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A physicochemical study of Medieval and Post-Medieval ceramics from the Aegean

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CHAPTER 7 X-RAY FLUORESCENCE SPECTROSCOPY

7. INTRODUCTION

In the framework of the present PhD study, the pXRF was used as an initial method of fast and non-invasive analysis. For the non-invasive handheld portable XRF (pXRF) measures of the 245 ceramic samples, a handheld Thermo Scientific™ Niton™ XL3t XRF analyzer was used at the National Centre for Scientific Research 'NCSR Demokritos'. First of all, it was very important to examine up to which extent the archaeological typology and fabric classification could be linked to grouping according to chemical composition. For this reason, pXRF was applied at all the 245 samples from the three studied archaeological regions. After this application some groups had few chemical fluctuations and some subgroups were created. For example, Monochrome Glazed Ware from the Castle of Mytilene in Lesvos of which two samples MYT200, MYT201 were put in a different fabric subgroup as well as two Glazed Frit Wares from Chalcis in Euboea that have different chemical composition in glaze. Secondly, pXRF analysis was applied in some selected glazes in order to create a glaze grouping for lead and alkali glazes also. At the same time a considerable number of pigments was analyzed. I used two different calibration methods and specifically pXRF 'mining' (wt%) for major elements at glazes and pigments; and pXRF 'soil' (ppm) for trace elements at clays. The data are balanced to 100%. The indicated *Balance (Bal)* is an estimation of the non-measured content, taking into account elements, which cannot be measured, such as H, C or O, as well as the intensity potentially lost due to irregular sample geometry, as the pXRF is calibrated for flat surfaces in contact.

Specifically, green, yellow, brown and dark pigments from Chalcis samples; green, yellow and brown pigments of the Athenian Agora samples in Attica; and green, yellow, brown and turquoise pigments of Mytilene samples were studied. All samples could not have been analyzed for specific reasons: some of the glazes were deteriorated; at some others the glazed area was actually too small taking into account a spot size of 6 mm for the XRF analysis; Other samples did not present a suitable or preferably flat surface geometry. Lastly, it was used to check if there are sherds that were deeply deteriorated and as a result, they have chemical alteration in order to remove away from for the following analysis. Finally, the pXRF was very useful in order to select the appropriate samples for the following physicochemical methods.

Finally, 76 ceramic body samples were selected and measured at the Fitch Laboratory of the British School at Athens using a BRUKER S8 TIGER with a 4 kW Rh X-ray tube. Apart from major and minor element concentrations, X-Ray Fluorescence Spectroscopy (WDXRF) provides sufficient sensitivity for determining the concentrations of a considerable series of trace elements with high energy resolution. The X-ray fluorescence radiation of the sample is separated according to wavelengths. The scanned signal may be converted into a spectrum providing higher energy resolution compared to pXRF, or if only some elements are of interest, the intensities of the appropriate wavelengths are recorded (Stuart 2007).

7.1 X-RAY FLUORESCENCE SPECTROSCOPY (pXRF, WDXRF)

X-Ray Fluorescence Spectroscopy (XRF) was used to determine the characteristic elemental composition of ceramic wares of known and unknown provenance. Small quantities of selected samples were taken for a more precise destructive determination using wavelength-dispersive WDXRF. At an initial step, a non-destructive approach using non-invasive handheld portable pXRF was applied. In this study, XRF provided a very effective technique for determining the composition of clay and glazes and thus provided information about the raw materials and the technology used in production. The ability of this technique to provide trace element concentrations allowed for classifying clays and glazes as these elements are comparably less affected by the high temperatures reached during pottery firing (Fleming and Swann 1987; Kilikoglou et al 1988; Buxeda i Garrigos et al 2001,2003a,b; Shortland et al 2007; Walton et al 2008; Polikreti et al 2011; Bertini et al 2011; Hein 2021, 2018; Hein and Kilikoglou 2015,2017,2020).

The main principle of X-Ray Fluorescence Spectroscopy (XRF) is the fluorescence radiation: atoms, when irradiated with X-Rays, radiate secondary X-Rays. The wavelength or energy of the Fluorescence radiation is characteristic for each element and the concentration of each element can be calculated using the intensity of the Fluorescence radiation with these characteristic wavelengths or energies (Woldseth 1973; Constantinescu et al. 2005). An electron can be excited and ejected from its atomic orbital by the absorption of an electromagnetic radiation (photon) of sufficient energy. The energy of the photon ($h\nu$) must be higher than the energy with which the electron is bound to the nucleus of the atom. When an inner orbital electron is ejected from an atom, an electron from a higher energy level orbital will be transferred to the lower energy level orbital. During this transition a photon is emitted from the atom. The energy of the emitted photon corresponds to the energy difference between the two orbitals occupied by the electron making the transition. Because of the fact that the energy difference between two specific orbital shells, in a given element, is always the same (i.e. characteristic of a particular element), the photon emitted when an electron is transmitted between these two levels, has always the same energy. Therefore, by determining the energy (wavelength) of the X-ray radiation (photon) emitted by a particular element, it is possible to determine the identity of that element (Skoog and Leary 1992; Ferretti 2000; Janssens et al. 2000; Moens et al. 2000; Milazzo 2004; Vittiglio 2004; Sianoudis 2010; Hegewisch 2021).

The two main types of XRF spectrometers are wavelength-dispersive (WDXRF) and non-invasive handheld portable (pXRF) (Skoog and Leary 1992; Ferretti 2000; Moens et al. 2000; Janssens 2004). For pXRF the energies of the fluorescence spectrum are measured simultaneous by a semiconductor detector allowing for determining the elemental composition of the specimen analysed. Apart from major and minor element concentrations pXRF provides sufficient sensitivity for determining the concentrations of a considerable series of trace elements even though the energy resolution is not as high as it can be achieved with WDXRF (Longoni et al. 1998; Karydas 2007). For this, pXRF constitutes a quite effective and comparably fast technique for determining the composition of ceramics even with non-invasive analyses and thus provides information about the diversity of raw materials and the technology used in production by compositional classification based on minor and trace element concentrations (Stuart 2007, p.238; Hein et al. 2021). In wavelength-dispersive XRF (WDXRF) spectrometry, the sample is irradiated in a vacuum chamber by the primary X-rays of an X-ray source. The X-ray fluorescence radiation of the sample

is separated according to wavelengths. For this it is guided through a collimator on a Bragg crystal where they are reflected according to Bragg's law that (Sianoudis 2010). By rotation of the crystal the X-rays are scanned for different wavelengths. The radiation diffracted by the Bragg reflector will pass a second collimator before it reaches a detector. The scanned signal may be converted into a spectrum providing higher energy resolution compared to pXRF, or if only some elements are of interest, the intensities of the appropriate wavelengths are recorded (Stuart 2007).

Due to technological development during the last 20 years, particularly of the semiconductor detectors, it was possible to minimize pXRF spectrometers in size allowing eventually for the construction of portable handheld spectrometers. The spectral resolution achieved by non-invasive handheld portable pXRF, though, is even smaller in comparison to WDXRF or laboratory pXRF. Portable systems, on the other hand, have the advantage that the instrumentation is simpler and less expensive. Microscopic XRF spectrometers have also been developed, allowing for the examination of a very small area of a sample surface in-situ (Janssens et al. 2000; Vittiglio et al. 2004; Stuart 2007). For the non-invasive handheld portable XRF (pXRF) measures of the 245 ceramic body samples, a handheld Thermo Scientific™ Niton™ XL3t XRF Analyzer was used at the National Centre for Scientific Research 'NCSR Demokritos'. The measurements were carried out in a normal atmosphere with a standard measurement time of 120s (Hein 2021).

For the laboratory measurement with WDXRF a fragment is cut from the ceramic sherd, weighing approximately 1.5 g. Its external surface is removed using a tungsten carbide handheld drill, and after removing dust with pressurized air, the sample is pulverized in an automatic agate ball mill to a fine powder. Loss on ignition is measured by heating the powder to 950 °C for 4 h in a muffle furnace. The glass beads are prepared on an automatic fluxer by mixing 1 g of the ignited sample with 6 g of a lithium borate mixture (34.83%LiT/ 64.67%LiM/ 0.5%LiBr) and cast in a 32 mm bead. In the case of samples rich in basic oxides (e.g. very calcium or magnesium rich), a different lithium borate mixture is used (49.75%LiT/ 49.75%LiM/ 0.5%LiBr) in the same ratio to the sample as earlier. Finally, 76 ceramic body samples were selected and measured at the Fitch Laboratory of the British School at Athens using a BRUKER S8 TIGER with a 4 kW Rh X-ray tube. The system is equipped with five analysing crystals (LiF 200, PET, XS -55, LIF-220 and Ge), two detectors (flow and scintillation counter), seven filters (Cu 300 µm, Cu 200 µm, Al 800 µm, Al 500 µm, Al 200 µm, Al 100 µm and Al 12.5 µm), two collimators (0.23 and 0.46o) and six beam masks (34, 28, 23, 18, 8 and 5mm). The analytical method is calibrated to measure 26 elements: Na, Mg, Al, Si, P, K, Ca, Ti and Fe are given as oxides in wt%, and V, Cr, Mn, Co, Ni, Cu, Zn, Rb, Sr, Y, Zr, Ba, La, Ce, Nd, Pb and Th as elements in ppm. The selection covers all major and minor elements relevant to ceramics and soils, as well as a substantial suite of trace elements that will be useful, particularly for provenance purposes. In addition, as LiBr is included in the glass beads, Br is also measured but not calibrated so that it can be used in overlap corrections for some elements. A total of 43 CRMs were used for the development of the calibration (Georgakopoulou et al. 2017).

7.2 RESULTS AND DISCUSSION OF pXRF

7.2.1 PIGMENTS

Green pigments of the samples from Chalcis in Euboea were presented in fragments of Champlévé Ware (CH124, CH144), Incised Sgraffito Ware (CH113, CH129, CH149), Splashed Ware (CH89), Painted Fine Sgraffito Ware (CH98), Didymoteicho Ware (CH100), Glazed Frit Ware (CH109) and Slip-Painted Ware (CH94) (Figure 89). Sherds of Splashed Ware (CH89) and Didymoteicho Ware (CH100) have Cu <1%, which is the main colourant of this green pigment. Furthermore, sherds of Incised Sgraffito Ware (CH113, CH129, CH149) have Cu 2.3% and sherds of Glazed Frit Ware (CH109) has Cu 2.9% and Fe 1.4%. All the other samples have Cu 1-2% and Fe 0.6-1.4% (Table 15). All these were dated in the Middle to Late Byzantine periods apart from imported sample of Glazed Frit Ware (CH109) that was dated in Islamic period and Didymoteicho Ware (CH100) in Early modern period. Furthermore, **green pigments of the samples from the Athenian Agora in Attica** were presented in fragments of Polychrome Painted Ware/Maiolica (AAG32), Zeuxippus Ware Subtype (AAG49), Green and Brown Painted Ware (AAG61, AGBZY852) and Polychrome Sgraffito Ware (AAG38, AAG60) (Figures 89,92). Apart from sherd of Zeuxippus Ware Subtype (AAG49) that has Cu<1%, all the others have Cu 1-1.8% (Table 15). All these were manufactured during the Late Byzantine to Turkish times apart from samples of Green and Brown Painted Ware in Middle Byzantine period. Finally, **green pigments of the samples from the Castle of Mytilene in Lesbos** were presented in fragments of Polychrome Sgraffito Ware (MYT175), Polychrome Painted Ware (MYT166), Polychrome Marbled Ware (MYT165) and Monochrome Glazed Ware (MYT216) (Figures 89,92). All of them have the main colourant Cu 1-1.9%. Samples of Monochrome Glazed Ware (MYT216) has also Fe 1% apart from Cu 1.2% (Table 15). All these pottery typologies were constructed during the Turkish period. As a result, there are four different percentages of Cu and specifically Cu<1%, Cu 1-2%, Cu 2-3%, Cu>3% which they produce from lighter to darker pigments. Another difference is the combination of Cu with Fe for brownish green hue. At all the studied pottery typologies from the three archaeological regions were used the same green pigment recipes.

Yellow pigments of the samples from Chalcis in Euboea were presented in fragments of Champlévé Ware (CH132, CH143, CH146, CH152), Splashed Ware (CH89) and Incised Sgraffito Ware (CH91) (Figure 90). Pieces of Champlévé Ware (CH132, CH143, CH146, CH152) consisted of the main colourant Fe 1.1% in combination with Cu 0.2% and Mn 0.1%. But, pieces of Splashed Ware (CH89) and Incised Sgraffito Ware (CH91) contain Fe <1% (Table 15). All these dated from the Middle to the Late Byzantine times. **Yellow pigments of the samples from the Athenian Agora in Attica** were presented in fragments of Incised Sgraffito Ware (AGBZY844), Late Sgraffito Ware (AAG45) and Plain Glazed Ware (AAG54) (Figures 90,93). Samples of Late Sgraffito Ware (AAG45) consisted of the main colourant Fe <1% in contrast to the other two pottery categories with Fe 1.3-1.6% (Table 15). All of them contain some traces of Cu 0.1% and Mn 0.1%. All these dated from the Middle to the Late Byzantine times. Finally, **yellow pigments of the samples from the Castle of Mytilene in Lesbos** were presented in fragments of Zeuxippus Ware Subtype (MYT233), Monochrome Glazed Ware (MYT193) and Monochrome and One Colour Sgraffito Ware (MYT177) (Figures 90,93). Samples of Zeuxippus Ware Subtype

(MYT233) and Monochrome and One Colour Sgraffito Ware (MYT177) have the main colourant Fe <1% in contrast to samples of Monochrome Glazed Ware (MYT193) that has Fe >1%. All of them contain some traces of Cu 0.1% and Mn 0.1% (Table 15). All these dated from the Late Byzantine to the Turkish times. The percentage of Fe <1% and Fe 1-2% produces from lighter to darker hue of yellow. At all the examined pottery typologies from the three archaeological regions were used the same yellow pigment recipes.

Brown pigments of the Chalcis samples in Euboea were presented in fragments of Champlevé Ware (CH151, CH141), Incised Sgraffito Ware (CH111), Didymoteicho Ware (CH100, CH135), Splashed Ware (CH145) and Painted Ware (CH104) (Figure 91). Sherds of Didymoteicho Ware (CH100), Splashed Ware (CH145) and Painted Ware (CH104) have the main colourant Fe <2% in combination with Cu <0.6% and Mn <0.08%. Pieces of Champlevé Ware (CH151) and Incised Sgraffito Ware (CH111) have Fe 2-3% in combination with Cu <0.1% and Mn <0.1%. Lastly, sherds of Champlevé Ware (CH141) and Didymoteicho Ware (CH135) have Fe >3% with Cu <0.1% (apart from CH135) and Mn 0.1% (Table 15). Fragments of Champlevé Ware, Incised Sgraffito Ware and Splashed Ware were dated in the Middle to the Late Byzantine periods. Painted Ware was dated in the Turkish period and Didymoteicho Ware in the Early Modern period. Moreover, **brown pigment of the samples from the Athenian Agora in Attica** was presented in fragment of Slip-Painted Ware (AAG58) that has the main colourant Fe 2.3% in combination with Cu 0.2% and Mn 0.1% (Figure 91, Table 15). It was dated in the Late Byzantine period. Also, **brown pigments of the samples from the Castle of Mytilene in Lesvos** were presented in fragments of Painted Ware (MYT191), Monochrome Glazed Ware (MYT173), Monochrome Sgraffito Ware (MYT171), Glazed White Ware IV (MYT203) and Porcelain (MYT222) (Figures 91,94). At Monochrome Glazed Ware sample (MYT173), the main colourant is Fe <2%, but also contains a high amount of Cu 3.4%. Fragments of Painted Ware (MYT191), Monochrome Sgraffito Ware (MYT171) and Porcelain (MYT222) contain the main colourant Fe 2-3% with also Mn 0.1% and Cu 0.1% (apart from MYT222). Finally, brown pigment of sherds of Glazed White Ware IV (MYT203) is due to a high amount of Mn 1.3% with Fe 0.3% (Table 15). Pieces of Painted Ware, Monochrome Glazed Ware and Porcelain were dated in the Ottoman period but pieces of Monochrome Sgraffito Ware and Glazed White Ware IV in the Late Byzantine period. All these date from the Late Byzantine to the Turkish times. The percentage of Fe, as Fe 1-2%, Fe 2-3% and Fe >3%, produces from light to dark hue of yellow. Apart from the percentage of Fe, three different brown pigment recipes were noticed. The first recipe of Champlevé Ware sample (CH141) is a high percentage of Fe about 2.5% with a low percentage of Mn about 0.2%. The second recipe of Porcelain sample (MYT222) is exactly the opposite with a higher percentage of Mn about 1.3% and a lower percentage of Fe about 0.3%. The third recipe is a combination of Fe 1.5% with Cu 3.4% for a greenish brown at Monochrome Glazed Ware sample (MYT173). The first one was detected in the samples from Chalcis in the Middle to the Late Byzantine periods, but the second and the third one in the samples from the Castle of Mytilene in Lesvos in the Ottoman period.

Two **dark pigments** were also analyzed at samples of Unglazed Plain Ware (CH134) and Incised Sgraffito Ware (CH139). Dark pigment of sherds of Unglazed Plain Ware (CH134) contains Fe 5.2% and Mn 0.1%. Dark glaze of sherds of Incised Sgraffito Ware (CH139) contains Fe 3.1%

and Mn 0.1% (Table 15). They were dated from the Middle to the Late Byzantine periods. It was observed that the ceramics without glaze need a higher amount of metal oxides than the pigments in or under the glazes.

Finally, **turquoise pigment** of Glazed Frit Ware sample (MYT182) from the Castle of Mytilene in Lesvos contains Cu 0.9%, Co 0.04%, Fe 1.3%, Mn 0.1% and Cr 0.01% (Table 15). It was dated during the Turkish period.

Regarding the glazes, all of them contain Lead apart from fragments of Kütahya Ware (MYT183), Porcelain, Overfired Stoneware (MYT202) and Frit Ware (CH147) (Figure 95; Tables 16,17,18). The results of the glazes from Chalcis, the Athenian Agora in Attica and the Castle of Mytilene are presented in the Tables 16,17,18 whereas the results of the fabrics in the Tables 19-24.

7.2.2 CERAMIC FABRIC

Trace elements detected in the body fabrics with the non-invasive handheld portable pXRF spectrometer are Zr, Sr, U, Rb, Th, Zn, Ni, Cr, Cs, Te, Sb and Sn. Trace elements are defined as elements with concentrations lower than 1000 ppm. In the 245 analyzed samples for trace elements, Sr was detected in all samples (apart from Monochrome Glazed Ware MYT230), while Zr in 234 samples [apart from Monochrome Glazed Ware (AAG34), Kütahya Ware (MYT169, MYT179, MYT188, MYT195, MYT230, MYT241), Polychrome Painted Ware (MYT228, MYT215) and Iznik Ware (MYT170, MYT214)]. Sb was detected in 214 samples. The remaining trace elements were founded in fewer samples (Tables 19-24).

Regarding the correlation of the ratio K/Fe with Ca/Fe for the body fabrics of pottery at Chalcis in Euboea, it was observed that all local pottery typologies (Champlevé Ware, Incised Sgraffito Ware, Monochrome Glazed Ware, Slip-Painted Ware, Plain Glazed Ware, Splashed Ware, A8A Amphora, Gunsenin 2 Amphora, Gunsenin 3 Amphora, Painted Fine Sgraffito Ware, Fine Sgraffito Ware, Unglazed Plain Ware, Green and Brown Painted Ware, Brown Painted Ware, Painted Ware) appeared at the same area in the plot (into cycle) as well as some imported typologies (Didymoteicho Ware, Zeuxippus Ware, Polychrome White Ware, Glazed White Ware II, Polychrome Marbled Ware, Roulette/Veneto Ware). Four of imported pottery typologies appeared at a totally different point in the plot, and specifically Glazed Frit Ware, Frit Ware, Lustre Ware and Maiolica. With all the mentioned groups, the ratio K/Fe remained constant and the ratio Ca/Fe was increased apart from Glazed Frit Ware and Frit Ware that they are in different areas. Glazed Frit Ware and Frit Ware had also the ratio K/Fe in a high level but they have a different ratio Ca/Fe and as a result they appeared in a different area in the plot (Figure 96). It is clear that the potters used the same raw materials for the body fabrics of the local pottery in Chalcis.

