen makalelerin en geç her yıl Kasım ayında gönderilmiş olması gerekmektedir.

1998 yılından bu yana basılan Olba; Küçükasya, Akdeniz bölgesi ve Ortadoğu'ya ilişkin orijinal sonuçlar içeren Antropoloji, Prehistorya, Protohistorya, Klasik Arkeoloji, Klasik Filoloji (ve Eskiçağ Dilleri ve Kültürleri), Eskiçağ Tarihi, Nümizmatik ve Erken Hıristiyanlık Arkeolojisi alanlarında yazılmış makaleleri kapsamaktadır.

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   c. Dipnotlar her sayfanın altına verilmeli ve makalenin başından sonuna kadar sayısal süreklilik izlemelidir.
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2. Noktalama (tireler) işaretlerinde dikkat edilecek hususlar:
   a. Metin içinde her cümlenin ortasındaki virgülden ve sonundaki noktadan sonra bir tab boşluk bırakılmalıdır.
   b. Cümle içinde veya cümle sonunda yer alan dipnot numaralarının herbirisi noktalama (nokta veya virgül) işaretlerinden önce yer almalıdır.
   c. Metin içinde yer alan "fig." ibareleri, küçük harf ile ve parantez içinde verilmeli; fig. ibaresinin noktasından sonra bir tab boşluk bırakılmalı (fig. 3); ikiden fazla ardışık figür belirtiliyorsa iki rakam arasına boşluksuz kısa tire konulmalı (fig. 2-4). Ardışık değilse, sayılar arasına nokta ve bir tab boşluk bırakılmalıdır (fig. 2. 5).

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Dipnot (kitaplar için)

Richter 1977, 162, res. 217.

Dipnot (Makaleler için)

Oppenheim 1973, 9, lev.1.

Diğer Kısaltmalar

| | |
|---|---|
| age. | adı geçen eser |
| ay. | aynı yazar |
| vd. | ve devamı |
| yak. | yaklaşık |
| v.d. | ve diğerleri |
| y.dn. | yukarı dipnot |
| dn. | dipnot |
| a.dn. | aşağı dipnot |
| bk. | Bakınız |

4. Tüm resim, çizim ve haritalar için sadece "fig." kısaltması kullanılmalı ve figürlerin numaralandırılmasında süreklilik olmalıdır. (Levha, Resim, Çizim, Şekil, Harita ya da bir başka ifade veya kısaltma kesinlikle kullanılmamalıdır).

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6. Figürler CD'ye yüklenmelidir ve ayrıca figür düzenlemesi örneği (layout) PDF olarak yapılarak burada yer almalıdır.
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Olba is printed once a year in May. Deadline for sending papers is November of each year.

The Journal 'Olba', being published since 1998 by the 'Research Center of Cilician Archeology' of the Mersin University (Turkey), includes original studies done on antropology, prehistory, protohistory, classical archaeology, classical philology (and ancient languages and cultures), ancient history, numismatics and early christian archeology of Asia Minor, the Mediterranean region and the Near East.

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2. Punctuation (hyphen) Marks:
   a. One space should be given after the comma in the sentence and after the dot at the end of the sentence.
   b. The footnote numbering within the sentence in the text, should take place before the comma in the sentence or before the dot at the end of the sentence.
   c. The indication fig.:

      * It should be set in brackets and one space should be given after the dot (fig. 3);

* If many figures in sequence are to be indicated, a short hyphen without space between the beginning and last numbers should be placed (fig. 2-4); if these are not in sequence, a dot and space should be given between the numbers (fig. 2. 5).

d) In the bibliography and abbreviations, if the author has two family names, a short hyphen without leaving space should be used (Dentzer-Feydy); if the article is written by two or more authors, after each author a space, a long hyphen and again a space should be left before the family name of the next author (Hagel – Tomaschitz).

3. The ‘Bibliography’ and ‘Abbreviations’ should take part at the end of the article. The ‘Abbrevations’ used in the footnotes should be explained in the ‘Bibliography’ part. The bibliography used in the footnotes should take place as abbreviations and the following order within the abbreviations should be kept: Name of writer, year of publishment, page (and if used, number of the illustration). This rule should be applied even if a publishment is used only once.

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Bibliography (for articles):

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Footnotes (for books):

Richter 1977, 162, fig. 217.

Footnotes (for articles):

Oppenheim 1973, 9, pl.1.

Miscellaneous Abbreviations:

| | |
|---|---|
| op. cit. | in the work already cited |
| idem | an auther that has just been mentioned |
| ff | following pages |
| et al. | and others |
| n. | footnote |
| see | see |
| infra | see below |
| supra | see above |

4. For all photographies, drawings and maps only the abbreviation ‘fig.’ should be used in continous numbering (remarks such as Plate, Picture, Drawing, Map or any other word or abbreviaton should not be used).
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OLBA XXV, 2017

# THE RESULTS OF CLAY ANALYSIS OF STAMPED AMPHORA HANDLES OF MILETUS AND RHODIAN PERAEA IN ALEXANDRIA (EGYPT)

Gonca CANKARDEŞ-ŞENOL – Erkan ALKAÇ – Mai ABDELGAWAD*

**ÖZET**

**Alexandria'da (Mısır) Ele Geçen Miletos ve Rhodos Peraia'sı Üretimi Mühürlü Amphora Kulplarının Kil Analizi Sonuçları**

Kil analizleri, seramik çalışmalarının önemli bir parçasını oluşturmaktadır. Kökeni bilinen seramiklerin kil analizlerinin yapılması, söz konusu üretim merkezlerinde üretilen ürünlerin kil özelliklerinin ve çeşitliliğinin belirlenmesine yardımcı olmaktadır. Böylece aynı üretim yerindeki farklı kil kaynaklarından elde edilen ürünlerin ve farklı atölyelerin tespiti sağlanmaktadır. Diğer yandan, kökeni konusunda kararsız kalınılan ya da kökeni hiç bilinemeyen seramiklerin kil kompozisyonlarının tespitine yönelik analizler yapılması ve sonuçların bilinen merkezlerin ürünlerinin analiz sonuçları ile karşılaştırılması, söz konusu seramiklerin kökeni konusunda karar verilmesine yardımcı olabilmektedir. Bu amaçla, OLBA XXIV 2016'da tarafımızdan yayınlanan, Alexandria'da bulunan Miletos kökenli mühürlü amphora kulplarının kil analizleri yapılmıştır. Aynı makalede, bazı meslektaşlar tarafından Miletos kökenli olarak önerilen, Boethos ismini taşıyan bir grup mühürün, kil özelliklerinden dolayı Rhodos Peraiası üretimi olmaları gerektiğinden de bahsedilmişti. Kil analizlerine ilişkin yapılan çalışmalarımızda, bu grup da incelenmiş ve kesinlikle Peraia'da üretildiği bilinen mühürlü kulpların kil analiz sonuçları ile karşılaştırılmıştır. Niton Xl3t XRF cihazı ile yapılan kil analizlerinin sonuçlarına göre Miletos ve Peraia üretimlerinin kil özelliklerinin birbirlerinden farklılıklar gösterdiği ve Boethos grubu amphora mühürlerinin killerinin Peraia kiline yakın olduğu saptanmıştır.