Regarding the correlation of the ratio K/Fe with Ca/Fe for the body fabrics of pottery at the Athenian Agora in Attica, two main zones were defined with lines as well as a subzone right of the main zones that have a positive slope and in which all local and imported pottery were showed. Quite different is Maiolica (AAG70) that appeared out of these zones (Figure 97). It is clear that the potters used mainly two different clay sources for local pottery in Athenian Agora.

Regarding the correlation of the ratio K/Fe with Ca/Fe for the body fabrics of pottery at the Castle of

Mytilene in Lesvos, two different areas in the plot appeared in which the most of pottery typologies were included. At the first area (black cycle), all local and some imported pottery appeared as Monochrome Glazed Ware, Polychrome Sgraffito Ware, Polychrome Painted Ware, Painted Ware, Monochrome Sgraffito Ware, Monochrome and One Colour Sgraffito Ware, Monochrome Painted Ware, Miletus Ware, Zeuxippus Ware Subtype, Elaborate Incised Ware. Where as in another area (blue cycle), imported pottery appeared as Polychrome Marbled Ware, Iznik Ware, Kütahya Ware, Maiolica and Monochrome Glazed Ware (MYT174, MYT193). Out of these areas, fragments of Porcelain appeared and next to these some of Kütahya Ware. Finally, loners as Glazed White Ware IV, Overfired Stoneware and Monochrome Glazed Ware (MYT200, MYT201) were seemed (Figure 98). It was usual for a few pottery laboratories to construct Monochrome Glazed Wares and it was also observed in this case as this pottery type appeared in different areas in the plot. Furthermore, Kütahya Ware was manufactured by some different laboratories. Finally, each pottery group appears chemical affinity in the same area.

Strontium Sr is the trace element which appeared in all samples from Chalcis in Euboea, the Athenian Agora in Attica and the Castle of Mytilene in Lesvos (Figures 99,100,101). Feldspars have a small contribution to the percentage of Sr in the final clay or glass (Degryse et al. 2006;2010). Sr always accompanies Ca and the main source of Sr is essentially the source of Ca. In addition to feldspars, Sr can be derived from three types of calcium sources: (a) pure calcite and related as dolomite (Freestone et al 2003), (b) marine fossils (Wedepohl and Baumann 2000), (c) sand (Sanderson et al 1984), which has high levels of Ca due to marine fossils, etc. Mollusk's shells are the raw material that contains significantly higher levels of Sr in contrast to limestone (Wedepohl and Baumann 2000). The marine fossils consist mainly of aragonite (CaCO_3 polymorphic mineral) or contain a combination of aragonite and calcite with the first one containing higher levels of Sr than the latter. Those composed mainly of aragonite contain relatively high Sr values more than 2000 ppm, while those containing calcite as the main component contain about 1000 ppm Sr. Mollusks deposit Sr in their shells that is absorbed by seawater (Wedepohl and Baumann 2000). Sr amount in Mytilene fabric body is almost double of those in Chalcis and Athens (Tables 19-24). Moreover, in all the studied areas, there is a tendency for positive correlation and an indicative straight line (Chalcis) or zone (the Athenian Agora, the Castle of Mytilene) with a positive slope was drawn (Figures 99,100,101). At the Mytilene pottery graphs the positive slopes are quite intense which proves that Sr probably originates from limestone rocks with a combination of marine organisms as the production laboratories and the location of raw materials next to them are located near to the coastal area (Figure 101). A short dispersion of trace elements was observed in Mytilene samples as the island was characterized by complex geological features due to volcanic deposits. Furthermore, a big dispersion of trace elements was noticed in samples from the Athenian Agora in Attica owing to the different clay sources that were used. Finally, uniformity of trace elements was observed at Chalcis samples as the clay source was the same.

Zirconium Zr is also presented in a large number of samples. Zr, as well as other elements, such as Ti, La, Cr, are important in the characterization of raw materials, because they are not affected by the high temperatures during pottery firing (Shortland et al 2007). These elements were also very often used to separate groups in the geochemistry of igneous rocks (Pearce and Cann 1973)

and generally information on the geochemistry of the areas (Freestone et al 2000; Silvestri et al 2008). Differences in the concentrations of specific trace elements, such as Zr and Sr, were used to identify/differentiate possible sources of raw materials.

Antimony Sb exists mainly in various minerals, such as Stibnite or Antimonite (Sb_2S_3) and Valentinite (Sb_2O_3), which is a product of the transformation of Stibnite. These antimony mixtures are commonly found in copper, silver, and lead ores (Filella et al. 2002). In addition to Stibnite, Antimony is also found in Bindheimite ($\text{Pb}_2(\text{Sb,Bi})_2\text{O}_6(\text{O.OH})$), which may contribute also in lead (Biek and Bayley 1979; Mass et al. 1998; Jackson 2005). In nature there are several minerals that contain Sb and Fe in different proportions at the same time, examples of which are: Berthierite (FeSb_2S_4) (mindat.org 2011a), Gudmundite FeSbS (mindat.org 2011b) and Garavelite FeSbBiS_4 (mindat.org 2011c). Also, Sb was used to identify/differentiate possible sources of raw materials.

Finally, local body fabrics in each pottery type was studied through the Q-Q plots which presented the correlation of Ca/Fe, Expected Normal Value with the reference line and the Upper and the Lower Percentiles in Chalcis in Euboea (Figures 102,103), in the Athenian Agora in Attica (Figures 104,105) and in the Castle of Mytilene in Lesvos (Figures 106,107). The Q-Q plot, "probability plot", or quantile-quantile plot, is a graphical tool with I assessed if a set of data plausibly came from some theoretical distribution such as a normal or exponential. When all the points plotted on the graph perfectly lies on a straight line, then we can clearly say that this distribution is Normally distribution because it is evenly aligned with the standard normal variate which is the simple concept of Q-Q plot. Q-Q plots were very useful to compare the data sets to a theoretical model and through it I based on estimates of the quantiles. Furthermore, I observed if my assumption is plausible, and if not, how the assumption is violated and what data points contribute to the violation. As a result, the correlation of Ca, Fe was used to define the local chemical pattern or 'chemical fingerprint' of each production site through the chemical distribution of Fe, Ca. In conclusion, the chemical grouping of the local pottery was primarily identified in each region. Specifically, I noticed the points of Chalcis pottery to lie homogeneity to the reference line in contrast to the pottery from the Athenian Agora in Attica that had a bigger distribution around the line (maybe different raw materials regions in Attica) and finally these of the Castle of Mytilene in Lesvos that some points were out of the straight line (imported pottery) (Figure 107).

7.3 RESULTS AND DISCUSSION OF WDXRF

7.3.1 ATHENIAN AGORA IN ATTICA AND CHALCIS IN EUBOEA

Regarding the samples from the Ancient Agora in Attica (Table 25), two groups of ceramics (Group 1 and Group 4) were locally made. **Group 1** consisted of fragments of Polychrome Sgraffito Ware (AAG37, AAG60), Polychrome Painted Ware/Maiolica (AAG29, AAG30, AAG66, AAG67), Pottery Waster (AGBZY836) and Spanish Luster Ware (AAG68). It was clear that copies of Spanish Luster Ware were also made in the Ancient Agora, although it was a characteristic pottery type made in Spain. **Group 4** consisted of fragments of Incised Sgraffito Ware (BYZ841), Green and Brown Painted Ware (AGBZY853, AAG69) and Fine Sgraffito Ware (AGBZY842) (Figure 108).

Regarding the samples from Chalcis in Euboea (Table 26), they appeared at **Group 3**. Group 3 firstly consisted of fragments of Incised Sgraffito Ware found in the Athenian Agora in Attica (AGBZY846) and Incised Sgraffito Ware found in Chalcis (CH113, CH114, CH133). Next to them, fragment of Painted Ware (AAG44) found in the Athenian Agora in Attica and fragment of Painted Fine Sgraffito Ware (CH98) found in Chalcis appeared. As a result, it was proved that fragments of Incised Sgraffito Ware (AGBZY846) and Painted Ware (AAG44) found in the Athenian Agora in Attica were constructed in Chalcis. To continue with, at the same group it was observed that samples of Brown Painted Ware (CH136), Günsenin 3 Amphora (CH160), Splashed Ware (CH89), Champlévé Ware (CH124), Green and Brown Painted Ware (CH95), Slip-Painted Ware (CH94), A8A Amphora (CH155), Günsenin 2 Amphora (CH162) were locally constructed also. In addition, within Group 3 there are some imitations of characteristic pottery typologies of other regions in Greece or of other countries that were made in Chalcis with local clay, such as fragments of Roulette/Veneto Ware (CH85, CH82), NE-Italy; Didymoteicho Ware (CH135), Dardanelles or Northern Greece; and Zeuxippus sub-Ware (AAG43), Western Turkey. Finally, fragments of Zeuxippus sub-Ware (AAG43) found in the Athenian Agora in Attica was made in Chalcis also. It is remarkable that samples of Champlévé Ware (CH84, CH92), Fine Sgraffito Ware (CH127) and Slip-Painted Ware (CH121) appeared separately from other ceramics of Chalcis although they were also locally made; this may be due to the different contamination, chemical alteration or deterioration of these fragments (Figure 108).

The rest of fragments belong to imported pottery. **Group 2** was constituted by fragments of Maiolica (AAG70, AAG154) from Italy and **Group 5** by fragments of Zeuxippus sub-Ware (AAG47, AAG48) from Western Turkey. Furthermore, **Group 6** consisted of fragments of Zeuxippus Ware (CH99, CH101) from Western Turkey, Didymoteicho Ware (CH100) from Dardanelles or Northern Greece and Painted Ware (CH104) from Western Turkey. Moreover, pieces of Polychrome Marbled Ware (CH102, CH103) were imported possibly from Western Turkey. At the end, two ceramics were noticed separately, Glazed Frit Ware sample (CH106) from Syria or Egypt and Glazed White Ware II sample (CH107) from Constantinople (Istanbul) (Figure 108).

To sum up, in the **Athenian Agora in Attica**, a big variety of pottery were made with local raw materials and two different types of clay were noticed. Specifically, Polychrome Sgraffito Ware and Polychrome Painted Ware/Maiolica were made with different clay than Incised Sgraffito Ware, Green and Brown Painted Ware and Fine Sgraffito Ware. Imitations were also found as Spanish Luster Ware (AAG68) from Spain. Imitations of Spanish Luster Ware had the same raw materials as Polychrome Sgraffito Ware and Polychrome Painted Ware/Maiolica used. But the potters of the Ancient Agora mainly imitated Maiolica of Italy, creating a unique style 'Polychrome Painted Ware/Maiolica'. Pieces of Zeuxippus sub-Ware (AAG47, AAG48) were imported possibly from Western Turkey.

Moreover, a big variety of ceramics were manufactured in **Chalcis** in Euboea; among them count Incised Sgraffito Ware, Painted Fine Sgraffito Ware, Brown Painted Ware, Splashed Ware, Champlévé Ware, Green and Brown Painted Ware, Slip-Painted Ware, A8A Amphora, Günsenin 2 Amphora and Günsenin 3 Amphora. Some ceramics found in the Ancient Agora were also constructed also in Chalcis with local clay and specifically Incised Sgraffito Ware sample (AGBZY846) and Painted Ware sample (AAG44) from the Athenian Agora in Attica. Furthermore, Chalkidian potters attempted to imitate some characteristic pottery typologies that were widespread and were produced in other regions such as Roulette/Veneto Ware from North east Italy, Didymoteicho Ware from Dardanelles or Northern Greece, Zeuxippus Ware from Western Turkey. In Chalcis, imported pottery was also found such as Glazed White Ware II, Zeuxippus Ware, Didymoteicho Ware, Glazed Frit Ware and Maiolica. Imported original Zeuxippus Ware and Didymoteicho Ware found also in Chalcis appeared separately than imitations at the cluster analysis. Painted Ware sample (AAG44) from the Athenian Agora in Attica was made in Chalcis while Painted Ware sample (CH104) from Chalcis was imported from Western Turkey.

7.3.2 THE CASTLE OF MYTILENE IN LESVOS

Group 4 consisted of wares that were locally fabricated in the Castle of Mytilene in Lesvos (Table 27) such as Monochrome Painted Ware (MYT176), Polychrome Sgraffito Ware (MYT194), Zeuxippus sub-Ware (MYT196), Kütahya Ware (MYT218), tripod stilt (MYT244) and pottery waster (MYT245). Attempts were being made to imitate original Zeuxippus Ware and Kütahya Ware in the Castle of Mytilene. It was characteristic that Kütahya Ware (MYT218) that was made in the Castle of Mytilene has red body fabric as opposed to original Kütahya Ware from Western Turkey with white body fabric (Figure 109).

It was noticed at the cluster analysis diagram that all the other ceramics were imported. Specifically, **Group 1** consisted of pieces of Polychrome Marbled Ware (MYT211), Iznik Ware (MYT168, MYT170) and Kütahya Ware (MYT184). Also, **Group 2** consisted of pieces of Glazed White Ware IV (MYT203) and Kütahya Ware (MYT179). Both of these groups came from Western Turkey but from different pottery workshops or from nearby workshops that used slightly different raw materials. **Group 5** was constituted by fragments of Miletus Ware (MYT167, MYT226, MYT204) and Painted Ware (MYT191) and they came from another region in Western Turkey than Groups 1,2. **Group 6** consisted of fragments of Iznik Ware (MYT214), Polychrome Marbled Ware (MYT208) and Polychrome Sgraffito Ware (MYT209) that was originated from a totally different region in Western Turkey than Groups 1,2,5. Group 6 and Group 1 concluded similar pottery typologies and they both came from Western Turkey but they used different raw materials. It is believed that they came from different pottery workshops in different areas in Western Turkey (Figure 109).

It was noticed that the Turkish potters made also Polychrome Marbled Ware that were widely manufactured in Italy. At the right end of the cluster analysis diagram, some imported wares such as Elaborate Incised Ware (MYT234), Zeuxippus Ware (MYT233), Monochrome and one colour Ware (MYT177), tripod stilt (MYT243) and Roulette/Veneto Ware (MYT178) were constructed in Western Turkey also. As a result, the Turkish potters made an imitation of the authentic Roulette/Veneto Ware from Northern Italy apart from Polychrome Marbled Ware.

Apart from the previous ceramics, two ceramics were observed separately, Polychrome Painted Ware (MYT228) and Glaze Frit Ware (MYT182) from Western Asia or Egypt.

Last but not least, **Group 3** consisted of imported ceramics as Painted Ware (MYT187) and Maiolica (MYT227, MYT236) from Italy. It seems that Painted Ware (MYT187) found in the Castle of Mytilene in Lesvos is an imported ware as well as Maiolica from Italy.

Lastly, a single Polychrome Sgraffito Ware (MYT217) was observed which is imported from an unknown region (Figure 109).

In conclusion, Monochrome Painted Ware and Polychrome Sgraffito Ware collections were locally made in the **Castle of Mytilene in Lesvos** as a pottery waster and one tripod stilt were found at the same group at the cluster analysis diagram. It was very impressive that sample Kütahya Ware (MYT218) was made in Mytilene with red body fabric and it is an imitation of original Kütahya Ware with white body fabrics. The rest of the studied ceramics were imported

mainly from present-day Turkey but also from Italy. Specifically, Polychrome Marbled Ware, Iznik Ware, Kütahya Ware, Glazed White Ware, Miletus Ware, Painted Ware, Polychrome Sgraffito Ware, Elaborate Incised Ware, Zeuxippus Ware, Monochrome and one-colour Ware, Roulette/Veneto Ware and a tripod stilt were constructed in Western Turkey. Although the potters constructed similar or same pottery types, these types possibly were manufactured in different pottery workshops (in nearby workshops that used slightly different raw materials or in workshops from other regions of Western Turkey) due to the differential of their raw materials. The Turkish potters made also imitations of the authentic Polychrome Marbled Ware and Roulette/Veneto Ware from Northern Italy that were found in the Castle of Mytilene. In addition, Polychrome Painted Ware (MYT228) and Glaze Frit Ware (MYT182) found in Mytilene were constructed in Western Asia or Egypt. Moreover, fragments of Maiolica (MYT227, MYT236) and Painted Ware (MYT187) were imported from Italy.

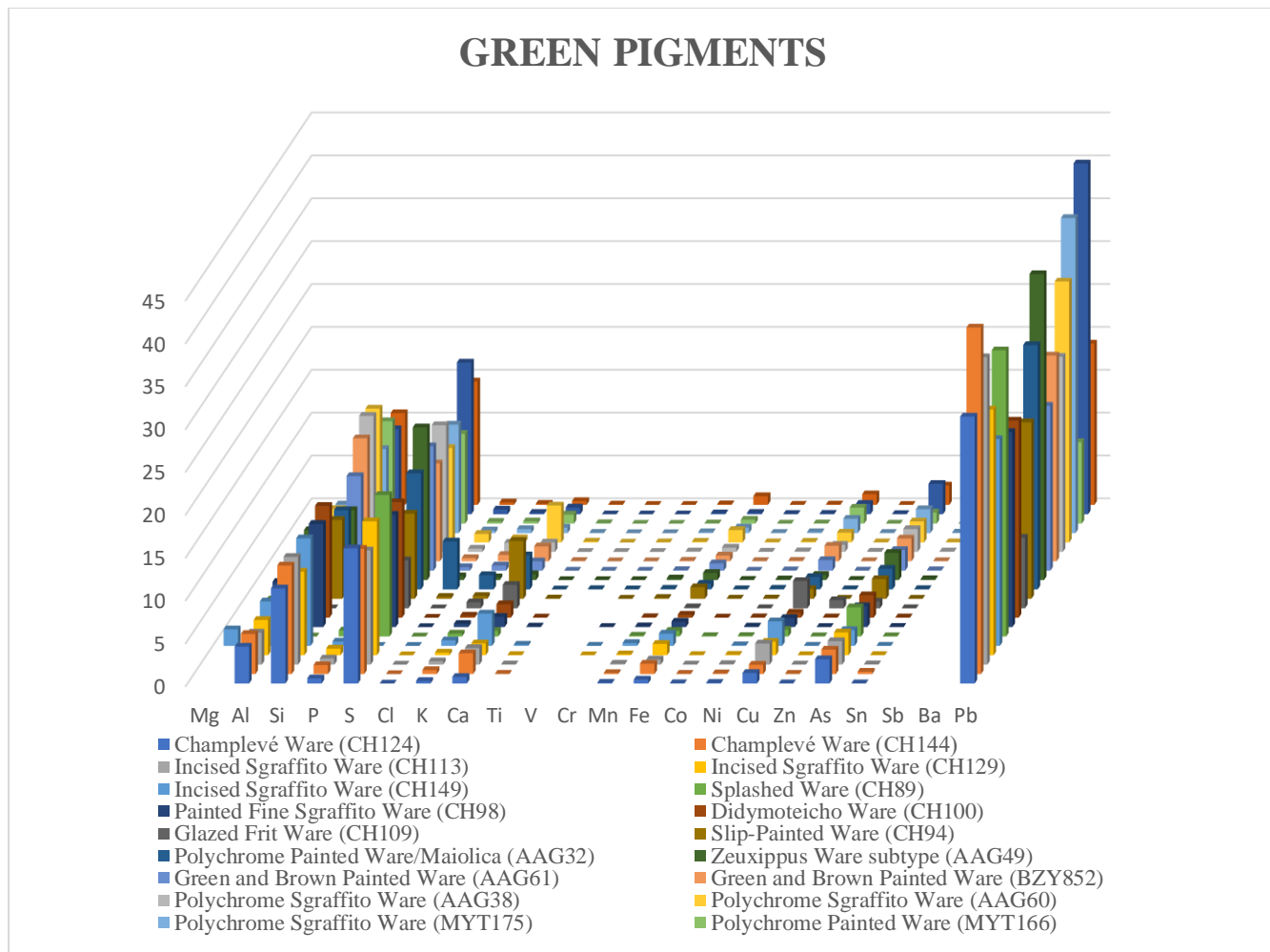


Figure 89 Green pigments of the pottery collection from Chalcis in Euboea, the Athenian Agora in Attica and the Castle of Mytilene in Lesbos.

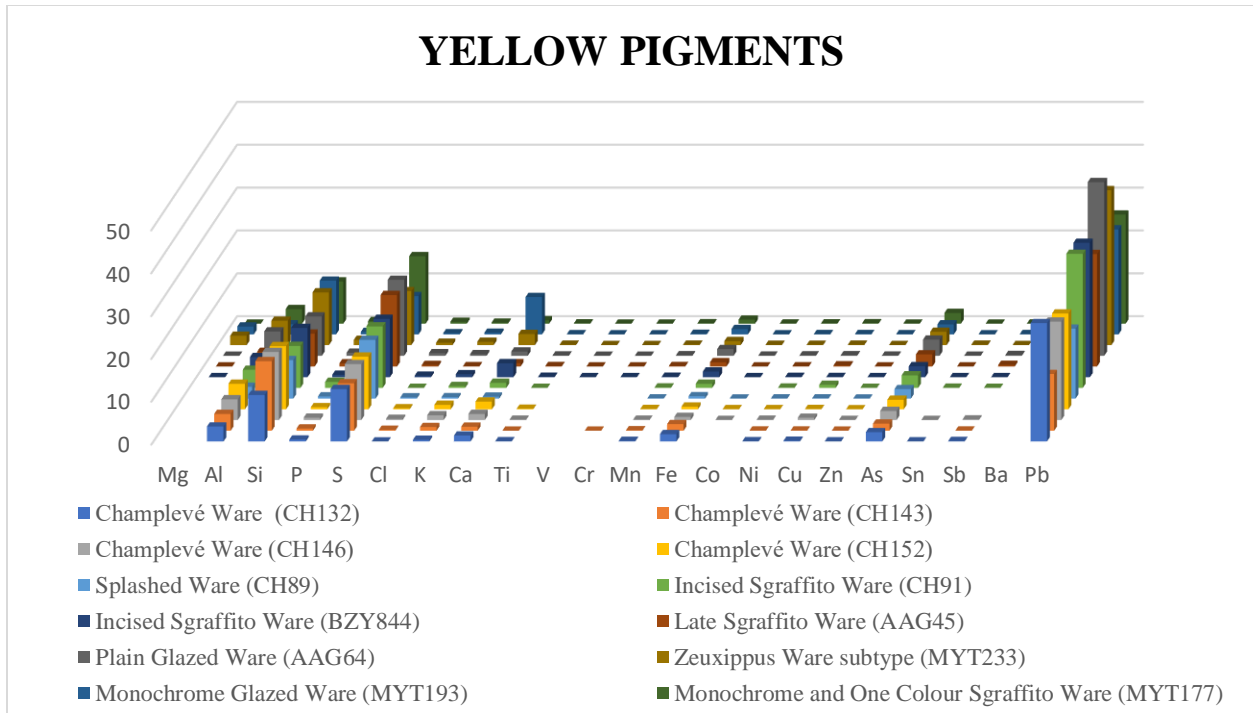


Figure 90 Yellow pigments of the pottery collection from Chalcis in Euboea, the Athenian Agora in Attica and the Castle of Mytilene in Lesvos.

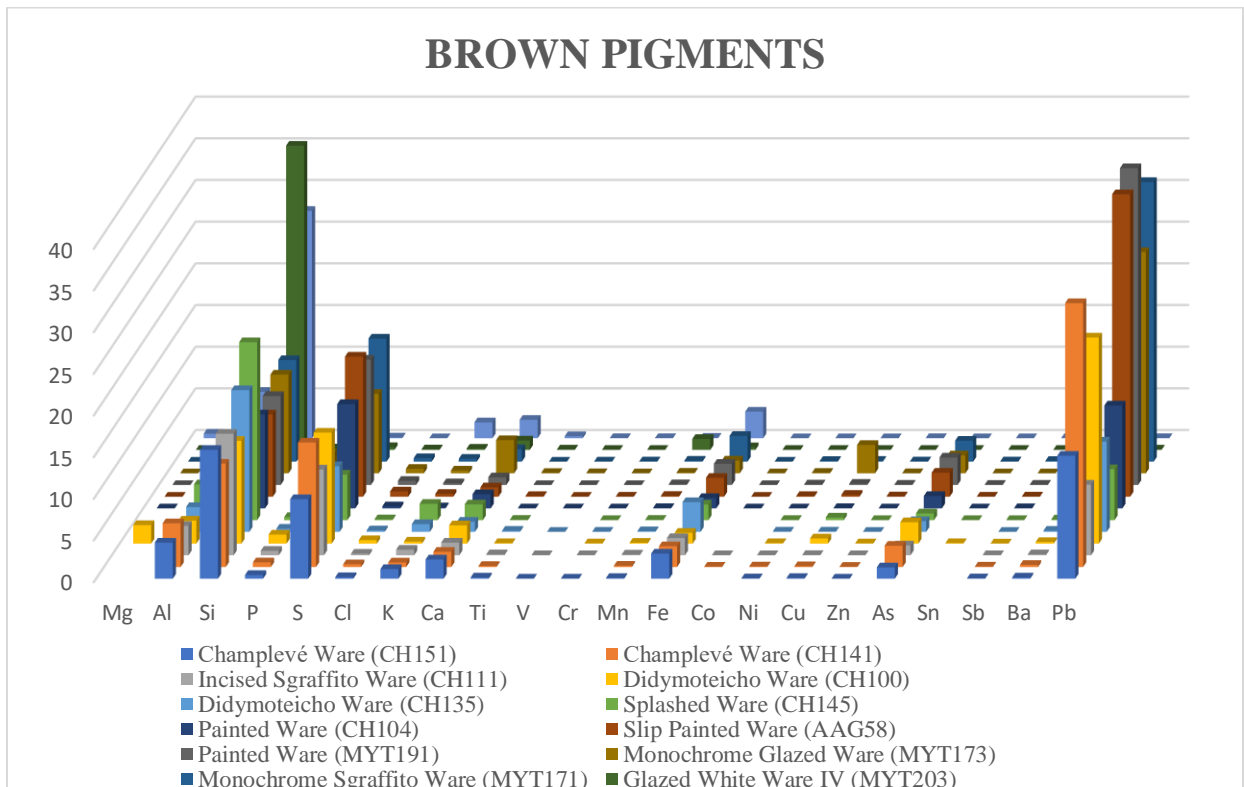
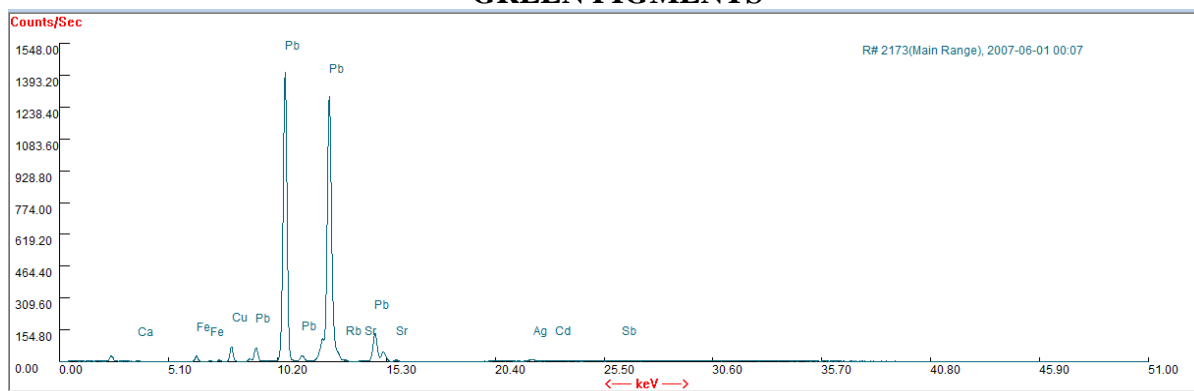
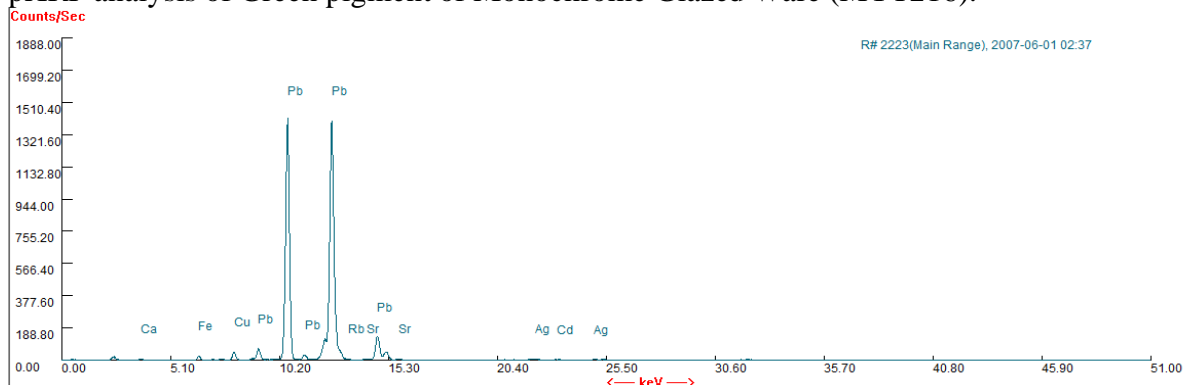


Figure 91 Brown pigments of the pottery collection from Chalcis in Euboea, the Athenian Agora in Attica and the Castle of Mytilene in Lesvos.

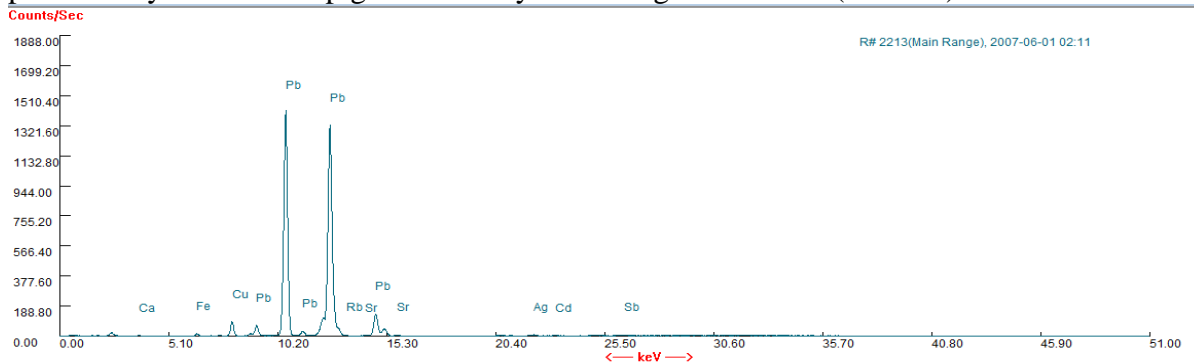
GREEN PIGMENTS



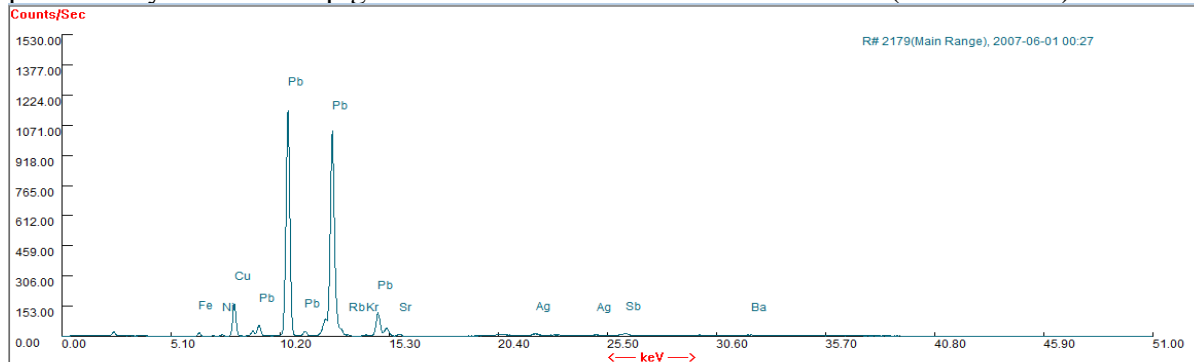
pXRF analysis of Green pigment of Monochrome Glazed Ware (MYT216).



pXRF analysis of Green pigment of Polychrome Sgraffito Ware (AAG60).



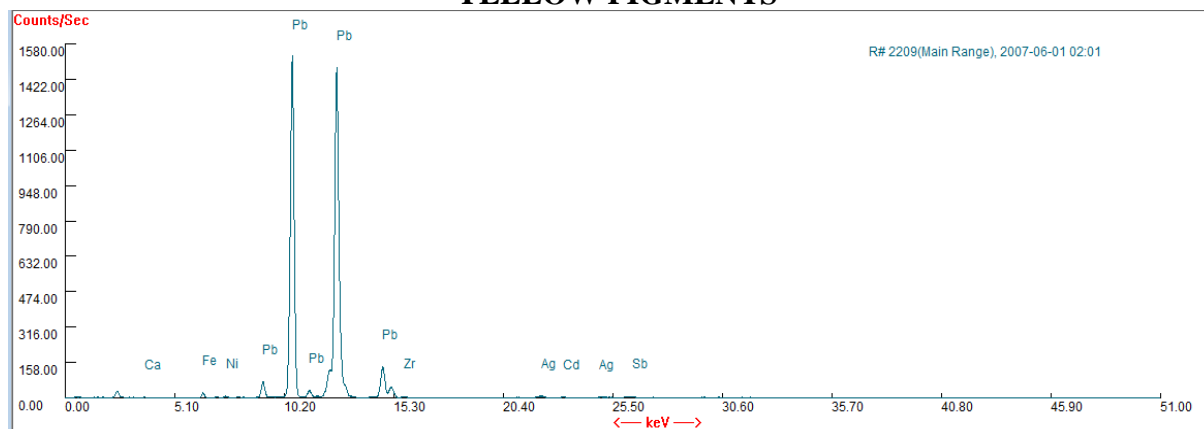
pXRF analysis of Green pigment of Green and Brown Painted Ware (AGBZY852).



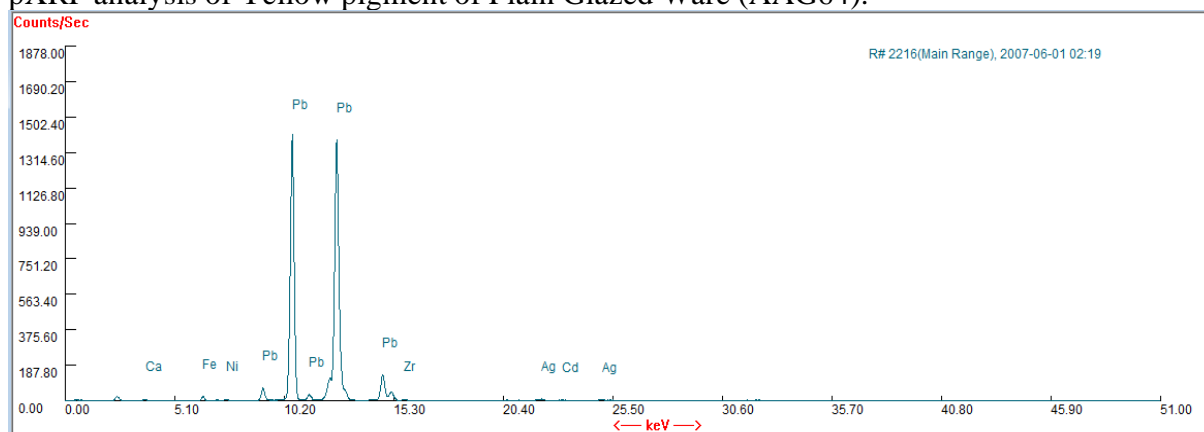
pXRF analysis of Green pigment of Polychrome Painted Ware (MYT166).

Figure 92 pXRF analysis of green pigments.

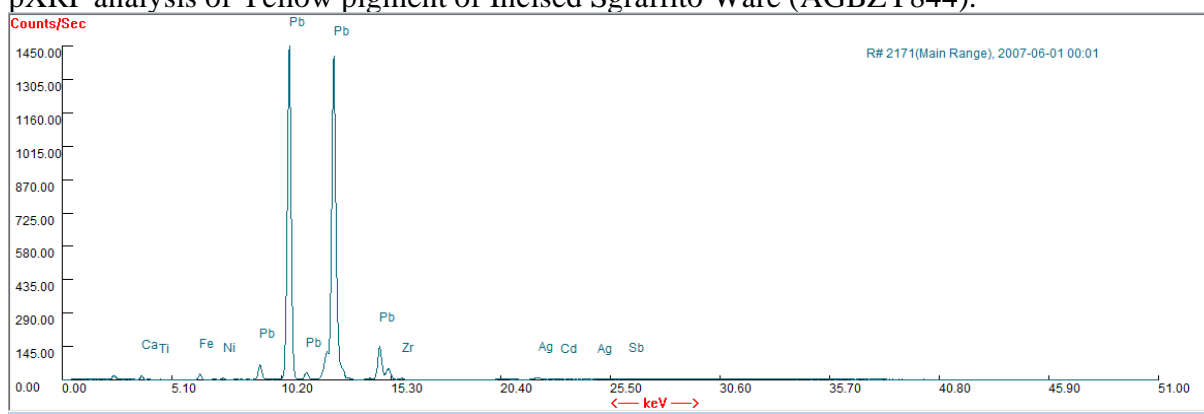
YELLOW PIGMENTS



pXRF analysis of Yellow pigment of Plain Glazed Ware (AAG64).



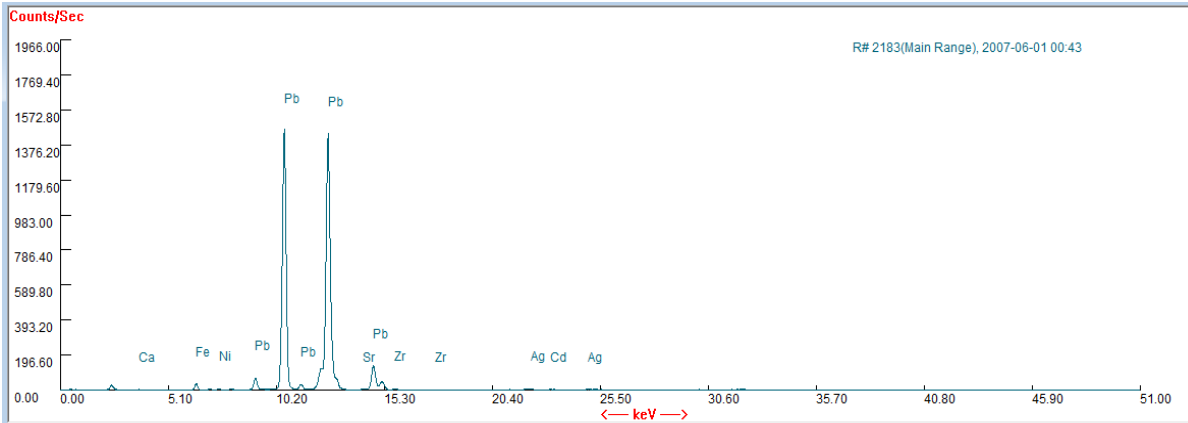
pXRF analysis of Yellow pigment of Incised Sgraffito Ware (AGBZY844).



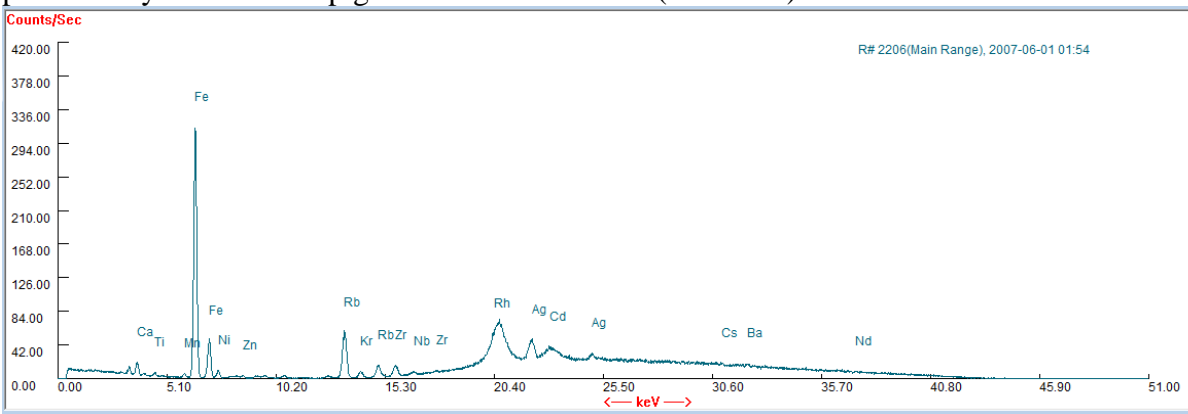
pXRF analysis of Yellow pigment of Monochrome Glazed Ware (MYT193).