**Anahtar Kelimeler:** Alexandria, amphora mühürü, Miletos, kil analizleri, Rhodos Peraiası

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**ABSTRACT**

Clay analyses constitute an important part of ceramic studies. Conducting clay analyses of groups whose origins are known can contribute to identifying the characteristics and diversity of fabrics produced in the known production centres. Thus, it is possible to establish the ceramics produced in the same centres with clays from different sources. On the other hand, analyses aimed at establishing the clay composition of ceramics whose production centres are problematic or unknown and comparisons of the results of analyses with those of known products, can help determine the origins of fabrics. With this purpose, the stamped amphora handles attributed to Miletus found in Alexandria that were published in OLBA XXIV in 2016 were analysed. In this article, a group of stamps naming Boethos, which has been given a Milesian origin by some scholars, that would appear to originate in the Rhodian Peraea because of clay characteristics was also mentioned. During our studies related to clay analyses, this group was also examined and compared with the fabrics of stamped handles that were certainly produced in the Peraea. Lastly, the results of analyses made with a Niton Xl3t XRF device have shown the differences between fabrics of Milesian and Peraean products and the closeness of the Boethos group to Peraean fabrics.

**Keywords:** Alexandria, amphora stamp, Miletus, clay analyses, Rhodian Peraea

Clay analyses constitute an important part of ceramic studies. Conducting clay analyses of groups whose origins are known can contribute to identifying the characteristics and diversity of fabrics produced in known production centres. Thus, it is possible to establish the ceramics produced in the same centres with clays from different sources. On the other hand, analyses aimed at establishing the clay composition of ceramics whose production centres are problematic or unknown and comparisons of the results of analyses with those of known products, can help determine the origins of fabrics.

To this end, we analysed stamped amphora handles found during the excavations in Alexandria and its environs by the CEAlex (Centre for Alexandrian Studies). Firstly, the groups of known production centres are examined and their fabrics ascertained. The clays of stamped handles that are not attributed with certainty to a specific centre are also analysed and the results are compared with the known groups.

In an article published in OLBA XXIV in 2016, we presented the stamped amphora handles originating from Miletus that are held in Alexandria's Graeco-Roman Museum and others found in excavations in the city[1]. This paper also included stamped handles resembling those found in Miletus and Didyma, published[2] in 2009 and 2014, and suggested to be of Milesian production (fig. 1-2).

[1] Alkaç – Cankardeş-Şenol 2016, 191-216.

[2] Jöhrens 2004, 153-164 ; Jöhrens 2009, 205-235; Jöhrens 2014, 177-219.

These stamped handles can be considered as an important clue regarding trade relations between Alexandria and Miletus in the 3rd century BC.

Additionally, it was mentioned in OLBA XXIV (2016) that the stamped handles naming the producer Boethos (fig. 3) might belong to amphora production of the Rhodian Peraea and that clay analysis of this group would be conducted[3]. Stamped handles of this producer were also found during excavations at Miletus and were attributed to Milesian production in the above-mentioned publications. In this volume[4], we present the results of clay analyses using a Niton Xl3t XRF device on the handles bearing button-type stamps which were certainly produced in the Rhodian Peraea (CRI 0058, CRI 0063, CRI 0127, CRI 1276, CON 0236, CON 0313, CON 0319, DIA 0371, DIA 0364, GAB 0730, GAB 0785 and GAB 0901[5]) (fig. 4), on the stamped handles of amphorae produced in Miletus (FOU 028, FOU 139, FOU 140, FOU 206 and LUX 279[6]), and on the stamped handles of the producer Boethos (CRI 0161 and CRI 0170[7]). The analyses were carried out by Mai Abdel Gawad, a chemical engineer with the CEAlex materials characterisation laboratory, in Alexandria, Egypt[8].

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3 Alkaç – Cankardeş-Şenol 2016, 195.

4 See the list of inventory numbers of amphora stamps and corresponding analysis numbers.

5 CRI 0058: Eponym Polykles (RE-ΠΟΛΥΚΛΗΣ-012, Cankardeş-Şenol 2000, 476, no. 127; *Lexicon* III, 274),
CRI 0063: Eponym Philonidas (RE-ΦΙΛΩΝΙΔΑΣ-001, Cankardeş-Şenol 2000, 478, no. 130; Cankardeş-Şenol – Canoğlu 2009, 148, B97; *Lexicon* IV, 162),
CRI 0127: Producer Philokles (RF-ΦΙΛΟΚΛΗΣ-001, Cankardeş-Şenol 2000, 477, no. 129, fig. 628; Cankardeş-Şenol 2007, 43, 55, fig. 20; Cankardeş-Şenol – Canoğlu 2009, 158, C33),
CRI 1276: not restorable,
CON 0236: Eponym Thrasydamos (RE-ΘΡΑΣΥΔΑΜΟΣ-001, Cankardeş-Şenol 2000, 311, no. 58; Cankardeş-Şenol – Canoğlu 2009, 131, B39; *Lexicon* II, 259),
CON 0313: Eponym Aristarchos (RE-ΑΡΙΣΤΑΡΧΟΣ-007, Cankardeş-Şenol 2000, 353, no. 142; Cankardeş-Şenol – Canoğlu 2009, 125, B17; *Lexicon* I, 315),
CON 0319: Producer Hieroteles (RF-ΙΕΡΟΤΕΛΗΣ-013, Cankardeş-Şenol 2000, 354, no. 144),
DIA 0371: Eponym Peithiadas (RE-ΠΕΙΘΙΑΔΑΣ-002, Cankardeş-Şenol 2000, 237, no. 1; Cankardeş-Şenol – Canoğlu 2009, 140, B70),
DIA 0364: Producer Hieroteles (RF-ΙΕΡΟΤΕΛΗΣ-006, Cankardeş-Şenol 2000, 237, no. 176),
GAB 0730: Producer Philios (RF-ΦΙΛΙΟΣ-001; Cankardeş-Şenol – Canoğlu 2009, 157, C32),
GAB 0785: Eponym Timokleidas (RE-ΤΙΜΟΚΛΕΙΔΑΣ-019; Cankardeş-Şenol 2001-I, 400, no. 6; *Lexicon* IV, 103),
GAB 0901: Eponym Aischylinos (RE-ΑΙΣΧΥΛΕΙΝΟΣ-001, Cankardeş-Şenol – Canoğlu 2009, 123, B12; *Lexicon* I, 155).

6 FOU 028: S[..], Alkaç – Cankardeş-Şenol 2016, 206, fig. 12; FOU 139: Botas, Alkaç – Cankardeş-Şenol 2016, 205, fig. 5; FOU 140: Auxe(, Alkaç – Cankardeş-Şenol 2016, 204, fig. 1; FOU 206: Phoky(, Alkaç – Cankardeş-Şenol 2016, 205, fig. 8 and LUX 279: Pho(, Alkaç – Cankardeş-Şenol 2016, 205, fig. 7.

7 CRI 0161 (RF-ΒΟΗΘΟΣ-001, Cankardeş-Şenol 2000, 474, no. 125) ve CRI 0170: Boeth(, (RF-ΒΟΗΘΟΣ-004, Cankardeş-Şenol 2000, 475, no. 126; Doğer – Şenol 1997, 41, no. 10; Şenol – Şenol – Doğer 2004, 358, fig. 19).

8 See *Appendix*.

The results of the analyses are specified in detail below in the *Appendix*. Firstly, Rhodian Peraean and Milesian products have been examined individually and the characteristics of each group are displayed after the comparisons. Subsequently, the clay composition of stamped handles of the producer Boethos (CRI 0161 ve CRI 0170) has been determined in an attempt to establish to which group it is closer. Only the clay analysis of Peraean stamped handles belonging to the amphorae produced in or around the workshop of the producer Hieroteles have been conducted in this study. As is known, amphorae were produced in various workshops in the Peraea[9] and it should be noted that the clay source of each workshop might have been different. At the same time, the minerals constituting the clay in the regional clay sources would normally exist in the clay used by all the workshops, but may show different ratios.

Similar clay characteristics have been observed in the handles with button-type stamps belonging to amphorae produced in the region under the control of Rhodes and those with stamps of the producer Boethos (who also worked in this region), as can be seen in the *Appendix*. On the other hand, the clay compositions of stamped handles attributed to Milesian production have different characteristics. In addition to these preliminary results, and in order to obtain more accurate data, it is eventually purposed to conduct petrographic analyses on our samples and on any new material found in the future.

## List of inventory numbers of amphora stamps and corresponding analysis numbers:

Button-type stamps produced in the Rhodian Peraea:

| *Inv. Numbers* | *Analysis Numbers* |
|---|---|
| CRI 0058 | XCRI0012 |
| CRI 0063 | XCRI0013 |
| CRI 0127 | XCRI0016 |
| CRI 1276 | XCRI0014 |
| CON 0236 | XCON0189 |
| CON 0313 | XCON0193 |
| CON 0319 | XCON0190 |
| DIA 0371 | XDIA0336 |

[9] See, Doğer – Şenol 1996, 59-73; Doğer – Şenol 2002, 13-19; Cankardeş-Şenol 2015, 233-241; Held – Cankardaş-Şenol – Şenol 2007, 41-45; Held – Cankardaş-Şenol – Şenol 2008, 371-373; Held – Cankardaş-Şenol – Şenol 2009; 217-219 ; Held – Cankardaş-Şenol – Şenol 2010, 215-232; Held – Cankardaş-Şenol – Şenol 2011, 330-334; Held – Cankardaş-Şenol – Şenol 2012, 190-192; Şenol 2011; Şenol 2015, 193-202. For archeometric analyses of amphorae found during the surveys in the region, see Akyol – Kadıoğlu – Şenol 2013, 163-177.

| | |
|---|---|
| DIA 0364 | XDIA0337 |
| GAB 0730 | XGAB0002 |
| GAB 0785 | XGAB0006 |
| GAB 0901 | XGAB0005 |

Milesian amphora stamps:

| *Inv. Numbers* | *Analysis Numbers* |
|---|---|
| FOU 028 | XFOU0667 |
| FOU 139 | XFOU0668 |
| FOU 140 | XFOU0669 |
| FOU 206 | XFOU0670 |
| LUX 279 | XLUX0009 |

Amphora stamps of the producer Boethos:

| *Inv. Numbers* | *Analysis Numbers* |
|---|---|
| CRI 0161 | XCRI0020 |
| CRI 0170 | XCRI001 |

## *Appendix*: Clay Comparison Between Some Stamped Amphora Handles Produced in the Rhodian Peraea and Miletus

In 2014, 30 samples of stamped handles of Rhodian Peraea production were analysed using a Niton Xl3t XRF portable analyser in order to determine the chemical compositions. The status of these individual objects was such that we could not create fresh breaks, and so the samples were cleaned, dried in a furnace for 30-40 minutes at 100°C to remove any humidity, and then the chemical analyses were performed, taking three measurements along the surface of each object. The concentrations of more than 25 elements were obtained, of which only 20 were used in our study. The remaining elements were eliminated as they were considered as contamination or because of the low precision of the device with respect to these elements. The elements used in the following statistical analyses were the nine major elements in ceramic production ($SiO_2$, $TiO_2$, $Al_2O_3$, $Fe_2O_3$, MnO, MgO, CaO, $K_2O$, and $P_2O_5$) and 11 trace elements (V, Cr, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Ba). Where, the concentrations of the 9 major elements in oxide wt.% and the trace elements in ppm.

The results of the statistical analyses for this list of samples provided one major group, with all the samples homogeneous together, and maybe the existence of five sub-groups, more or less. These sub-groups might be due to differences in the workshops in which the objects (amphorae) were manufactured, or chronology etc.

It was subsequently proposed that two analysed samples found on the Cricket Ground site in Alexandria, Egypt (samples XCRI0019 and XCRI0020), with a supposed provenance of the Rhodian Peraea, might actually be of Milesian provenance and not from the Peraea. Their stamps resemble a group of stamped handles from Miletus that were mentioned in a publication in 2009 by G. Jöhrens[10], who notes that by NAA (Neutron Activation Analysis) the samples with this specific stamp belonged to productions of Miletus.