Figure 93 pXRF analysis of yellow pigments.

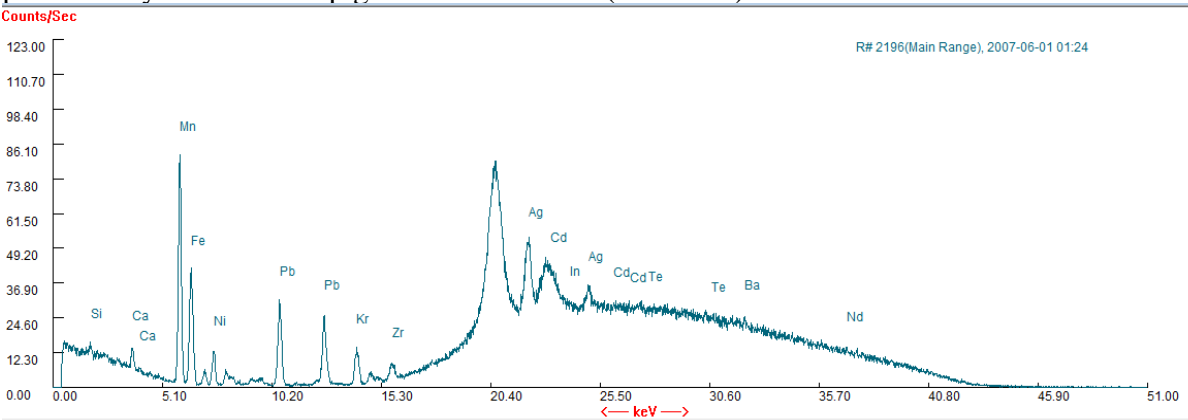
BROWN PIGMENTS



pXRF analysis of Brown pigment of Painted Ware (MYT191).



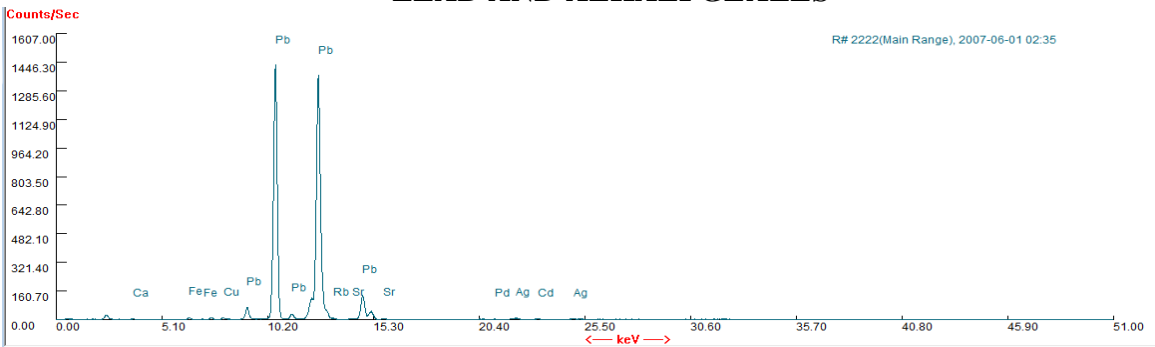
pXRF analysis of Brown pigment of Porcelain (MYT222).



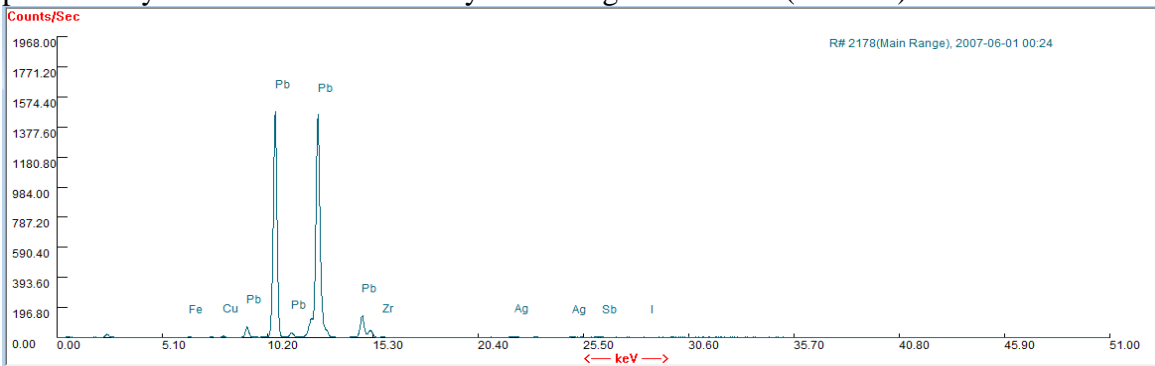
pXRF analysis of Brown pigment of Glazed White Ware IV (MYT203).

Figure 94 pXRF analysis of brown pigments.

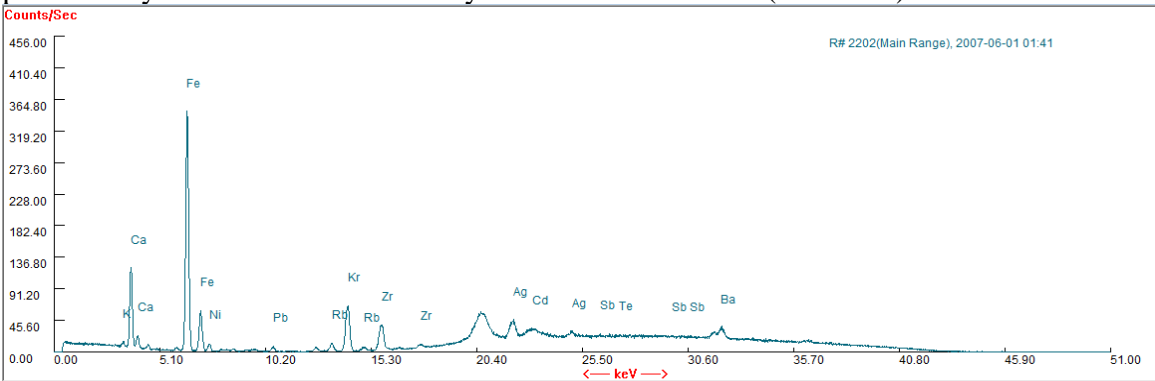
LEAD AND ALKALI GLAZES



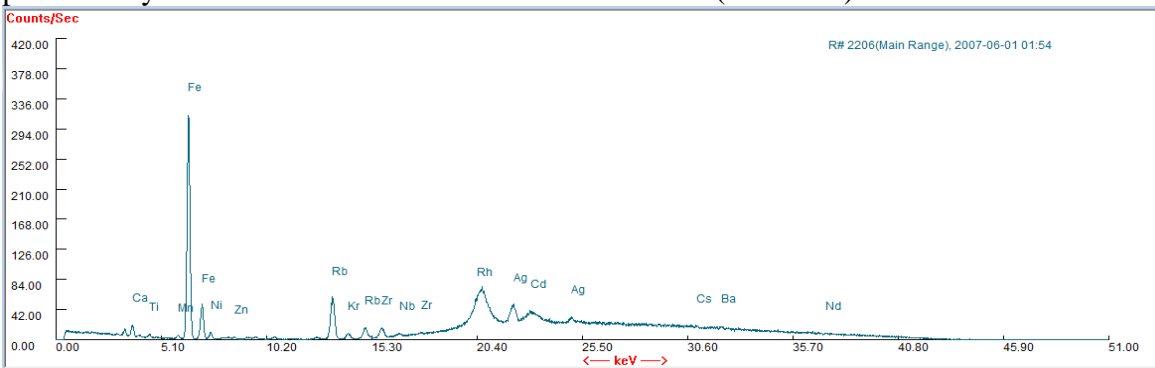
pXRF analysis of Lead Glaze of Polychrome Sgraffito Ware (AAG41).



pXRF analysis of Lead Glaze of Polychrome Painted Ware (MYT228).



pXRF analysis of Alkali Glaze of Overfired Stoneware (MYT202).



pXRF analysis of Alkali Glaze of Porcelain (MYT222).

Figure 95 pXRF analysis of Lead and Alkali glazes.

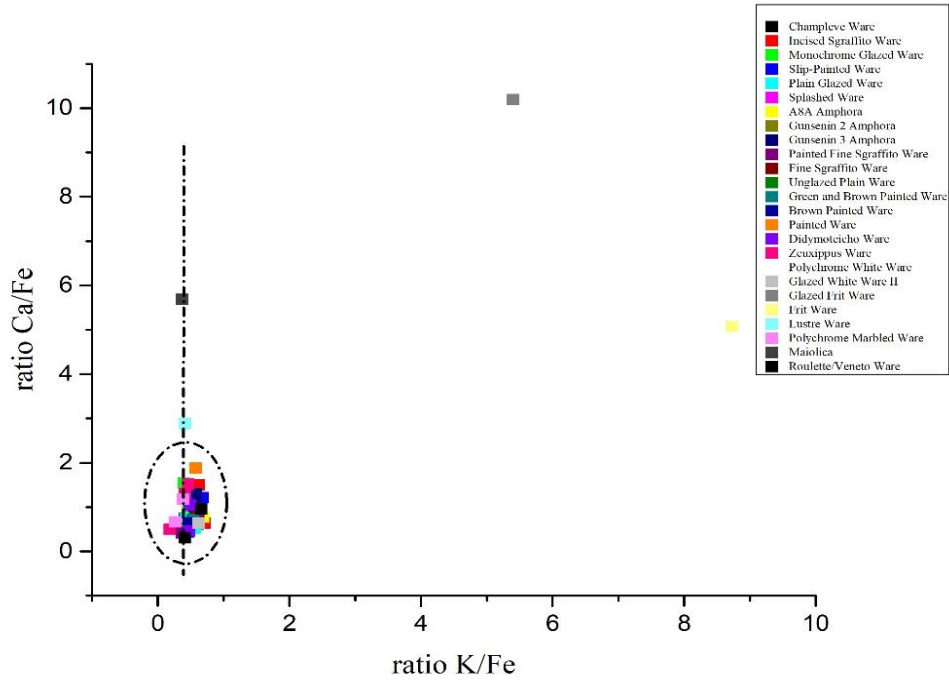


Figure 96 Correlation of the ratio K/Fe with Ca/Fe for the body fabrics at Chalchis in Euboea. The samples have separated based on their pottery types, X-Ray Fluorescence Spectroscopy (XRF).

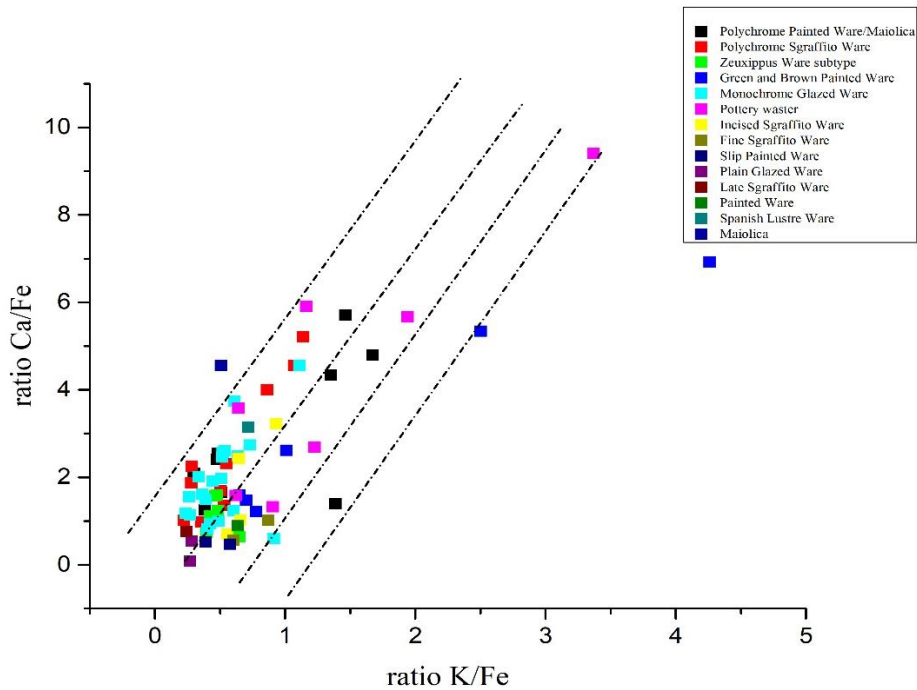


Figure 97 Correlation of the ratio K/Fe with Ca/Fe for the body fabrics at the Athenian Agora in Attica. The samples have separated based on their pottery types, X-Ray Fluorescence Spectroscopy (XRF).

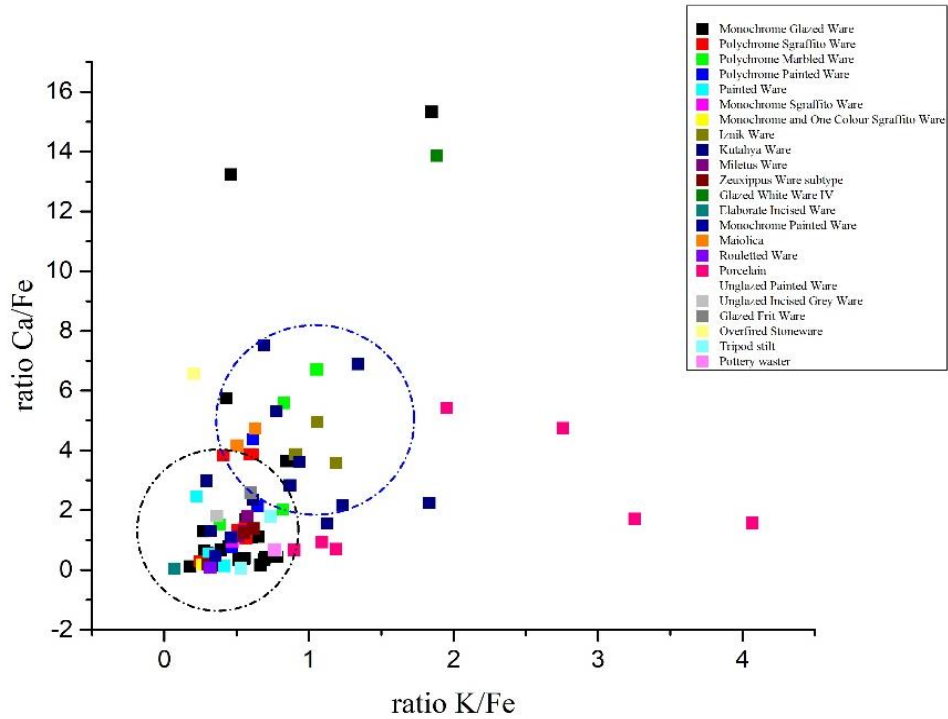


Figure 98 Correlation of the ratio K/Fe with Ca/Fe for the body fabrics at pottery from the Castle of Mytilene in Lesvos. The samples have separated based on their pottery types X -Ray Fluorescence Spectroscopy (XRF).

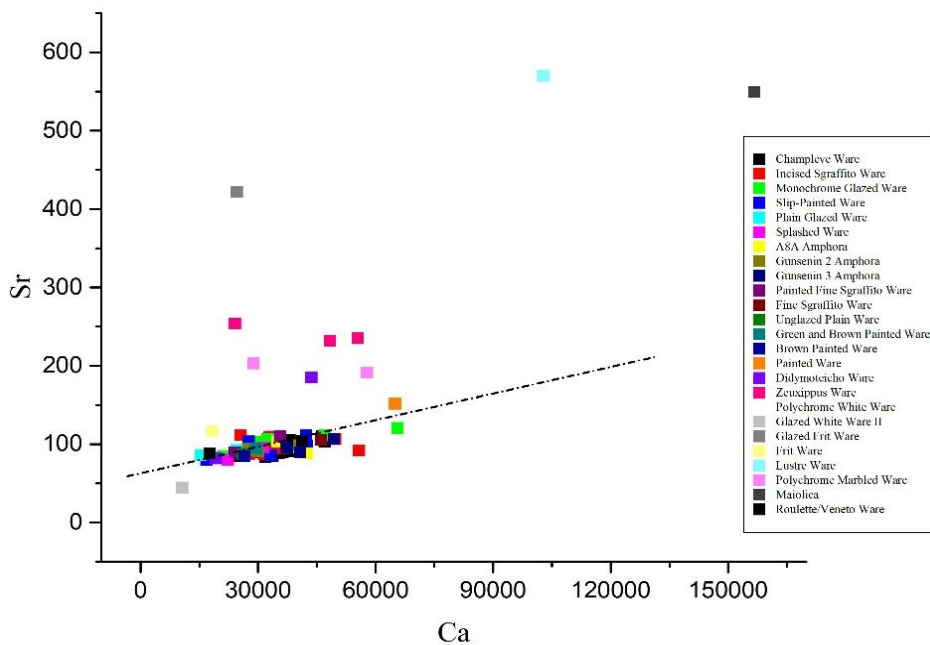


Figure 99 Correlation of Sr with Ca for the body fabrics at Chalcis in Euboea. The samples have separated based on their pottery types, X -Ray Fluorescence Spectroscopy (XRF).

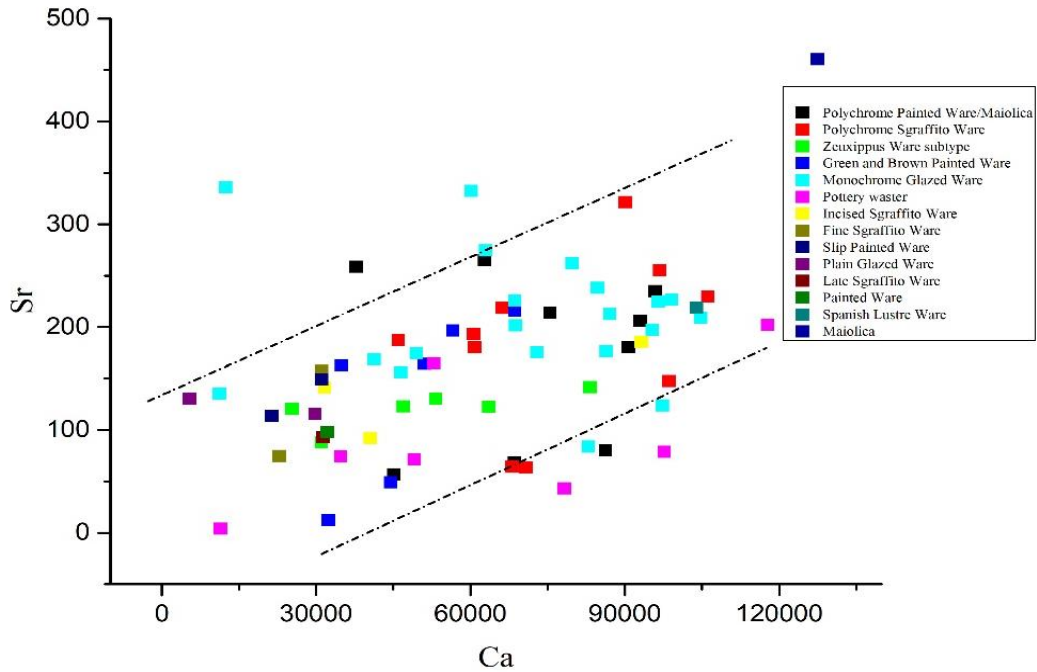


Figure 100 Correlation of Sr with Ca for the body fabrics at the Athenian Agora in Attica. The samples have separated based on their pottery types, X-Ray Fluorescence Spectroscopy (XRF).