We chose several samples from the previously studied list of stamped handles from the Peraea bearing a certain type of stamp and of definite Peraean provenance and we compared them with these two samples and a group of stamped handles from Miletus found on the Fouad and Lux sites in Alexandria that were chemically analysed in 2016. The aim was to try to determine whether they belonged to Miletus or Rhodian Peraea productions. The list of samples used can be seen in fig. 5.

Figures 6, 7, and 8 show the means and standard deviations obtained from the results of the samples that were chosen to be compared with the two samples XCRI0019 and XCRI0020.

Comparing the composition of these two samples shown in figure 8 with the averages ($m \pm \sigma$) shown in figures 6 and 7, it can be seen that there is a difference between the chemical compositions of the stamped handles from the Rhodian Peraea and those of Miletus. It can also be seen that the samples from the Cricket Ground site (XCRI0019 and XCRI0020) have chemical compositions that are closer or inside the range of means and standard deviations of the stamped handles from Peraea and are not at all homogeneous with the samples from Miletus.

Statistical analyses of the samples chosen for comparison were performed to visualize the homogeneity between the samples. The histograms below show that samples from the Rhodian Peraea including the two uncertain samples are different from those of Miletus. The difference is with respect to some major elements, like $Fe_2O_3$ and CaO, which could be related to firing or fabrication technology (fig. 9).

There are some other elements which could be related to the clay source itself, the additives or the treatment of the clay before firing, such as $K_2O$, $TiO_2$, V, Cr, Rb, and Sr. The histograms for the mentioned elements can be seen in figs. 10, 11, 12, 13, 14 and 15.

The two groups of samples have similar clay properties with respect to silica and alumina contents, where the two groups of samples have silica ($SiO_2$) contents between 40-60% and alumina ($Al_2O_3$) concentrations between 7-17% (fig. 16a-b).

10 Jöhrens 2009, 207.

2D scatter plots were performed between the elements to see the differences between the two groups of samples and to verify that the two samples from the Cricket Ground belonged to the group of samples with stamped handles from the Rhodian Peraea, which was clearly demonstrated in the histograms above.

It is clear from the 2D diagrams that the two samples from the Cricket Ground most probably belong to the group of Rhodian Peraean provenance. The Peraea group has different concentrations of elements from those of Milesian provenance with respect to several elements, especially trace elements, which are an indication of the geological property of the provenance and the clay source used in the production of the analysed handles. This can be seen in fig. 17a, b, c.

It is clear that the samples from the Rhodian Peraea fall into two groups, one with higher Cr and Ni concentrations [higher than 250 ppm] which could be a possible indication of that group being volcanic or containing more volcanic inclusions than the other[11]. The one that is non-volcanic or with less volcanic inclusions is homogeneous with the group of stamped handles from Miletus, including the two samples from the Cricket Ground (XCRI0019 and XCRI0020) (fig. 18).

Regarding the silica / calcium correlation (fig. 19), it is also evident that the samples from the Rhodian Peraea form two sub-groups with respect to these two elements. One group, to which the two Cricket Ground samples belong, displays lower concentrations of CaO and higher $SiO_2$. This is perhaps due to firing or to different types of clay or, perhaps, to the recrystallization depending on the conditions of the environment where the findings are preserved.

While the other group, with lower volcanic inclusions, lies in the calcareous (8-10% CaO) with low $SiO_2$ concentration range.

The $SiO_2$ / CaO correlation (fig. 19), which can also be related to fabrication technology, shows that the two groups of samples have different fabrication technologies (two different correlation lines). Having higher $SiO_2$ content and lower CaO content could be due to a difference in firing. During firing the $SiO_2$ content increases and that of CaO decreases as the result of chemical reactions like the decomposition of feldspar and kaolin, which gives out a higher $SiO_2$ content and a decrease in the CaO content, as a result of the oxidation process where limestone $CaCO_3$ decomposes, giving off $CO_2$ which evaporates, and CaO which decreases the concentration of the total lime within the sample[12].

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11 Desbat – Picon 1986, 637-648. On p. 645, it is indicated that the relatively high value of Chromium is explained by the fact that it is a clay produced from alterations of volcanic material. See also Empereur – Picon 1988, 33-38. On p. 36, it is mentioned that having high contents of Cr and Ni is typical of clay derived as an erosion product of Ophiolitic material.

12 Weems 1903, 319-. 346.

Samples from Miletus have higher calcareous concentrations than those of the Rhodian Peraea.

If the strontium concentration is below 150 ppm, it indicates the inland origin of the clay, while if it is above 400 ppm, it has a marine origin. Strontium is similar to calcium geochemically and is found in substances that contain lime (seashells, limestone etc.). If the sand used in making ceramics contains more than 400 ppm, it can be asserted that the clay is obtained from marine sediments, while for inland sand that contains limestone, the amount of Sr is usually less than 150 ppm. Also, if inland sand has been used in the production, zirconium concentration would be expected to be more than 160 ppm.[13]

Accordingly, and from Sr / Zr correlation (fig. 20), the clay source for both groups of samples is marine. The Rhodian Peraea group of samples has lower strontium concentration, between 150-400 ppm (clay source with lower calcareous inclusions?), while the group of Miletus stamped handles have a higher strontium concentration, above 400 ppm, and the two groups of samples have zirconium concentrations of around 160 ppm, which indicates a marine clay source.

One sample of the Miletus group of stamped handles has higher strontium and zirconium concentrations, which could be due to contamination or, perhaps, mixed clay (?).

In a previously published thesis submitted to the Middle East Technical University, Turkey, concerning archaeometric studies applied to a group of Ottoman ceramics from İznik that were mostly Miletus wares, the common minerals detected in the bodies of the ceramic samples were quartz, feldspar, hematite, mica/biotite, and others. Mica/muscovite was also encountered among other minerals[14].

Hence, it could be considered that one of the differences between ceramic samples from Miletus and samples from Peraea is the existence of mica in the former and its rarity in the latter. There are two types of mica, mica/biotite and mica/muscovite, with chemical formulas of $K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$ and $KAl_2(AlSi_3O_{10})(OH)_2$ respectively; the compositions of elements for the two types of mica are shown in fig. 21.

The weight percentages of the oxides in the ceramic samples should be more than the compositions of pure mica due to the existence of a percentage of these oxides inside the clay itself. Comparing the above compositions of mica with the compositions of the two samples XCRI0019 and XCRI0020, it can be observed

13 Özkul-Fındık – Akyol – Sarı 2014, 259-269; Freestone – Leslie – Thirlwall – Gorin-Rosen 2003, 19-32.

14 Kırmızı 2004.

that the compositions of the two samples do not display a high indication that they could contain mica.

The above cannot be presented as a definitive result but could be viewed as the beginnings of a study. Further examinations of the samples should be conducted, such as petrographic analyses, through taking thin sections from the samples, and studying and comparing the minerals within each group of samples.

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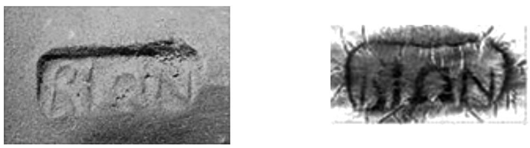
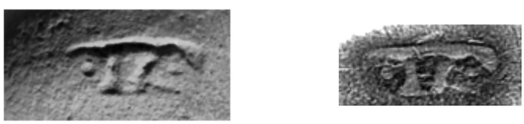


MGR 1068.25 (P.11300)

MGR 1068.30 (P.11269)

Fou.03.10748.11 (F 139)

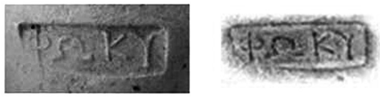


MGR 1073.4 (P.0189)

0 1 2 3 4 5

Fig. 1 Alexandria'da ele geçen Miletos kökenli amphora mühürleri (Alkaç – Cankardeş-Şenol 2016, 211-212, fig. 1-6).

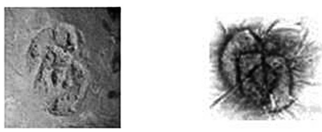
Lux. 02. 30727. 51 15 (L 279)



Fou. 04.11048.10 (F 206)

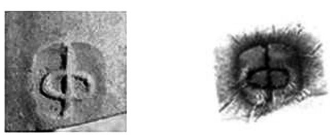
MGR P.11326

MGR 1029.3 (P.10891)



MGR 1062.34 (P.10894)

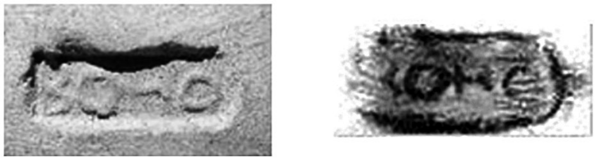
Fou.00. 10028. 40. 188 (F 028)



MGR 1071.14 (P.10914)




Fig. 2 Alexandria’da ele geçen Miletos kökenli amphora mühürleri (Alkaç – Cankardeş-Şenol 2016, 212-214, fig. 7-13).



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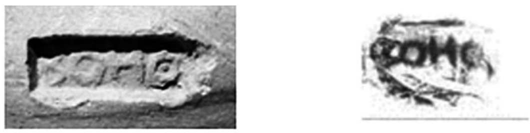

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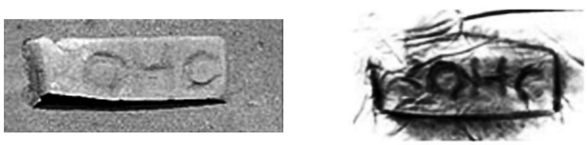


CRI.97.6075.01 (CRI 161)

CRI.97.6002.01.03 (CRI 170)


Fig. 3 Alexandria'da ele geçen, Rhodos Peraiası'nda üretim yapan Boethos'a ait amphora mühürleri (Alkaç – Cankardeş-Şenol 2016, 214-215, fig. 14-18. Ayrıca bkz. dipnot 6).

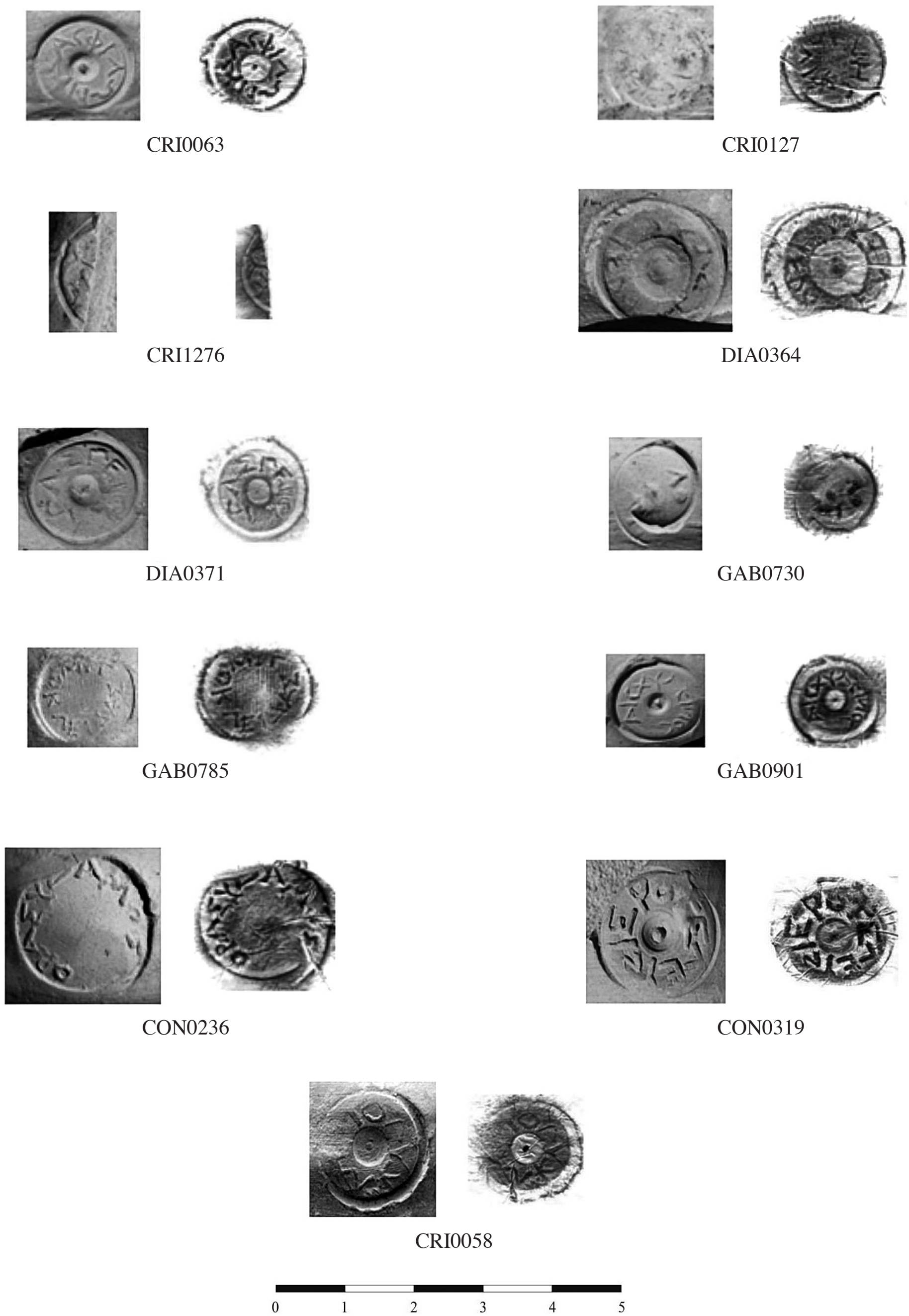



Fig. 4 Alexandria'da ele geçen, Rhodos Peraiası'nda üretilen amphoralara ait düğme formlu mühürler (Referanslar için dipnot 4'e bakınız).