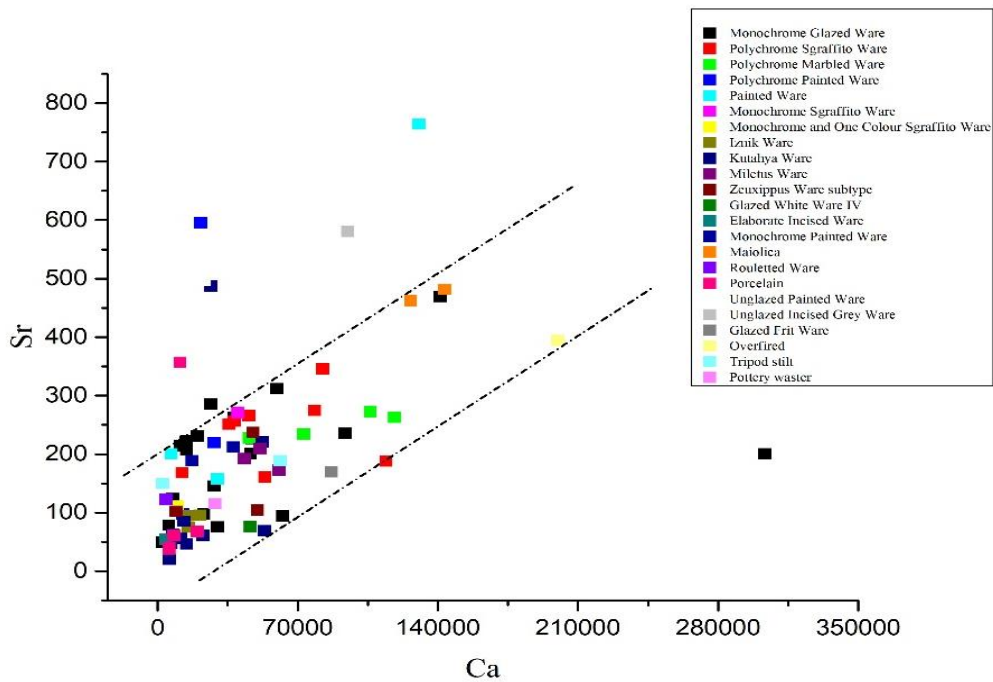


Figure 101 Correlation of Sr with Ca for the body fabrics at pottery from the Castle of Mytilene in Lesbos. The samples have separated based on their pottery types, X-Ray Fluorescence Spectroscopy (XRF).

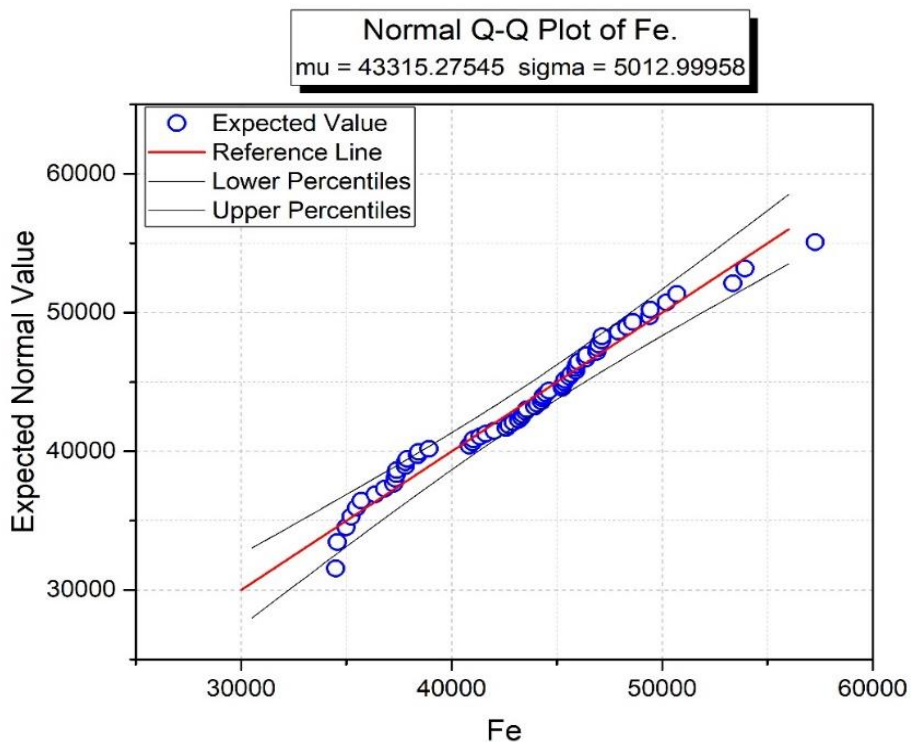


Figure 102 The Upper and the Lower Percentiles of the Fe Expected Normal Value at body fabrics from Chalcis in Euboea.

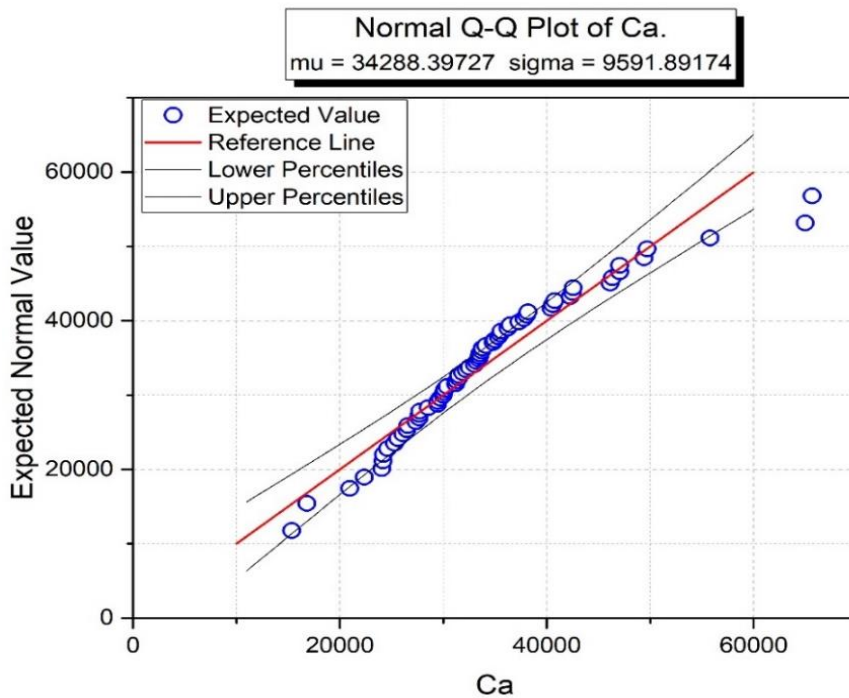


Figure 103 The Upper and the Lower Percentiles of the Ca Expected Normal Value at body fabrics from Chalcis in Euboea.

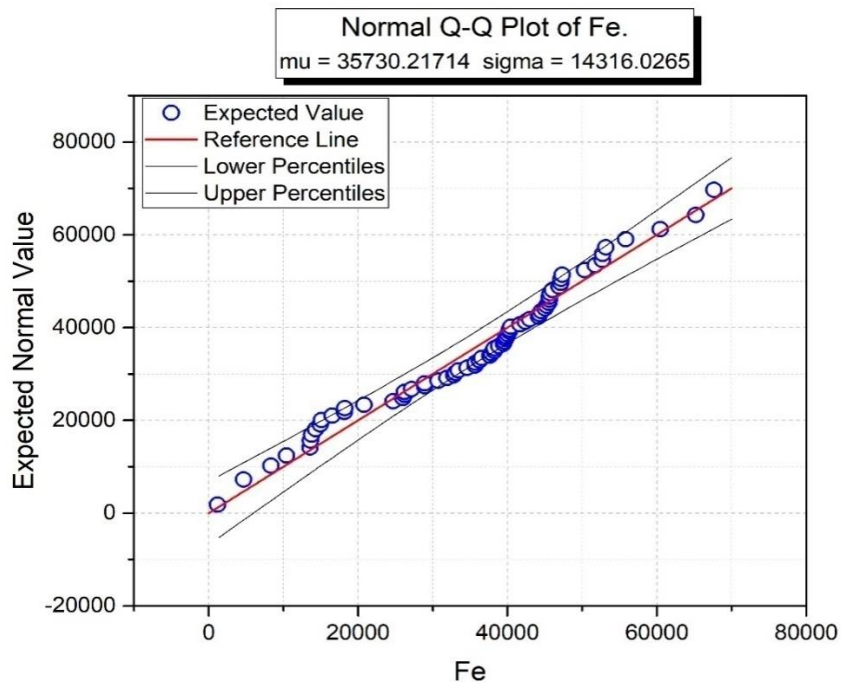


Figure 104 The Upper and the Lower Percentiles of the Fe Expected Normal Value at body fabrics from the Athenian Agora in Attica.

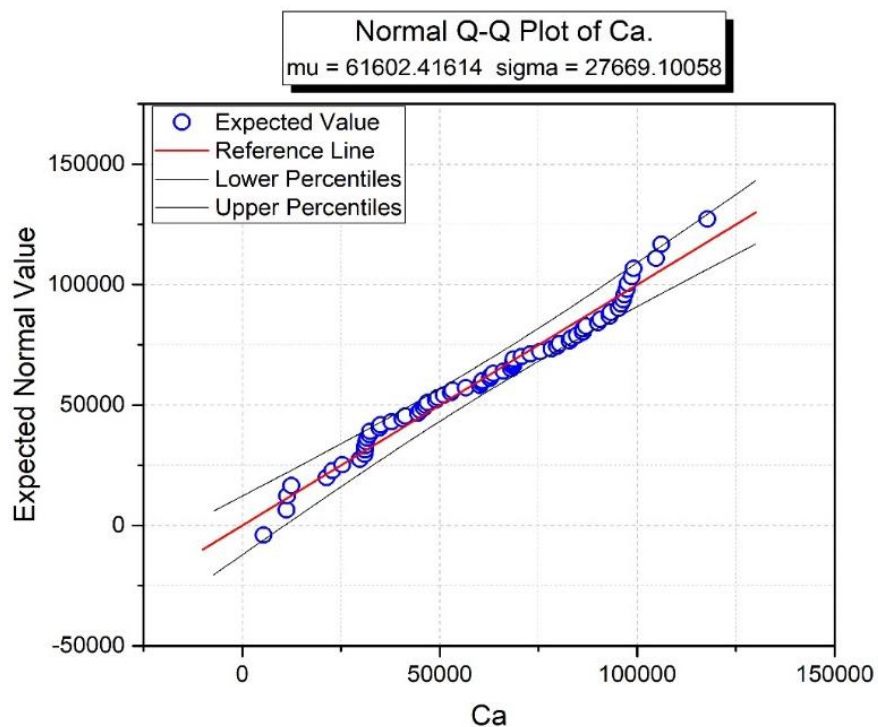


Figure 105 The Upper and the Lower Percentiles of the Ca Expected Normal Value at body fabrics from the Athenian Agora in Attica.

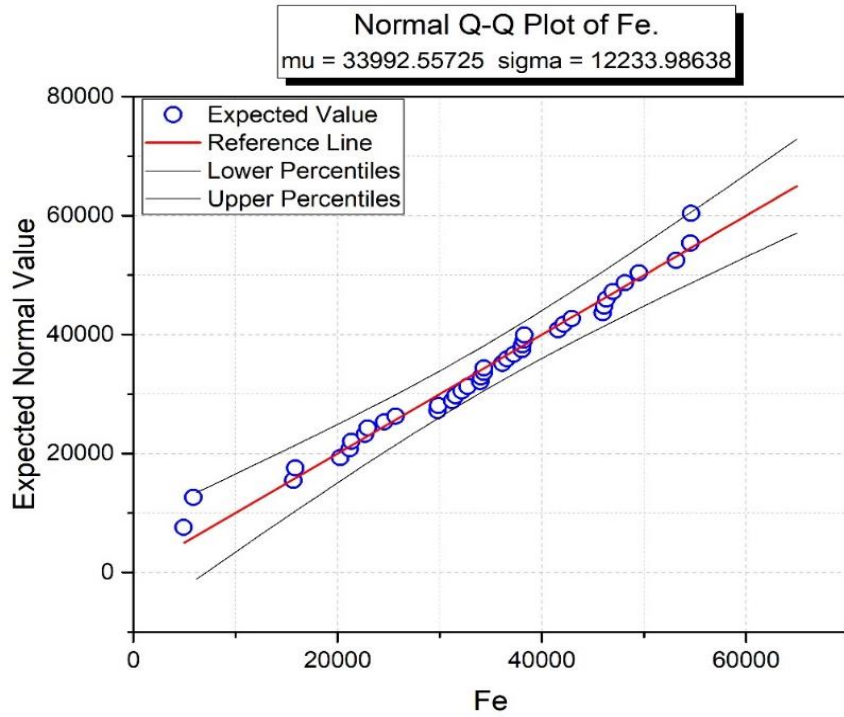


Figure 106 The Upper and the Lower Percentiles of the Fe Expected Normal Value at body fabrics of pottery from the Castle of Mytilene in Lesvos.

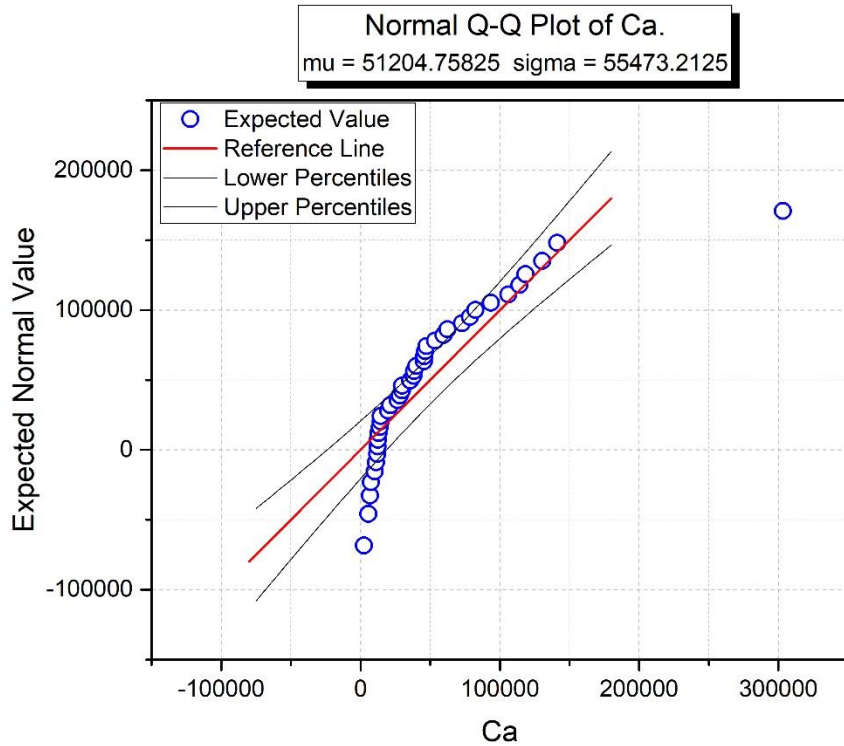


Figure 107 The Upper and the Lower Percentiles of the Ca Expected Normal Value at body fabrics of pottery from the Castle of Mytilene in Lesvos.