| No. Echantillon | No. Archeologique | Type | Provenance |
|---|---|---|---|
| **XFOU0667** | FOU.00.10028.40.188 | Anse Timbree | Miletus |
| **XFOU0668** | FOU.03.10748.11 | Anse Timbree | Miletus |
| **XFOU0669** | FOU.03.10760.16 | Anse Timbree | Miletus |
| **XFOU0670** | FOU.04.11048.10 | Anse Timbree | Miletus |
| **XLUX0009** | LUX.02.30727.51.15 | Anse Timbree | Miletus |
| **XCON0189** | CON.96.10088.03-236 | Anse Timbree | Peraea |
| **XCON0190** | CON.96.10291.02.04-319 | Anse Timbree | Peraea |
| **XCON0193** | CON.96.11143.02.05-313 | Anse Timbree | Peraea |
| **XCRI0012** | CRI.96.2029.06.12-058 | Anse Timbree | Peraea |
| **XCRI0013** | CRI.96.2050.03.06-063 | Anse Timbree | Peraea |
| **XCRI0014** | CRI.96.2087.2-1276 | Anse Timbree | Peraea |
| **XCRI0016** | CRI.96.5143.02.01-127 | Anse Timbree | Peraea |
| **XCRI0019** | CRI.96.6002.01.03-170 | Anse Timbree | Peraea or Miletus? |
| **XCRI0020** | CRI.97.6076.01-161 | Anse Timbree | Peraea or Miletus? |
| **XDIA0336** | DI.DecapageZ.02.16.03-371 | Anse Timbree | Peraea |
| **XDIA0337** | DI.96.3002.2.5-364 | Anse Timbree | Peraea |
| **XGAB0002** | GAB.97.0004.1.3-730 | Anse Timbree | Peraea |
| **XGAB0005** | GAB.98.50200.5.5-901 | Anse Timbree | Peraea |
| **XGAB0006** | GAB.98.60035.2.1-785 | Anse Timbree | Peraea |

Fig. 5 List of analysed samples to be studied statistically.

| **Miletus** | **SiO2** | **TiO2** | **Al2O3** | **Fe2O3** | **MnO** | **MgO** | **CaO** | **K2O** | **P2O5** | **V** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean (μ)** | 46,53 | 0,48 | 13,41 | 5,41 | 0,07 | 5,36 | 17,75 | 2,18 | 0,20 | 73,82 |
| **St. Dev. (σ)** | 3,09 | 0,05 | 1,56 | 0,49 | 0,01 | 1,08 | 2,02 | 0,21 | 0,05 | 7,49 |
| **Miletus** | **Cr** | **Ni** | **Cu** | **Zn** | **Rb** | **Sr** | **Y** | **Zr** | **Nb** | **Ba** |
| **Mean (μ)** | 221,55 | 216,60 | 89,83 | 78,99 | 86,49 | 623,29 | 21,13 | 175,53 | 12,52 | 469,07 |
| **St. Dev. (σ)** | 26,35 | 21,50 | 26,54 | 4,33 | 9,10 | 184,22 | 2,01 | 20,67 | 1,11 | 67,73 |

Fig. 6 Means and standard deviations of five Miletus stamped handles.

| **Pereae** | **SiO2** | **TiO2** | **Al2O3** | **Fe2O3** | **MnO** | **MgO** | **CaO** | **K2O** | **P2O5** | **V** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean (μ)** | 48,45 | 0,68 | 11,51 | 7,10 | 0,09 | 7,41 | 8,21 | 2,72 | 0,24 | 147,78 |
| **St. Dev. (σ)** | 7,23 | 0,08 | 2,54 | 0,56 | 0,01 | 2,59 | 2,00 | 0,32 | 0,07 | 19,87 |
| **Pereae** | **Cr** | **Ni** | **Cu** | **Zn** | **Rb** | **Sr** | **Y** | **Zr** | **Nb** | **Ba** |
| **Mean (μ)** | 370,20 | 286,20 | 64,19 | 107,42 | 109,50 | 310,02 | 20,03 | 147,16 | 14,53 | 398,99 |
| **St. Dev. (σ)** | 56,33 | 80,87 | 15,29 | 16,82 | 7,88 | 78,56 | 1,24 | 11,58 | 1,08 | 78,20 |

Fig. 7 Means and standard deviations of 12 Rhodian Peraea stamped handles.

| **No. Echantillon** | **No. Archeologique** | **Type** | **Provenance** | **SiO2** | **TiO2** | **Al2O3** | **Fe2O3** | **MnO** | **MgO** | **CaO** | **K2O** | **P2O5** | **V** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **XCRI0019** | CRI.96.6002.01.03-170 | Anse Timbree | Pereae or Miletus? | 49,10 | 0,78 | 11,77 | 7,32 | 0,07 | 7,79 | 5,13 | 3,13 | 0,25 | 145,14 |
| **XCRI0020** | CRI.97.6076.01-161 | Anse Timbree | Pereae or Miletus? | 58,58 | 0,83 | 16,36 | 7,01 | 0,09 | 10,51 | 4,39 | 3,30 | 0,26 | 178,25 |
| **No. Echantillon** | **No. Archeologique** | **Type** | **Provenance** | **Cr** | **Ni** | **Cu** | **Zn** | **Rb** | **Sr** | **Y** | **Zr** | **Nb** | **Ba** |
| **XCRI0019** | CRI.96.6002.01.03-170 | Anse Timbree | Pereae or Miletus? | 299,67 | 200,72 | 59,61 | 133,53 | 107,21 | 159,46 | 21,22 | 153,03 | 14,69 | 436,75 |
| **XCRI0020** | CRI.97.6076.01-161 | Anse Timbree | Pereae or Miletus? | 298,89 | 197,32 | 56,63 | 111,58 | 112,84 | 95,11 | 21,35 | 161,29 | 14,87 | 430,43 |

Fig. 8 Chemical composition of two stamped handles from the Cricket Ground site in Alexandria.

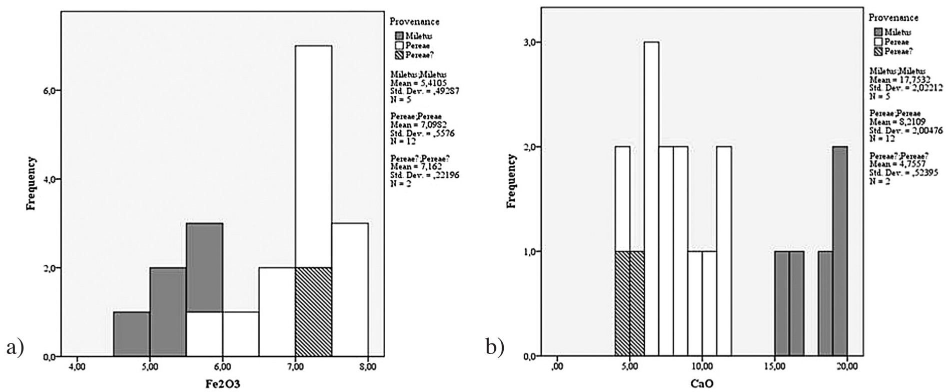



Fig. 9a-b Histograms with respect to (a) Iron (Fe2O3) and (b) Calcium (CaO)

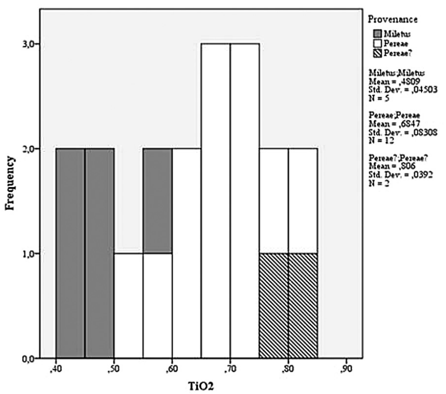



Fig. 10 Histogram of TiO2

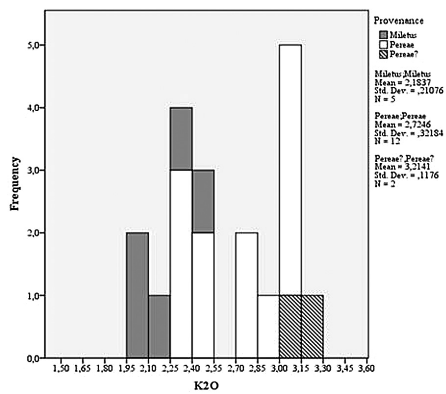



Fig. 11 Histogram of K2O

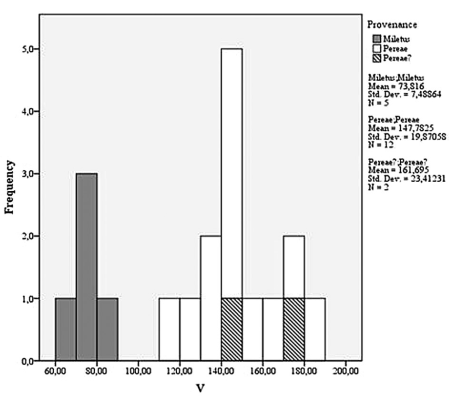



Fig. 12 Histogram of vanadium

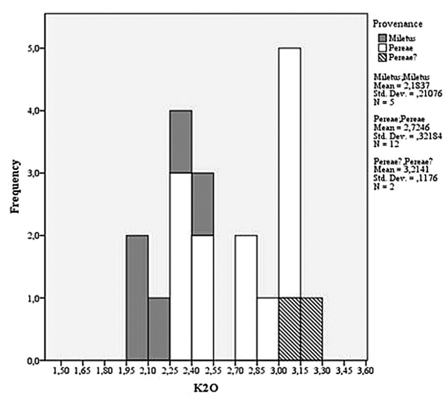



Fig. 13 Histogram of chromium

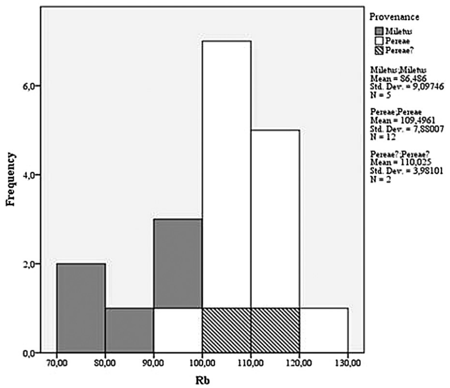



Fig. 14 Histogram of rubidium

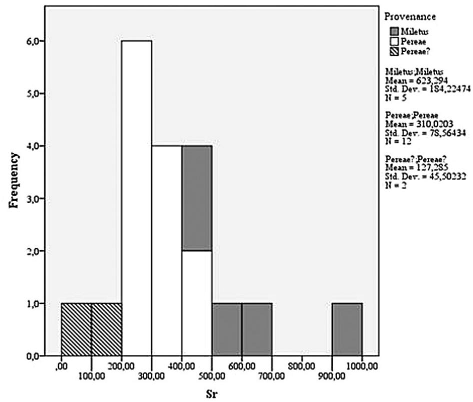
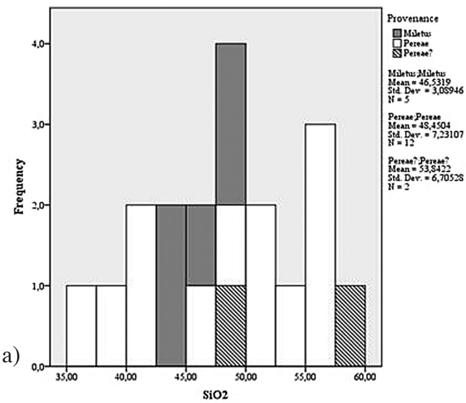



Fig. 15 Histogram of strontium

a)




b)

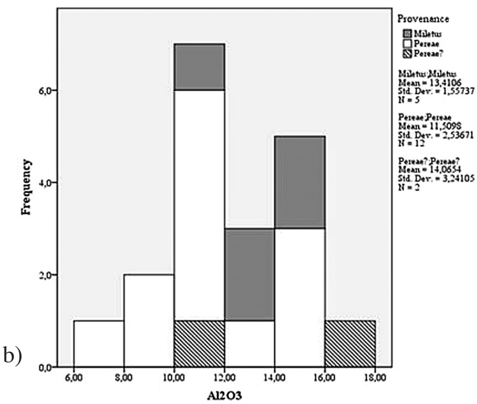



Fig. 16 Histograms with respect to (a) Silica (SiO2) and (b) Alumina (Al2O3)