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

SAMPLES	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Sn	Sb	Ba	Pb	
GREEN																							
Champlevé Ware	CH124	<LOD	4.30	11.1	0.59	15.8	0.33	0.29	0.76	<LOD	<LOD	<LOD	0.09	0.45	0.03	0.07	1.22	0.02	2.83	0.02	<LOD	0.28	31.1
Champlevé Ware	CH144	<LOD	4.68	12.7	1.04	14.6	0.52	0.46	2.42	0.03	<LOD	<LOD	0.12	1.21	0.03	0.09	1.09	0.03	2.85	0.28	0.18	0.15	40.4
Incised Sgraffito Ware	CH113	<LOD	3.74	12.6	0.72	13.3	0.32	0.39	1.94	0.03	<LOD	<LOD	0.11	0.61	0.02	0.07	2.46	0.02	2.74	0.04	0.16	0.25	35.9
Incised Sgraffito Ware	CH129	<LOD	4.11	9.75	0.78	15.6	0.33	0.31	1.38	0.03	<LOD	0.01	0.11	1.32	0.03	0.06	1.56	0.02	2.66	0.03	<LOD	0.28	28.7
Incised Sgraffito Ware	CH149	1.93	5.18	12.5	0.50	10.2	0.26	0.64	3.77	0.14	<LOD	0.01	0.33	1.43	<LOD	0.07	2.86	0.02	1.84	0.01	0.18	0.25	24.1
Splashed Ware	CH89	<LOD	4.31	8.92	0.69	16.5	0.43	0.34	0.66	<LOD	<LOD	<LOD	0.09	0.65	0.04	0.06	0.78	0.03	3.40	0.03	<LOD	0.32	33.4
Painted Fine Sgraffito Ware	CH98	<LOD	5.27	12.0	0.63	13.1	0.26	0.37	1.19	0.06	<LOD	0.01	0.09	0.63	<LOD	0.07	1.06	0.01	2.43	0.03	0.02	0.29	22.7
Didymoteicho Ware	CH100	<LOD	2.95	13.0	1.27	13.5	0.51	0.24	1.57	0.02	<LOD	<LOD	0.07	0.35	0.02	0.05	0.59	0.04	2.62	0.04	0.01	0.19	23.0
Glazed Frit Ware	CH109	<LOD	2.76	16.7	0.26	5.59	0.14	0.69	2.72	<LOD	<LOD	<LOD	<LOD	0.11	<LOD	0.01	3.17	0.94	0.79	0.01	<LOD	0.04	8.23
Slip-Painted Ware	CH94	<LOD	2.50	9.20	2.82	9.94	0.24	0.34	6.76	0.05	<LOD	0.02	0.12	1.35	0.04	0.05	1.14	0.02	2.31	0.02	0.01	0.21	20.6
Polychrome Painted Ware/Maiolica	AAG32	<LOD	2.84	9.24	0.57	13.6	0.60	1.67	3.99	<LOD	0.05	0.02	0.08	0.67	0.03	0.09	1.45	0.03	2.42	0.04	<LOD	0.18	28.5
Zeuxippus Ware Subtype	AAG49	<LOD	5.82	8.16	0.70	17.8	0.44	0.32	0.69	<LOD	<LOD	<LOD	0.19	0.83	0.03	0.08	0.61	0.03	3.17	0.11	0.06	0.24	35.7
Green and Brown Painted Ware	AAG61	<LOD	3.62	11.0	0.59	14.5	0.42	0.60	1.09	<LOD	<LOD	<LOD	0.07	0.86	<LOD	0.05	1.23	0.02	2.41	0.06	0.02	0.20	19.2
Green and Brown Painted Ware	AGBZY852	<LOD	4.16	14.3	0.49	11.4	0.38	0.74	1.74	0.04	<LOD	<LOD	0.07	0.67	0.03	0.06	1.80	0.02	2.66	0.02	0.09	0.22	24.0
Polychrome Sgraffito Ware	AAG38	<LOD	3.01	15.9	0.60	14.8	0.38	1.07	1.10	<LOD	<LOD	<LOD	0.06	0.49	0.03	0.07	0.83	0.03	2.66	0.05	0.02	0.18	22.8
Polychrome Sgraffito Ware	AAG60	<LOD	3.90	15.6	0.46	11.0	1.00	0.49	4.31	0.10	<LOD	0.02	0.09	1.45	0.03	0.09	1.15	0.02	2.45	0.03	<LOD	0.16	30.4
Polychrome Sgraffito Ware	MYT175	<LOD	3.33	9.81	0.48	12.7	0.32	0.46	0.64	0.04	<LOD	<LOD	0.10	0.65	0.03	0.11	1.67	0.03	2.79	0.06	0.04	0.26	36.8
Polychrome Painted Ware	MYT166	<LOD	1.96	12.0	0.45	10.5	0.22	0.27	1.06	0.06	<LOD	<LOD	0.03	0.46	0.01	0.03	1.87	0.01	1.30	<LOD	0.08	0.11	9.50
Polychrome Marbled Ware	MYT165	<LOD	2.77	9.93	0.75	17.7	0.56	0.17	0.79	<LOD	<LOD	<LOD	0.11	0.17	0.05	0.06	1.22	0.04	3.54	0.17	0.16	0.24	40.9
Monochrome Glazed Ware	MYT216	<LOD	2.93	10.7	0.56	14.4	0.28	0.12	0.44	0.04	0.01	<LOD	0.07	1.02	0.02	0.05	1.24	<LOD	2.26	<LOD	0.04	0.19	18.8
YELLOW																							
Champlevé Ware	CH132	<LOD	3.48	10.9	0.45	12.2	0.26	0.37	1.37	0.04	<LOD	<LOD	0.13	1.70	<LOD	0.04	0.15	0.01	2.16	0.01	0.09	0.22	27.6
Champlevé Ware	CH143	<LOD	3.91	16.2	0.51	11.1	0.21	0.87	0.93	0.01	<LOD	0.01	0.09	1.54	<LOD	0.04	0.05	0.01	1.67	<LOD	0.04	0.18	13.2
Champlevé Ware	CH146	<LOD	4.83	15.9	0.55	13.0	0.26	1.10	1.41	0.08	<LOD	<LOD	0.08	0.72	0.02	0.06	0.53	0.02	2.11	0.01	0.14	0.22	23.0
Champlevé Ware	CH152	<LOD	5.96	14.7	0.50	12.3	0.25	1.04	1.81	0.13	<LOD	<LOD	0.06	0.62	0.03	0.04	0.07	0.02	2.23	<LOD	<LOD	0.20	22.4
Splashed Ware	CH89	<LOD	2.75	8.98	0.52	13.7	0.28	0.33	0.45	<LOD	<LOD	<LOD	0.05	0.55	0.02	0.03	0.05	0.02	2.21	<LOD	<LOD	0.22	16.3
Incised Sgraffito Ware	CH91	<LOD	4.23	9.79	1.41	14.4	0.56	0.42	1.19	0.02	<LOD	<LOD	0.09	0.96	<LOD	0.06	0.72	0.02	2.92	0.03	0.01	0.26	31.3
Incised Sgraffito Ware	AGBZY844	<LOD	4.69	11.5	0.56	13.6	0.35	0.69	3.26	0.08	<LOD	0.02	0.08	1.33	<LOD	0.07	0.05	0.02	2.55	0.02	0.01	0.19	31.4
Late Sgraffito Ware	AAG45	<LOD	3.40	7.67	0.75	16.7	0.35	0.07	0.77	0.09	<LOD	<LOD	0.10	0.98	<LOD	0.05	0.26	0.02	2.82	0.01	0.36	0.18	26.2
Plain Glazed Ware	AAG64	<LOD	5.67	9.17	0.70	17.7	0.60	0.37	0.98	0.05	<LOD	<LOD	0.12	1.56	0.04	0.09	0.12	0.03	3.78	0.02	0.18	0.17	40.5
Zeuxippus Ware Subtype	MYT233	2.17	5.68	12.3	1.20	12.6	0.55	0.76	2.59	0.08	0.01	<LOD	0.10	0.92	0.05	0.07	0.08	0.01	3.10	0.09	0.01	0.21	36.1
Monochrome Glazed Ware	MYT193	1.83	2.34	12.5	0.57	8.92	0.27	0.38	8.71	0.02	<LOD	<LOD	0.11	1.24	<LOD	0.05	0.07	0.04	2.33	<LOD	0.05	0.26	24.5
Monochrome and One Colour Sgraffito Ware	MYT177	<LOD	3.40	9.85	0.59	15.7	0.43	0.24	0.79	0.07	<LOD	<LOD	0.09	0.94	0.02	0.05	0.10	0.01	2.50	<LOD	0.02	0.19	25.5
BROWN																							
Champlevé Ware	CH151	<LOD	4.33	15.5	0.45	9.54	0.19	1.15	2.30	0.15	0.01	0.01	0.09	3.01	<LOD	0.04	0.08	0.02	1.36	<LOD	0.05	0.15	14.8
Champlevé Ware	CH141	<LOD	5.24	12.4	0.55	14.9	0.32	0.54	1.82	0.12	<LOD	<LOD	0.15	2.49	0.03	0.07	0.09	0.02	2.55	<LOD	0.05	0.25	31.7
Incised Sgraffito Ware	CH111	<LOD	3.54	14.6	0.53	10.3	0.19	0.67	1.52	0.12	0.01	0.01	0.09	2.06	0.02	0.02	0.03	0.01	1.19	<LOD	0.02	0.11	8.48
Didymoteicho Ware	CH100	2.22	2.75	12.3	10.70	13.3	0.42	0.24	2.18	0.05	<LOD	0.02	0.09	1.30	<LOD	0.06	0.61	0.03	2.56	0.05	0.01	0.19	24.7
Didymoteicho Ware	CH135	<LOD	2.98	17.0	0.38	7.88	0.17	0.92	1.22	0.14	0.01	0.02	0.08	3.56	<LOD	0.03	0.03	0.01	1.29	<LOD	0.01	0.14	10.8
Splashed Ware	CH145	<LOD	4.29	21.4	0.37	5.46	0.10	1.96	1.89	0.04	<LOD	0.01	0.04	1.87	<LOD	0.02	0.32	0.01	0.81	0.01	0.01	0.09	6.11
Painted Ware	CH104	<LOD	1.52	11.3	0.69	12.5	0.25	0.14	1.71	<LOD	<LOD	<LOD	0.05	1.24	0.01	0.01	0.05	0.01	1.49	<LOD	0.03	0.14	12.3
Slip Painted Ware	AAG58	<LOD	5.05	9.88	0.66	16.8	0.64	0.34	1.13	0.08	<LOD	0.02	0.10	2.27	<LOD	0.08	0.23	0.04	2.88	0.02	0.03	0.18	36.3
Painted Ware	MYT191	<LOD	3.26	10.7	0.93	15.0	0.50	0.21	0.92	<LOD	<LOD	<LOD	0.09	2.54	<LOD	0.06	0.15	0.04	3.30	0.02	0.04	0.33	38.0
Monochrome Glazed Ware	MYT173	<LOD	3.26	11.8	2.35	9.53	0.53	0.34	3.98	0.05	0.02	<LOD	0.08	1.53	<LOD	0.06	3.41	0.01	2.15	<LOD	<LOD	0.30	26.6
Monochrome Sgraffito Ware	MYT171	<LOD	2.95	12.2	0.86	14.8	0.41	0.34	1.50	<LOD	0.01	0.02	0.11	3.08	<LOD	0.08	0.09	0.03	2.51	0.02	0.08	0.16	33.6
Glazed White Ware IV	MYT203	<LOD	0.44	36.5	0.18	0.34	0.06	0.15	1.13	0.04	0.01	<LOD	1.31	0.32	<LOD	0.01	0.01	<LOD	0.01	<LOD	<LOD	<LOD	0.05
Porcelain	MYT222	0.54	5.56	27.3	0.12	0.08	<LOD	1.90	2.20	0.24	0.01	0.01	0.05	3.18	<LOD	<LOD	<LOD	0.01	<LOD	0.00	<LOD	<LOD	0.01
BLACK																							
Unglazed Plain Ware	CH134	<LOD	6.10	21.7	0.18	0.22	0.02	1.83	5.00	0.46	0.02	0.03	0.09	5.19	<LOD	0.01	<LOD	0.01	<LOD	<LOD	<LOD	0.07	<LOD
Incised Sgraffito Ware	CH139	<LOD	5.00	20.0	0.86	5.63	0.14	3.05	2.11	0.20	0.01	0.01	0.06	3.07	0.03	0.01	<LOD	0.01	0.24	<LOD	<LOD	0.07	0.12
TURQUOISE																							
Glazed Frit Ware	MYT182	<LOD	3.88	19.3	0.61	7.68	0.20	1.87	2.78	0.08	<LOD	0.01	0.05	1.28	0.04	0.04	0.94	<LOD	1.44	3.30	0.03	0.20	23.0

Table 15 pXRF analysis of the pigments (%) of the pottery collection from Chalcis in Euboea, the Athenian Agora in

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

c	SAMPLE	Bal	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Sn	Sb	Ba	Pb
Champlevé Ware	CH84	59.5	1.40	2.25	9.11	0.44	11.3	0.20	0.19	1.11	0.07	< LOD	0.01	0.06	1.29	0.02	0.03	0.05	0.01	1.43	< LOD	0.01	0.16	11.3
Champlevé Ware	CH92	48.3	< LOD	3.13	9.45	0.53	11.6	0.23	0.54	1.17	0.07	< LOD	0.01	0.08	1.56	< LOD	0.04	0.14	0.01	1.86	< LOD	0.03	0.19	20.9
Champlevé Ware	CH112	26.3	< LOD	4.42	10.5	0.64	16.7	0.36	0.35	0.90	0.05	< LOD	< LOD	0.11	1.14	0.03	0.06	0.19	0.02	3.16	< LOD	0.05	0.23	32.8
Champlevé Ware	CH115	40.5	< LOD	4.87	13.5	0.56	13.5	0.31	0.73	1.26	0.09	< LOD	0.02	0.07	1.43	0.01	0.03	0.08	0.01	1.61	< LOD	0.03	0.22	21.0
Champlevé Ware	CH116	50.1	< LOD	3.33	11.5	0.58	14.2	0.27	0.32	0.79	0.03	< LOD	0.01	0.06	0.86	0.02	0.04	0.08	0.01	1.98	< LOD	0.04	0.19	14.4
Champlevé Ware	CH122	27.6	< LOD	4.29	10.2	0.59	16.2	0.34	0.37	0.69	0.02	< LOD	< LOD	0.09	1.11	< LOD	0.07	0.07	0.02	3.03	0.02	< LOD	0.22	35.1
Champlevé Ware	CH123	33.9	< LOD	4.28	10.7	0.57	15.3	0.32	0.51	1.58	0.08	< LOD	0.01	0.15	1.74	0.04	0.06	0.10	0.02	2.55	0.02	0.03	0.27	27.8
Champlevé Ware	CH118	25.9	< LOD	4.46	9.12	0.63	16.2	0.35	0.40	0.96	0.05	< LOD	0.01	0.13	1.69	0.03	0.07	0.12	0.02	2.88	0.01	< LOD	0.26	36.6
Champlevé Ware	CH130	23.0	< LOD	5.60	10.3	0.68	16.5	0.36	0.50	1.53	0.04	< LOD	< LOD	0.07	0.90	< LOD	0.07	0.12	0.01	3.08	0.02	0.09	0.33	36.8
Champlevé Ware	CH140	49.0	< LOD	3.59	16.5	0.43	9.82	0.20	0.91	1.33	0.08	< LOD	0.01	0.08	2.10	< LOD	0.03	0.03	0.02	1.43	< LOD	0.01	0.16	14.2
Champlevé Ware	CH142	28.4	1.25	5.25	11.0	0.55	15.2	0.32	0.63	1.26	0.09	< LOD	0.01	0.11	1.95	< LOD	0.06	0.08	0.03	2.54	< LOD	< LOD	0.27	29.6
Champlevé Ware	CH152	43.7	< LOD	3.78	12.4	0.46	11.0	0.22	0.80	2.44	0.14	0.01	0.01	0.12	2.32	< LOD	0.03	0.10	0.02	1.85	0.01	< LOD	0.22	20.3
AVERAGE			1.33	4.10	11.2	0.56	14.0	0.29	0.52	1.25	0.07	0.01	0.01	0.09	1.51	0.03	0.05	0.10	0.02	2.28	0.02	0.04	0.23	25.1
Incised Sgraffito Ware	CH83	48.8	1.61	3.16	12.0	0.48	11.8	0.23	0.91	0.76	< LOD	< LOD	0.01	0.06	1.43	< LOD	0.03	0.07	0.03	1.96	< LOD	0.02	0.21	16.3
Incised Sgraffito Ware	CH90	55.3	< LOD	3.51	10.1	1.29	9.29	0.19	0.75	1.11	0.06	< LOD	0.01	0.07	0.96	< LOD	0.03	0.05	0.01	1.98	< LOD	0.02	0.14	14.3
Incised Sgraffito Ware	CH114	34.0	< LOD	6.05	13.7	0.67	12.3	0.26	0.82	1.62	0.11	< LOD	< LOD	0.10	2.41	< LOD	0.05	0.19	0.02	2.21	0.01	0.09	0.29	24.0
Incised Sgraffito Ware	CH117	52.8	< LOD	3.46	15.5	0.48	11.4	0.20	0.58	0.69	0.03	< LOD	0.01	0.04	0.55	0.02	0.03	0.03	0.03	1.79	< LOD	0.01	0.16	12.2
Incised Sgraffito Ware	CH133	51.5	< LOD	2.66	15.0	0.48	11.8	0.22	0.37	1.16	0.05	< LOD	< LOD	0.05	0.74	< LOD	0.04	0.04	0.01	1.72	0.01	0.03	0.17	13.9
AVERAGE			1.61	3.77	13.3	0.68	11.3	0.22	0.69	1.07	0.06	0.00	0.01	0.06	1.22	0.02	0.04	0.08	0.02	1.93	0.01	0.03	0.19	16.1
Fine Sgraffito Ware	CH127	59.8	< LOD	3.93	12.0	0.49	11.8	0.19	0.34	1.16	0.10	< LOD	0.01	0.07	1.28	0.03	0.02	0.03	0.01	1.22	< LOD	< LOD	0.12	7.28
Painted Fine Sgraffito Ware	CH97	25.9	2.71	3.62	10.6	0.67	14.7	0.37	0.16	1.24	< LOD	< LOD	0.32	0.16	3.09	< LOD	0.34	0.11	0.03	2.72	0.04	0.02	0.32	32.9
Painted Ware	CH104	59.6	< LOD	1.60	10.0	0.65	12.0	0.24	0.15	1.40	< LOD	< LOD	0.01	0.04	0.93	0.01	0.01	0.04	0.01	1.38	< LOD	0.02	0.13	9.92
Polychrome Marbled Ware	CH102	56.1	< LOD	1.70	11.2	0.43	10.2	0.20	0.54	0.88	0.04	< LOD	0.01	0.09	0.82	0.03	0.01	0.09	0.03	2.18	0.01	0.01	0.13	15.2
Polychrome White Ware	CH108	50.6	1.82	1.65	10.6	2.16	5.30	0.43	0.79	5.33	0.06	0.02	0.03	3.93	1.53	< LOD	0.04	0.79	0.06	0.66	1.30	0.02	0.15	12.7
Glazed White Ware II	CH107	55.2	< LOD	2.66	8.20	0.81	11.6	0.22	0.22	1.18	0.05	< LOD	0.01	0.10	0.66	0.02	0.03	0.08	0.01	2.04	< LOD	< LOD	0.14	16.7
Green and Brown Painted Ware	CH95	58.9	< LOD	2.12	12.1	0.53	13.7	0.25	0.07	0.16	< LOD	< LOD	< LOD	0.05	0.48	0.03	0.02	0.04	0.01	1.67	< LOD	0.01	0.13	9.72
Brown Painted Ware	CH136	49.7	< LOD	3.51	16.6	0.45	10.6	0.20	0.76	0.44	0.05	< LOD	0.01	0.08	0.53	0.03	0.03	0.80	0.01	1.78	0.07	0.01	0.18	14.1
Monochrome Glazed Ware	CH119	23.2	< LOD	5.03	18.6	0.41	10.5	0.25	1.24	1.10	0.06	< LOD	0.01	0.09	0.57	0.03	0.05	0.40	0.02	3.09	0.01	0.01	0.26	35.1
Monochrome Glazed Ware	CH120	40.4	< LOD	3.20	11.8	2.43	10.2	0.53	0.75	3.83	0.01	< LOD	0.01	0.09	0.39	0.02	0.06	2.53	0.11	2.36	0.05	0.02	0.26	20.9
Monochrome Glazed Ware	CH126	24.6	< LOD	3.79	11.3	0.63	15.1	0.34	0.48	1.47	0.05	< LOD	0.02	3.19	1.59	0.03	0.04	0.08	0.03	2.56	0.02	< LOD	0.2	34.5
Monochrome Glazed Ware	CH128	34.9	< LOD	5.68	19.2	0.60	9.90	0.28	2.65	1.03	0.08	< LOD	< LOD	0.08	0.72	0.02	0.05	0.04	0.02	2.50	0.01	< LOD	0.22	21.9
Monochrome Glazed Ware	CH137	39.5	< LOD	4.85	16.3	0.47	11.9	0.24	1.90	0.87	< LOD	< LOD	< LOD	0.06	1.44	< LOD	0.06	0.02	0.02	2.07	0.01	0.05	0.19	19.9
AVERAGE			0.00	4.51	15.4	0.91	11.5	0.33	1.40	1.66	0.05	0.00	0.01	0.70	0.94	0.03	0.05	0.61	0.04	2.52	0.02	0.03	0.23	26.5
Slip-Painted Ware	CH138	53.1	< LOD	3.42	13.7	0.63	10.3	0.25	1.37	1.71	0.09	< LOD	0.01	0.05	0.66	0.03	0.02	0.06	0.01	1.84	0.00	< LOD	0.12	11.7
Slip-Painted Ware	CH86	50.0	< LOD	3.36	12.5	0.47	12.3	0.24	0.67	1.28	0.09	0.01	< LOD	0.10	2.02	0.03	0.03	0.05	0.02	1.84	< LOD	< LOD	0.18	14.8
AVERAGE			0.00	3.39	13.1	0.55	11.3	0.25	1.02	1.50	0.09	0.01	0.01	0.08	1.34	0.03	0.03	0.06	0.02	1.84	0.00	0.00	0.15	13.3
Plain Glazed Ware	CH87	22.1	3.23	4.58	8.65	0.73	11.6	0.33	0.59	3.34	0.12	< LOD	0.02	0.14	2.17	< LOD	0.05	0.12	0.02	3.00	0.01	0.11	0.23	38.7
Plain Glazed Ware	CH88	41.4	< LOD	3.01	7.66	0.58	14.2	0.29	0.18	0.59	0.07	< LOD	0.02	0.09	1.71	< LOD	0.04	0.10	0.02	2.80	0.02	< LOD	0.23	27.0
Plain Glazed Ware	CH125	19.8	< LOD	5.19	9.35	0.71	16.9	0.41	0.32	1.44	0.09	0.01	0.02	0.11	2.16	< LOD	0.06	0.15	0.03	2.87	0.02	0.19	0.05	40.1
AVERAGE			3.23	4.26	8.55	0.67	14.2	0.34	0.36	1.79	0.09	0.01	0.02	0.11	2.01	0.00	0.05	0.12	0.02	2.89	0.02	0.15	0.17	35.3
Zeuxippus Ware	CH99	36.5	< LOD	3.07	14.0	2.23	10.1	0.50	0.54	3.38	0.04	0.01	0.02	0.06	0.58	0.02	0.07	0.05	0.03	2.53	0.01	< LOD	0.20	24.9
Zeuxippus Ware	CH101	31.0	< LOD	3.01	13.2	0.9	14.7	0.34	0.28	1.21	0.02	< LOD	< LOD	0.10	0.79	0.03	0.07	0.05	0.03	2.81	0.01	< LOD	0.20	31.3
AVERAGE			0.00	3.04	13.6	1.57	12.4	0.42	0.41	2.30	0.03	0.01	0.02	0.08	0.69	0.03	0.07	0.05	0.03	2.67	0.01	0.00	0.20	28.1
Glazed Frit Ware	CH106	45.6	< LOD	1.43	5.80	3.34	5.04	0.37	0.33	11.1	0.06	< LOD	0.03	0.10	1.81	< LOD	0.05	1.15	0.03	0.41	6.90	0.02	0.08	16.3
Frit Ware	CH147	60.6	< LOD	5.98	27.2	0.19	0.26	0.01	2.79	2.00	0.15	0.00	0.01	< LOD	0.53	< LOD	< LOD	0.06	0.07	< LOD	0.00	< LOD	0.09	0.10
Maiolica	CH154	41.4	< LOD	2.22	19.6	0.51	11.7	0.27	1.69	0.59	0.01	< LOD	< LOD	0.06	0.47	0.20	0.12	0.03	0.01	1.91	1.37	< LOD	0.15	17.6
Roulette/Veneto Ware	CH82	45.6	< LOD	2.79	10.4	0.59	14.7	0.29	0.25	1.07	0.04	< LOD	0.01	0.07	2.52	< LOD	0.04	0.04	0.05	2.39	0.06	< LOD	0.18	18.8
Roulette/Veneto Ware	CH85	47.2	< LOD	3.47	10.4	0.49	13.0	0.27	0.33	1.48	0.08	< LOD	< LOD	0.11	1.74	< LOD	0.05	0.20	0.01	2.35	0.01	< LOD	0.23	18.5
AVERAGE			0.00	3.13	10.4	0.54	13.9	0.28	0.29	1.28	0.06	0.00	0.01	0.09	2.13	0.00	0.05	0.12	0.03	2.37	0.04	0.00	0.21	18.7
Lustre Ware	CH110	31.3	< LOD	2.13	18.1	0.47	10.7	0.31	1.13	0.53	0.10	< LOD	0.01	0.04	0.46	< LOD	0.04	0.05	0.01	1.66	57.0	< LOD	0.12	27.1

Table 16 pXRF analysis of pottery glazes (%) from Chalcis in Euboea.

TYPOLOGY	SAMPLE	Bal	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Sn	Sb	Ba	Pb
Polychrome Sgraffito Ware	AAG41	31.1	<LOD	3.83	10.5	0.67	16.0	0.41	0.23	1.74	0.03	<LOD	<LOD	0.09	0.64	0.04	0.16	0.24	0.02	3.08	0.01	<LOD	0.17	31.0
Incised Sgraffito Ware	AGBZY849	32.9	1.93	4.12	12.6	0.67	15.4	0.58	0.50	1.06	0.05	<LOD	<LOD	0.06	0.42	0.03	0.07	0.10	0.02	3.08	0.01	0.07	0.22	26.0
Incised Sgraffito Ware	AGBZY843	52.2	<LOD	3.01	12.2	0.61	14.8	0.28	0.11	0.60	0.04	<LOD	<LOD	0.06	0.41	0.02	0.03	0.06	0.01	2.03	0.02	0.02	0.12	13.42
AVERAGE			1.93	3.57	12.4	0.64	15.1	0.43	0.31	0.83	0.05	0.00	0.00	0.06	0.42	0.03	0.05	0.08	0.02	2.56	0.02	0.05	0.17	19.7
Zeuxippus Ware Subtype	AAG46	35.6	<LOD	3.76	8.70	0.66	16.2	0.35	0.09	0.76	0.09	<LOD	<LOD	0.08	0.51	0.04	0.04	0.23	0.02	2.69	0.02	0.42	0.19	29.53
Monochrome Glazed Ware	AGBZY840	42.1	<LOD	3.52	13.7	0.54	13.3	0.29	1.07	2.29	0.04	<LOD	<LOD	0.06	0.84	0.03	0.05	0.10	0.01	2.25	0.02	<LOD	0.16	19.58
Monochrome Glazed Ware	AAG21	52.5	<LOD	2.20	14.4	0.61	11.8	0.40	1.17	1.23	0.04	<LOD	<LOD	0.04	0.69	0.02	0.07	0.13	0.01	1.75	<LOD	<LOD	0.14	12.87
Monochrome Glazed Ware	AAG63	30.1	<LOD	3.98	13.8	0.62	16.0	0.45	0.52	0.54	0.05	<LOD	0.50	0.13	0.62	0.02	0.07	0.12	0.03	3.12	0.01	0.07	0.29	29.0
AVERAGE			0.00	3.23	14.0	0.59	13.7	0.38	0.92	1.35	0.04	0.00	0.50	0.08	0.72	0.02	0.06	0.12	0.02	2.37	0.02	0.07	0.20	20.5

Table 17 pXRF analysis of pottery glazes (%) from the Athenian Agora in Attica.

TYPOLOGY	SAMPLE	Bal	Mg	Al	Si	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Rb	Sr	Sn	Sb	Ba	Pb
Polychrome Sgraffito Ware	MYT194	19.8	<LOD	4.71	10.1	0.64	17.7	0.47	0.23	0.41	0.08	<LOD	<LOD	0.10	0.87	0.04	0.08	0.10	0.01	3.23	<LOD	<LOD	0.03	0.04	0.24	41.1
Polychrome Sgraffito Ware	MYT209	44.9	<LOD	2.51	14.4	0.85	13.6	0.40	0.21	0.73	0.03	<LOD	<LOD	0.24	0.33	0.03	0.05	0.27	0.02	2.37	<LOD	0.01	<LOD	0.01	0.17	17.7
AVERAGE		0.00	3.61	12.3	0.75	15.7	0.44	0.22	0.57	0.06	0.01	0.00	0.17	0.60	0.04	0.07	0.19	0.02	2.80	0.00	0.01	0.03	0.03	0.21	29.4	
Polychrome Painted Ware	MYT228	31.8	<LOD	1.91	15.6	0.63	14.4	0.42	0.24	0.85	<LOD	<LOD	<LOD	0.14	0.19	0.03	0.08	0.22	0.02	2.56	<LOD	<LOD	0.03	0.04	0.12	30.7
Polychrome Marbled Ware	MYT208	29.9	<LOD	2.81	15.1	0.67	14.5	0.35	0.17	0.81	<LOD	<LOD	<LOD	0.08	0.51	0.03	0.06	0.84	0.02	2.98	<LOD	<LOD	0.05	0.02	0.21	30.9
Painted Ware	MYT205	24.0	<LOD	2.96	16.6	0.58	15.1	0.39	0.07	0.42	<LOD	<LOD	0.03	0.10	0.63	0.03	0.06	0.08	0.02	2.89	<LOD	<LOD	0.03	0.04	0.24	35.7
Iznik Ware	MYT214	47.7	<LOD	1.22	19.4	0.36	8.27	0.28	0.58	0.70	<LOD	<LOD	<LOD	0.04	0.25	<LOD	0.02	0.05	0.01	1.36	<LOD	<LOD	1.54	0.08	0.06	17.2
Iznik Ware	MYT170	59.5	<LOD	0.75	13.5	0.48	6.34	0.23	0.24	6.82	<LOD	<LOD	0.01	0.03	0.17	<LOD	0.02	0.05	0.01	1.19	<LOD	<LOD	0.55	0.02	0.03	10.0
AVERAGE		0.00	0.99	16.5	0.42	7.31	0.26	0.41	3.76	0.00	0.00	0.01	0.04	0.21	0.00	0.02	0.05	0.01	1.28	0.00	0.00	1.05	0.05	0.05	13.6	
Kütahya Ware	MYT184	41.2	<LOD	1.33	23.1	0.43	9.29	0.33	0.69	1.72	<LOD	<LOD	<LOD	0.06	0.27	<LOD	0.04	0.37	0.02	1.56	<LOD	<LOD	0.01	0.01	0.07	19.5
Kütahya Ware	MYT169	45.4	<LOD	1.80	15.7	0.58	12.4	0.42	0.32	0.79	<LOD	<LOD	<LOD	0.06	0.20	<LOD	0.04	0.09	0.01	2.18	<LOD	<LOD	0.01	0.12	0.09	19.8
Kütahya Ware	MYT239	61.2	<LOD	0.58	28.7	0.24	2.54	0.24	1.21	2.20	0.02	<LOD	<LOD	0.02	0.40	<LOD	<LOD	0.07	0.01	0.31	<LOD	0.00	0.03	<LOD	<LOD	2.20
Kütahya Ware	MYT183	54.1	<LOD	4.42	33.6	0.12	0.33	<LOD	1.67	5.20	0.03	0.00	<LOD	0.07	0.44	<LOD	<LOD	<LOD	<LOD	0.00	0.01	0.01	0.00	<LOD	<LOD	0.01
AVERAGE		0.00	2.03	25.3	0.34	6.14	0.33	0.97	2.48	0.03	0.00	<LOD	0.05	0.33	0.00	0.04	0.18	0.01	1.01	0.01	0.01	0.01	0.01	0.07	0.08	10.4
Zeuxippus Ware Subtype	MYT196	46.2	<LOD	3.30	10.9	0.60	14.6	0.31	0.35	0.96	0.07	<LOD	0.02	0.07	0.90	0.02	0.09	0.26	0.02	2.22	<LOD	<LOD	0.01	0.01	0.22	18.8
Elaborate Incised Ware	MYT234	23.6	<LOD	4.05	16.2	0.58	14.3	0.38	0.38	0.54	<LOD	<LOD	<LOD	0.10	0.35	0.04	0.06	0.13	0.02	3.12	<LOD	<LOD	0.10	0.05	0.20	35.8
Maiolica	MYT236	49.7	<LOD	2.29	15.4	0.81	12.1	0.28	1.31	1.60	0.02	<LOD	<LOD	0.04	0.41	0.02	0.03	0.03	0.01	1.84	0.00	0.00	0.09	0.01	0.14	13.8
Maiolica	MYT227	53.2	<LOD	2.18	17.1	0.79	10.5	0.23	1.59	1.30	0.02	<LOD	<LOD	0.04	0.43	<LOD	0.03	0.02	0.01	1.52	0.01	0.01	0.07	<LOD	0.10	10.7
AVERAGE		0.00	2.24	16.3	0.80	11.3	0.26	1.45	1.45	1.45	0.02	0.00	0.00	0.04	0.42	0.02	0.03	0.03	0.01	1.68	0.01	0.01	0.08	0.01	0.12	12.3
Monochrome Painted Ware	MYT176	43.0	<LOD	2.29	17.6	0.55	12.7	0.32	0.21	0.92	0.03	0.01	0.20	0.07	0.38	0.02	0.04	0.09	0.02	2.15	<LOD	<LOD	<LOD	0.01	0.19	18.0
Monochrome Painted Ware	MYT210	21.7	<LOD	3.81	11.1	0.67	16.0	0.52	0.23	0.90	0.04	<LOD	<LOD	0.08	0.31	0.03	0.08	0.70	0.03	3.40	<LOD	<LOD	0.02	0.02	0.26	38.5
AVERAGE		0.00	3.05	14.4	0.61	14.4	0.42	0.22	0.91	0.04	0.01	0.20	0.08	0.35	0.03	0.06	0.40	0.03	2.78	0.00	0.00	0.02	0.02	0.23	28.3	
Porcelain	MYT221	57.2	<LOD	1.24	34.7	0.15	0.24	0.14	0.76	4.36	0.07	0.00	0.00	0.16	0.56	0.02	<LOD	0.03	0.01	0.01	<LOD	0.04	<LOD	<LOD	<LOD	0.04
Overfired Stoneware	MYT202	54.6	2.93	3.52	19.0	0.16	0.10	0.03	1.04	13.93	0.36	0.01	0.04	0.09	4.10	<LOD	0.01	0.00	0.01	0.00	0.00	0.03	<LOD	<LOD	0.08	0.02

Table 18 pXRF analysis of pottery glazes (%) from the Castle of Mytilene in Lesvos.

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

TYOLOGY	SAMPLE	S (%)	K (%)	Ca (%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb (%)	Th	U
Champlevé Ware	CH84	0.41	1.99	2.40	0.34	97.6	157	774	4.44	119	89.5	108	793	135	89.1	148	38.5	52.3	146	88.7	908	0.93	87.9	14.9
Champlevé Ware	CH92	0.18	2.68	3.04	0.44	128	179	1640	4.70	139	208	130	35.4	141	103	159	13.2	17.4	64.1	56.4	759	0.02	13.7	16.8
Champlevé Ware	CH112	0.47	2.27	4.04	0.36	130	131	1050	5.39	166	509	125	< LOD	151	97.7	133	40.9	43.8	167	92.8	863	1.72	163	12.0
Champlevé Ware	CH115	2.48	2.00	3.37	0.29	64.7	76.9	775	4.16	171	398	119	5680	137	84.8	87.0	106	154	469	264	1680	3.71	252	< LOD
Champlevé Ware	CH116	0.15	2.49	3.35	0.40	110	122	799	4.35	98.5	99.7	103	< LOD	129	86.7	166	24.2	27.8	60.4	53.1	621	0.54	77.6	11.2
Champlevé Ware	CH118	0.48	2.42	3.35	0.40	109	147	825	40.7	104	347	110	< LOD	138	88.3	158	23.7	36.8	93.1	71.3	719	0.76	77.6	15.2
Champlevé Ware	CH122	0.17	2.12	2.65	0.37	93.0	133	846	4.57	130	137	114	74.6	138	87.3	141	30.1	32.5	123	82.6	784	0.62	79.3	14.1
Champlevé Ware	CH123	0.08	2.52	3.55	0.44	99.5	144	732	3.84	123	81.8	98.6	41.1	123	96.8	192	22.1	27.2	108	68.3	762	0.02	12.7	15.0
Champlevé Ware	CH124	0.10	2.41	3.01	0.42	119	139	815	4.36	105	104	103	< LOD	137	89.9	177	15.4	24.8	85.4	58.7	697	0.21	33.6	13.3
Champlevé Ware	CH130	0.08	2.02	4.64	0.34	79.2	194	711	3.64	121	208	105	15.7	116	110	193	14.3	18.5	67.9	62.7	681	0.02	10.2	12.2
Champlevé Ware	CH132	0.07	2.54	3.81	0.46	104	150	792	4.33	93.5	85.9	110	< LOD	131	105	199	< LOD	19.8	59.8	37.1	567	0.05	17.5	10.8
Champlevé Ware	CH140	0.43	1.95	2.42	0.35	92.3	124	893	4.53	102	80.4	125	897	130	85.0	146	26.2	33.5	101	69.3	743	1.35	165	10.0
Champlevé Ware	CH141	0.06	2.32	3.82	0.44	110	139	720	3.78	119	81.0	90.0	29.9	116	91.3	196	14.5	24.6	78.4	54.6	698	0.08	22.2	16.8
Champlevé Ware	CH142	0.06	2.26	3.19	0.38	115	137	783	4.29	131	130	106	61.7	133	83.3	150	22.7	27.7	90.8	74.2	823	0.06	18.7	17.4
Champlevé Ware	CH143	0.16	2.44	4.71	0.43	123	152	729	4.56	115	87.9	119	< LOD	139	104	169	< LOD	29.5	87.7	51.9	670	0.41	62.7	14.7
Champlevé Ware	CH144	0.77	2.49	3.12	0.43	109	133	945	5.34	125	253	130	512	152	96.4	129	64.0	63.6	149	95.9	865	2.07	221	14.4
Champlevé Ware	CH146	0.10	2.06	3.62	0.38	100	120	744	3.78	106	77.9	97.1	< LOD	120	89.5	194	31.2	47.2	146	99.4	909	0.25	38.3	15.6
Champlevé Ware	CH148	0.22	2.47	3.41	0.41	101	123	778	4.10	101	123	115	< LOD	130	95.0	181	26.1	36.5	107	59.2	729	0.61	90.5	16.2
Champlevé Ware	CH151	0.17	1.84	2.94	0.31	79.4	99.0	791	4.32	99.1	151	122	480	131	102	169	40.7	81.3	175	107	897	1.19	145	11.4
Champlevé Ware	CH152	0.08	2.01	3.53	0.36	86.9	121	665	3.68	112	132	86.3	32.5	116	88.9	201	20.4	20.3	94.1	61.9	676	0.18	32.1	16.3
AVERAGE		0.34	2.27	3.40	0.39	103	136	840	6.14	119	169	111	721	132	93.7	164	31.9	41.0	124	80.5	803	0.74	81.0	14.1
STDEV		0.54	0.25	0.62	0.05	16.9	25.3	206	8.15	21.2	121	12.5	1594	10.4	7.79	29.1	22.3	31.1	88.5	47.0	228	0.92	72.3	2.26
MEDIAN		0.17	2.30	3.36	0.39	103	135	787	4.34	117	126	110	68.2	132	90.6	168	25.2	31.0	97.6	68.8	751	0.48	70.2	14.7
PERCENTILE LOWER DECILE		0.06	1.95	2.44	0.31	79.2	101	712	3.69	96.3	80.5	90.7	20.0	116	84.8	129	14.2	18.6	60.8	52.0	626	0.02	12.8	10.8
PERCENTILE UPPER DECILE		0.74	2.54	4.58	0.44	128	177	1040	5.39	163	393	130	4244	150	105	199	68.2	79.5	174	106	909	2.04	215	16.8
Incised Sgraffito Ware	CH83	0.05	2.56	2.53	0.43	109	181	815	4.20	116	62.6	107	46.7	129	89.7	166	17.3	31.0	109	68.9	888	0.06	18.7	13.9
Incised Sgraffito Ware	CH90	0.07	2.43	3.30	0.39	113	137	915	3.89	107	232	105	31.6	124	109	186	16.1	24.6	112	68.0	653	0.33	49.2	13.0
Incised Sgraffito Ware	CH91	0.06	2.28	3.00	0.37	108	151	694	3.55	98.1	88.2	103	34.5	114	95.8	180	15.7	28.2	97.2	67.6	690	0.11	18.5	17.0
Incised Sgraffito Ware	CH111	0.34	1.89	3.38	0.36	102	117	799	4.43	113	128	120	< LOD	122	97.1	175	20.9	62.4	86.4	60.9	687	1.62	150	12.0
Incised Sgraffito Ware	CH113	0.08	2.89	3.34	0.47	122	160	856	4.94	111	103	125	36.0	154	110	176	20.3	31.1	86.6	55.1	749	0.09	24.2	14.0
Incised Sgraffito Ware	CH114	3.47	2.32	2.56	0.31	78.4	115	792	4.10	155	146	177	3820	148	111	110	51.3	86.0	298	166	1220	1.82	133	10.4
Incised Sgraffito Ware	CH117	0.06	2.36	3.65	0.43	106	137	737	3.74	120	67.7	103	32.6	118	94.5	215	16.7	16.0	68.2	52.4	683	0.01	11.1	12.7
Incised Sgraffito Ware	CH129	0.42	2.41	4.97	0.39	115	168	936	4.79	134	243	134	77.7	137	106	166	24.9	33.2	96.6	72.2	825	0.22	29.0	9.10
Incised Sgraffito Ware	CH133	0.05	2.33	5.58	0.42	107	191	763	3.73	128	128	97.5	23.7	115	91.4	230	19.4	29.0	99.8	64.7	739	0.02	14.1	12.0
Incised Sgraffito Ware	CH139	0.15	2.43	3.22	0.38	131	136	780	4.59	106	102	112	< LOD	140	97.1	136	24.2	49.0	82.6	66.8	810	0.69	91.1	15.7
Incised Sgraffito Ware	CH149	0.05	2.09	3.15	0.37	98.8	141	724	3.52	104	124	89.1	22.8	108	86.9	221	15.4	25.9	65.9	64.8	710	0.02	13.9	15.4
Incised Sgraffito Ware	CH150	0.06	3.14	2.77	0.46	121	137	789	4.40	111	69.5	110	43.1	131	87.8	156	20.4	24.8	90.2	74.7	849	0.04	16.3	19.4
Incised Sgraffito Ware	CH153	0.04	1.87	3.15	0.37	91.5	129	750	3.73	117	123	97.7	20.5	117	93.2	190	13.7	< LOD	67.0	52.9	649	0.03	15.2	17.4
AVERAGE		0.38	2.38	3.43	0.40	108	146	796	4.12	117	124	114	406	128	97.7	178	21.3	36.8	105	72.0	781	0.39	45.0	14.0
STDEV		0.94	0.35	0.89	0.04	13.7	23.1	70.9	0.48	15.0	56.6	22.5	1140	14.0	8.55	33.3	9.64	19.7	60.0	29.2	154	0.62	48.1	2.92
MEDIAN		0.06	2.36	3.22	0.39	108	137	789	4.10	113	123	107	36.0	124	95.8	176	19.4	30.0	90.2	66.8	739	0.09	18.7	13.9
PERCENTILE LOWER DECILE		0.04	1.88	2.54	0.33	83.6	116	706	3.53	105	64.6	92.5	21.0	110	87.3	120	14.4	18.6	66.3	52.6	651	0.01	12.2	9.62
PERCENTILE UPPER DECILE		2.25	3.04	5.34	0.47	127	187	928	4.88	147	239	160	3115	152	111	226	40.7	78.9	224	130	1090	1.74	143	18.6
Monochrome Glazed Ware	CH93	0.36	2.02	2.10	0.33	104	137	827	4.54	114	640	101	226	135	85.0	145	42.4	51.6	164	85.2	885	0.75	87.4	11.2
Monochrome Glazed Ware	CH96	0.10	2.39	3.00	0.40	98.8	151	779	4.43	130	194	121	< LOD	130	103	142	19.2	24.4	65.3	41.0	607	0.25	41.5	17.9
Monochrome Glazed Ware	CH119	0.14	2.73	2.74	0.45	102	143	793	4.54	106	138	102	< LOD	140	94.2	157	29.8	36.8	94.3	63.8	791	0.46	56.0	18.4
Monochrome Glazed Ware	CH120	0.07	2.55	3.25	0.39	99.3	149	821	4.60	144	151	100	< LOD	138	106	149	26.3	38.0	103	81.0	859	0.11	27.8	14.8
Monochrome Glazed Ware	CH126	0.77	2.34	4.71	0.39	121	133	1160	5.02	149	338	125	683	146	111	163	28.5	30.5	140	76.0	750	1.64	70.4	< LOD
Monochrome Glazed Ware	CH128	0.28	2.15	2.86	0.37	113	97.4	930	4.86	138	64.3	107	99.8	143	93.5	149	29.7	37.0	154	94.4	921	0.92	63.8	15.4
Monochrome Glazed Ware	CH137	0.49	1.68	6.57	0.22	68.4	93.9	850	4.27	280	340	132	< LOD	130	121	117	55.3	120	242	138	1100	2.40	222	12.9
AVERAGE		0.32	2.27	3.60	0.36	101	129	880	4.61															