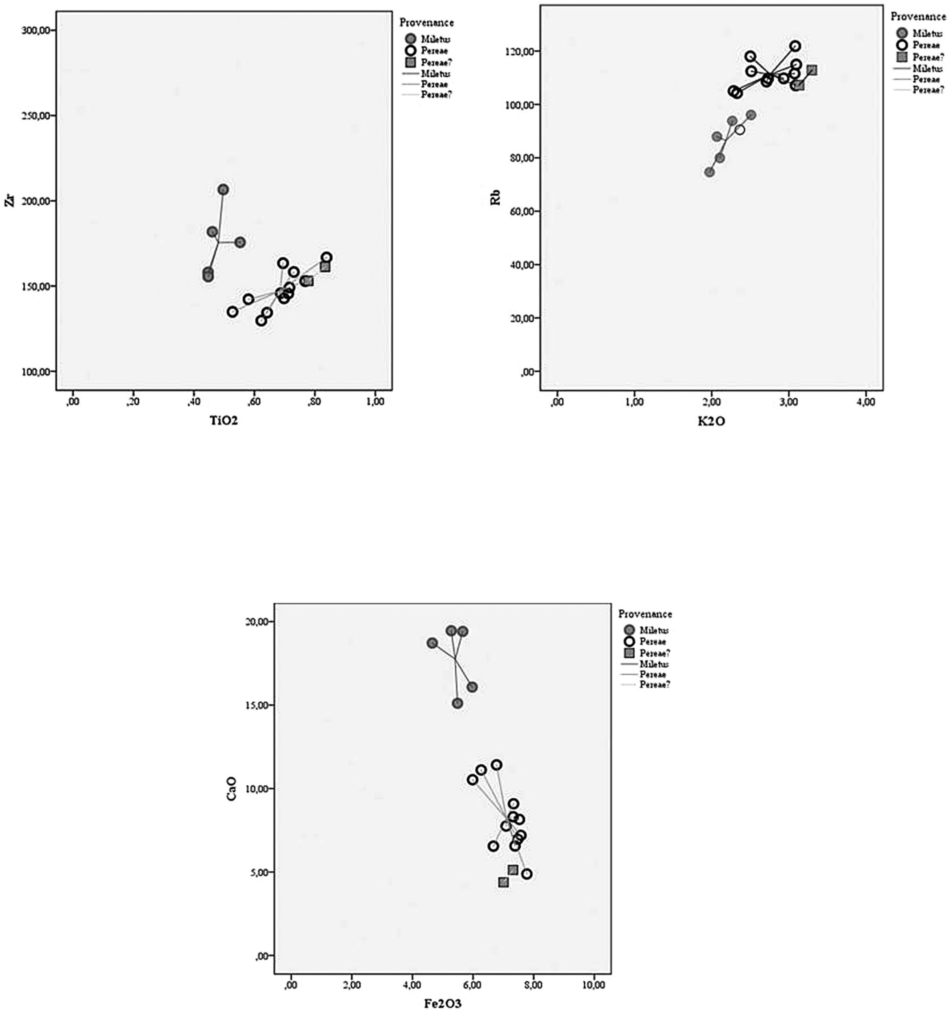



Fig. 17 2D scatter plots showing the correlations between (a) TiO2 vs Zr (b) K2O vs Rb (c) Fe2O3 vs CaO.

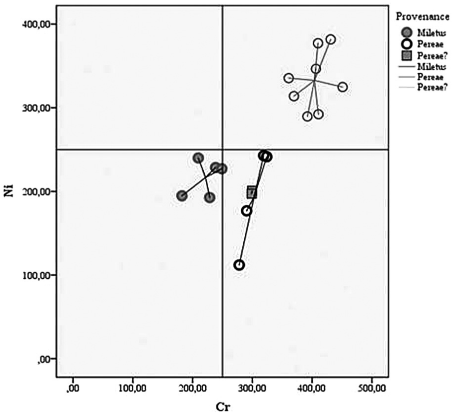



Fig. 18 2D scatter plot showing Cr vs. Ni correlation

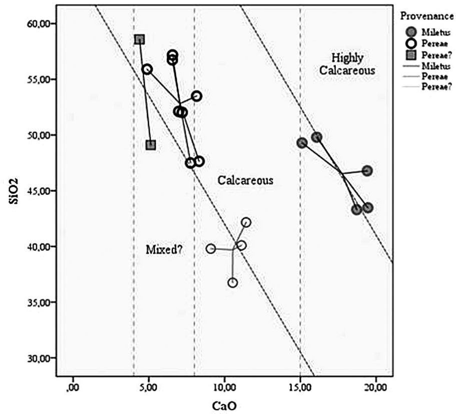



Fig. 19 2D scatter plot showing SiO2 / CaO correlation

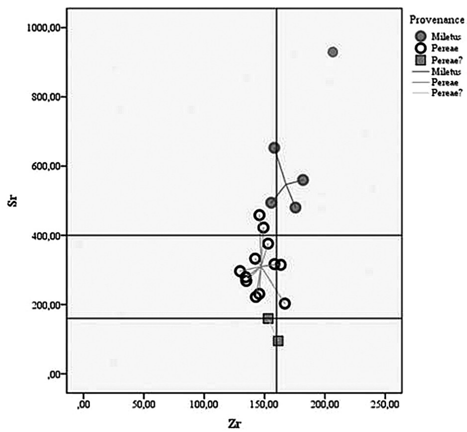



Fig. 20 2D scatter plot showing the Zr vs Sr correlation

| Oxide Wt% | $K_2O$ | MgO | $Al_2O_3$ | $Fe_2O_3$ | $SiO_2$ | CaO | $P_2O_5$ |
|---|---|---|---|---|---|---|---|
| Biotite* | 10.86 | 23.24 | 11.76 | 8.29 | 41.58 | - | - |
| Muscovite** | 3.28±0.10 | 1.69±0.10 | 15.8±0.34 | 6.32±0.23 | 65.8±0.43 | 1.40±0.07 | 0.16±0.025 |

* Webmineral.com/data/Biotite.shtml#.VbXXv_mqqko.

** D.B. Smith, United States Geological Survey, Certificate of Analysis, Mica Schist, SDC-1.

Fig. 21 Compositions of mica types