TYOLOGY	SAMPLE	S (%)	K (%)	Ca (%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb (%)	Th	U
Slip-Painted Ware	CH86	0.07	2.70	3.33	0.42	118	158	788	4.45	106	95.9	108	51.0	133	85.6	157	28.1	27.1	100	66.4	788	0.12	25.6	14.1
Slip-Painted Ware	CH94	0.04	1.76	1.68	0.30	76.4	119	730	3.84	125	49.3	96.1	20.9	125	80.3	153	27.7	35.8	152	78.0	889	0.02	12.9	13.6
Slip-Painted Ware	CH121	0.77	2.38	4.23	0.35	86.2	136	693	3.50	103	143	89.3	<LOD	122	112	155	17.2	30.8	74.6	59.0	720	0.28	34.4	13.6
Slip-Painted Ware	CH138	0.19	2.65	2.76	0.44	109	148	783	4.64	163	101	114	<LOD	141	103	161	<LOD	35.1	55.9	33.1	566	0.53	66.9	12.6
Slip-painted Ware	CH131	0.50	2.46	4.25	0.40	95.7	151	839	4.34	118	149	104	49.0	133	98.3	149	25.6	33.6	111	73.2	807	0.04	16.2	12.1
AVERAGE		0.31	2.39	3.25	0.38	97.1	142	767	4.15	123	108	102	40.3	131	95.8	155	24.7	32.5	98.7	61.9	754	0.20	31.2	13.2
STDEV		0.28	0.34	0.97	0.05	15.0	13.7	50.4	0.42	21.5	36.2	8.71	13.7	6.71	11.5	4.00	4.40	3.19	32.9	15.8	108	0.19	19.4	0.73
MEDIAN		0.19	2.46	3.33	0.40	95.7	148	783	4.34	118	101	104	49.0	133	98.3	155	26.7	33.6	100	66.4	788	0.12	25.6	13.6
Plain Glazed Ware	CH87	<LOD	2.64	2.46	0.46	107	213	844	4.69	137	87.2	107	50.1	134	92.5	167	15.4	19.2	62.0	48.9	701	0.02	12.7	22.1
Plain Glazed Ware	CH88	0.07	2.10	1.53	0.58	150	599	329	5.07	262	74.5	122	<LOD	115	86.2	179	15.6	25.0	64.5	59.5	562	0.04	14.3	16.3
Plain Glazed Ware	CH125	0.35	2.00	3.50	0.37	90.8	129	875	4.59	144	143	112	189	136	105	186	42.5	50.0	172	105	973	1.14	119	16.5
AVERAGE		0.21	2.25	2.50	0.47	116	314	683	4.78	181	102	114	120	128	94.6	177	24.5	31.4	99.5	71.1	745	0.40	48.7	18.3
Splashed Ware	CH89	0.04	2.04	2.24	0.33	102	122	607	3.45	84.1	61.7	83.8	34.2	106	79.7	181	14.2	24.9	122	71.3	754	0.01	10.8	14.5
Splashed Ware	CH145	0.09	2.15	3.13	0.36	97.8	130	689	3.57	108	90.8	106	22.4	120	95.5	155	21.6	26.5	109	73.6	747	0.03	14.7	15.9
AVERAGE		0.07	2.10	2.69	0.35	99.9	126	648	3.51	96.1	76.3	94.9	28.3	113	87.6	168	17.9	25.7	116	72.5	751	0.02	12.8	15.2
A8A Amphora	CH155	0.10	2.76	4.26	0.44	123	170	786	4.46	140	68.4	105	37.2	141	87.9	155	18.4	24.4	96.0	60.1	744	0.00	15.2	13.7
A8A Amphora	CH156	0.07	2.69	3.49	0.40	88.1	185	847	4.83	129	59.4	138	35.9	145	103	138	14.7	32.5	101	64.2	803	0.01	15.0	20.0
A8A Amphora	CH157	<LOD	3.40	3.78	0.51	181	183	928	4.94	32	71.4	144	36.1	151	95.6	150	<LOD	21.4	96.4	63.9	811	0.01	11.8	15.1
Günsenin 2 Amphora	CH161	0.05	2.55	3.01	0.42	111	135	837	4.64	102	58.6	114	27.4	139	90.7	156	23.8	34.9	88.5	55.5	700	0.00	11.2	19.2
Günsenin 2 Amphora	CH162	<LOD	2.23	2.77	0.37	94.8	161	798	4.69	123	59.3	116	31.7	139	94.4	140	19.8	28.5	102	72.7	804	0.01	8.15	19.1
Günsenin 2 Amphora	CH163	<LOD	2.85	4.06	0.47	117	178	810	4.60	116	63.6	113	30.1	140	98.6	170	<LOD	24.8	68.5	57.2	752	0.00	12.9	20.7
Günsenin 3 Amphora	CH158	0.17	2.09	4.08	0.38	96.4	148	1520	3.74	107	69.4	103	18.4	116	89.7	178	<LOD	24.4	62.8	42.3	624	0.01	9.83	16.0
Günsenin 3 Amphora	CH159	0.48	2.19	4.94	0.37	101	132	828	3.79	107	76.4	95.8	32.2	116	107	201	12.8	24.0	74.7	44.8	608	0.00	10.1	17.0
Günsenin 3 Amphora	CH160	<LOD	2.65	3.73	0.46	117	160	863	4.53	114	60.6	107	23.9	135	95.0	173	16.5	29.8	114	65.8	762	0.00	9.82	17.7
AVERAGE		0.17	2.60	3.79	0.42	115	161	913	4.47	119	65.2	115	30.3	136	95.8	162	17.7	27.2	89.3	58.5	734	0.00	11.6	17.6
Painted Fine Sgraffito Ware	CH97	0.34	2.10	2.42	0.33	98.5	136	948	5.73	99.3	99.7	131	314	156	89.7	126	18.8	20.4	<LOD	22.6	488	1.48	171	13.6
Painted Fine Sgraffito Ware	CH98	<LOD	2.57	3.56	0.45	109	181	807	4.26	117	282	108	28.8	132	110	174	22.5	27.6	73.7	60.7	772	0.01	12.4	14.2
AVERAGE		0.34	2.34	2.99	0.39	104	159	878	5.00	108	191	120	171	144	99.9	150	20.7	24.0	73.7	41.7	630	0.75	91.7	13.9
Fine Sgraffito Ware	CH127	1.48	2.68	4.61	0.40	128	158	774	4.71	132	836	114	597	150	105	148	17.2	24.5	88.5	48.3	657	0.24	21.6	8.10
Unglazed Plain Ware	CH134	<LOD	2.11	2.61	0.37	101	145	750	4.41	89.4	79.1	95.9	14.5	133	87.2	149	<LOD	25.8	82.3	58.4	705	0.00	12.9	13.0
Green and Brown Painted Ware	CH95	0.12	2.17	2.95	0.38	102	143	801	4.08	108	86.6	99.7	164	124	94.0	154	22.7	34.6	73.1	73.1	714	0.58	90.8	13.6
Brown Painted Ware	CH136	0.06	1.96	2.66	0.34	86.8	125	835	4.13	118	68.0	97.1	89.4	129	84.5	163	34.7	44.4	143	102	900	0.18	30.0	16.8
Painted Ware	CH104	0.09	2.01	6.50	0.28	75.1	218	745	3.46	148	71.8	93.1	36.4	116	151	182	<LOD	19.3	<LOD	21.0	382	0.12	14.5	9.50
Didymoteicho Ware	CH100	0.81	2.01	4.36	0.41	86.3	229	796	4.17	140	157	152	563	93.9	185	170	18.3	24.2	63.6	47.8	465	0.28	40.7	15.7
Didymoteicho Ware	CH135	0.06	1.98	1.93	0.38	90.3	232	809	4.16	131	61.5	105	<LOD	129	81.5	154	29.1	50.1	143	93.1	915	0.21	25.3	15.7
AVERAGE		0.44	2.00	3.15	0.40	88.3	231	803	4.17	136	109	129	563	112	133	162	23.7	37	103.3	70.5	690	0.25	33	15.7
Zeuxippus Ware	CH99	0.11	1.70	5.55	0.36	89.8	185	798	3.65	140	64.6	84.5	27.4	88.4	235	150	21.7	37.1	112	76.2	649	0.17	26.5	13.2
Zeuxippus Ware	CH105	0.49	0.88	2.41	0.19	44.4	121	1080	4.83	168	77.9	110	730	101	254	149	<LOD	<LOD	<LOD	<LOD	1.63	<LOD	<LOD	
Zeuxippus Ware	CH101	0.25	1.55	4.85	0.38	85.3	219	947	3.72	160	74.7	101	289	93.4	231	156	22.6	28.7	136	88.0	642	0.21	26.1	15.8
AVERAGE		0.28	1.38	4.27	0.31	73.2	175	942	4.07	156	72.4	98.5	349	94.3	240	152	22.2	30.9	124	82.1	646	0.67	26.3	14.5
Polychrome White Ware	CH108	0.05	0.29	0.29	0.65	113	52.8	90.1	2.24	26.4	68.5	72.3	<LOD	10.3	28.3	140	41.3	15.5	53.3	22.6	216	0.25	7.47	4.20
Glazed White Ware II	CH107	4.43	1.05	1.07	0.25	75.3	129	282	1.70	87.5	160	73.3	3400	67.6	44.5	131	61.3	88.4	302	139	874	17.7	78.3	<LOD
Glazed Frit Ware	CH106	0.07	1.31	2.46	0.14	27.0	<LOD	68.1	0.24	<LOD	223	14.7	35.2	31.2	422	67.6	36.5	<LOD	37.4	14.0	374	0.39	12.6	12.0
Frit Ware	CH147	0.12	3.15	1.83	0.16	25.5	67.0	95.4	0.36	36.1	457	634	42.3	48.6	116	308	41.0	23.9	54.0	47.7	887	1.21	35.9	13.0
Lustre Ware	CH110	0.32	1.47	10.3	0.28	87.2	201	747	3.57	188	123	105	102	35.5	570	252	324	22.4	<LOD	34.7	420	3.74	35.7	6.50
Polychrome Marbled Ware	CH102	0.20	1.17	2.89	0.23	49.2	1																	

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

TYOLOGY	SAMPLE	S (%)	K (%)	Ca (%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb (%)	Th	U
Polychrome Painted Ware/Maiolica	AGBZY861	0.62	2.21	8.62	0.32	90.8	277	127	1.51	112	57.7	93.9	112	44.7	80.0	46.6	<LOD	<LOD	<LOD	<LOD	56.0	0.29	37.3	<LOD
Polychrome Painted Ware/Maiolica	AGBZY862	0.15	2.39	6.85	0.43	94.4	315	<LOD	1.43	41.2	13.0	45.8	56.5	37.9	68.5	25.1	<LOD	<LOD	<LOD	<LOD	<LOD	0.09	7.66	<LOD
Polychrome Painted Ware/Maiolica	AGBZY863	0.45	1.41	4.51	0.25	94.0	227	<LOD	1.04	76.9	80.0	37.0	<LOD	31.8	57.0	19.0	<LOD	<LOD	<LOD	<LOD	<LOD	0.46	47.8	<LOD
Polychrome Painted Ware/Maiolica	AAG29	0.57	1.89	9.59	0.30	68.6	347	590	3.98	453	109	173	351	107	235	130	54.4	75.7	194	119	880	1.28	110	12.9
Polychrome Painted Ware/Maiolica	AAG30	0.27	1.73	9.07	0.28	81.5	297	494	3.57	246	154	132	127	96.3	181	139	26.4	46.8	120	81.1	644	0.71	71.5	9.67
Polychrome Painted Ware/Maiolica	AAG31	0.27	1.34	9.31	0.33	96.2	381	611	4.45	275	154	157	259	94.7	207	138	28.2	53.8	104	57.6	509	1.11	104	10.1
Polychrome Painted Ware/Maiolica	AAG32	0.60	1.93	6.28	0.32	104	387	688	5.03	443	681	141	411	141	265	82.6	43.2	58.1	143	103	709	2.53	252	<LOD
Polychrome Painted Ware/Maiolica	AAG66	0.35	2.32	7.54	0.37	105	484	576	4.57	339	137	142	167	134	214	118	<LOD	24.7	74.8	29.5	400	0.81	114	12.1
Polychrome Painted Ware/Maiolica	AAG67	2.26	3.77	3.78	0.14	41.1	139	659	2.72	154	129	384	3170	148	259	107	39.1	61.1	176	78.3	635	1.64	149	<LOD
AVERAGE		0.62	2.11	7.28	0.30	86.2	317	535	3.14	238	168	145	582	92.8	174	89.5	38.3	53.4	136	78.1	548	1.00	99.3	11.2
STDEV		0.64	0.72	2.11	0.08	20.3	99.7	191	1.52	153	198	101	1054	45.2	83.4	48.2	11.5	17.0	44.8	31.9	264	0.76	72.3	1.55
MEDIAN		0.45	1.93	7.54	0.32	94.0	315	590	3.57	246	129	141	213	96.3	207	107	39.1	56.0	132	79.7	635	0.81	104	11.1
PERCENTILE LOWER DECILE		0.15	1.34	3.78	0.14	41.1	139	0.00	1.04	41.2	13.0	37.0	0.00	31.8	57.0	19.0	0.00	0.00	0.00	0.00	0.00	0.09	7.66	0.00
PERCENTILE UPPER DECILE		2.26	3.77	9.59	0.43	105	484	0.00	5.03	453	681	384	0.00	148	265	139	0.00	0.00	0.00	0.00	0.00	2.53	252	0.00
Polychrome Sgraffito Ware	AGBZY828	0.37	1.55	7.08	0.34	83.0	122	45.8	1.36	41.2	180	48.2	55.4	34.1	63.6	26.1	<LOD	<LOD	<LOD	<LOD	<LOD	0.36	33.2	<LOD
Polychrome Sgraffito Ware	AGBZY829	0.53	1.60	6.81	0.33	93.4	237	<LOD	1.49	49.8	144	47.3	197	34.6	64.1	18.3	<LOD	<LOD	<LOD	<LOD	<LOD	0.54	44.2	<LOD
Polychrome Sgraffito Ware	AGBZY860	0.21	2.13	9.86	0.38	98.9	422	403	2.47	198	78.0	103	71.1	71.2	147	81.1	16.2	34.2	105	57.5	369	0.26	27.3	7.05
Polychrome Sgraffito Ware	AAG37	1.36	1.45	9.68	0.32	101	366	637	5.18	338	719	182	231	139	255	110	11.7	43.3	170	89.5	700	1.45	127	12.6
Polychrome Sgraffito Ware	AAG38	0.41	1.45	6.62	0.27	78.7	364	799	6.52	351	551	166	651	115	218	63.8	50.3	68.8	173	116	779	2.88	240	<LOD
Polychrome Sgraffito Ware	AAG39	1.40	1.33	10.6	0.25	97.3	255	720	4.71	270	332	160	360	114	229	88.4	58.0	46.9	166	98.7	719	1.68	142	16.0
Polychrome Sgraffito Ware	AAG40	0.21	1.81	6.06	0.25	69.7	334	435	3.57	287	882	116	1210	114	194	81.6	36.6	69.4	195	99.6	784	1.09	103	12.7
Polychrome Sgraffito Ware	AAG41	0.30	1.68	4.60	0.28	75.0	345	514	4.72	537	157	151	<LOD	131	187	122	37.4	54.1	137	98.6	732	1.29	104	<LOD
Polychrome Sgraffito Ware	AAG60	0.46	2.40	6.09	0.48	132	581	519	4.50	314	69.8	154	35.4	141	181	148	34.4	24.9	76.4	41.2	532	0.02	12.1	15.3
Polychrome Sgraffito Ware	AAG62	0.12	2.13	9.01	0.34	102	404	605	3.89	285	90.5	121	61.2	113	322	116	<LOD	<LOD	62.9	38.0	423	0.11	20.9	16.1
AVERAGE		0.54	1.75	7.64	0.32	93.1	343	520	3.84	267	320	125	319	101	186	85.5	40.0	50.0	136	80.0	630	0.97	85.4	13.3
STDEV		0.46	0.36	2.00	0.07	17.9	123	219	1.65	146	294	47.4	389	40.0	80.0	41.3	13.5	16.5	48.9	29.9	165	0.89	72.1	3.40
MEDIAN		0.39	1.64	6.95	0.33	95.4	355	519	4.20	286	169	136	197	114	191	85.0	37.4	50.1	152	94.1	710	0.82	73.6	14.0
PERCENTILE LOWER DECILE		0.13	1.34	4.75	0.25	70.2	134	45.8	1.37	42.1	70.6	47.4	35.4	34.2	63.7	19.1	0.00	0.00	0.00	0.00	0.00	0.03	13.0	0.00
PERCENTILE UPPER DECILE		1.40	2.37	10.5	0.47	129	565	799	6.39	518	866	180	1210	141	315	145	0.00	0.00	0.00	0.00	0.00	2.76	230	0.00
Zeuxippus Ware Subtype	AAG43	1.70	2.61	2.54	0.43	96.6	144	651	4.01	129	123	149	2680	130	121	129	42.4	64.0	190	110	886	1.39	104	13.6
Zeuxippus Ware Subtype	AAG46	0.31	1.90	6.35	0.34	88.1	241	1090	3.98	188	87.6	94.6	161	97.3	122	158	16.3	60.5	86.2	64.8	561	0.69	49.3	8.39
Zeuxippus Ware Subtype	AAG47	4.17	2.00	5.32	0.33	85.6	241	962	4.73	240	208	119	3970	108	130	145	61.8	151	288	153	1000	2.12	156	<LOD
Zeuxippus Ware Subtype	AAG48	1.79	2.44	8.33	0.27	159	187	1140	5.27	231	199	168	3080	90.6	142	130	55.0	125	292	140	930	1.79	124	<LOD
Zeuxippus Ware Subtype	AAG49	4.58	1.68	3.10	0.25	64.1	145	1090	4.24	278	692	126	10620	119	88.3	62.9	167	236	694	372	2000	6.09	385	<LOD
Zeuxippus Ware Subtype	AAG50	3.52	1.84	4.70	0.35	78.3	202	915	3.79	203	146	129	3150	109	123	145	55.8	83.4	264	138	1030	1.90	142	11.7
AVERAGE		2.68	2.08	5.06	0.33	95.3	193	976	4.34	212	243	131	3940	109	121	128	66.4	120	302	163	1070	2.33	160	11.2
STDEV		1.67	0.37	2.13	0.06	33.1	43.4	181	0.56	51.1	225	25.3	3520	14.3	17.9	33.8	51.9	67.0	207	107	487	1.91	116	2.60
MEDIAN		2.66	1.95	5.01	0.34	86.9	195	1028	4.13	217	173	128	3110	109	123	138	55.4	104	276	139	965	1.85	133	11.7
Green and Brown Painted Ware	AGBZY847	1.45	20.9	44.5	3.81	87.5	<LOD	<LOD	0.83	<LOD	44.1	32.2	<LOD	33.3	49.2	36.5	<LOD	<LOD	<LOD	<LOD	<LOD	0.11	12.3	<LOD
Green and Brown Painted Ware	AGBZY854	0.93	20.0	32.4	3.74	<LOD	<LOD	<LOD	0.47	<LOD	<LOD	12.5	32.6	13.3	12.5	16.1	<LOD	<LOD	<LOD	<LOD	<LOD	0.03	<LOD	<LOD
Green and Brown Painted Ware	AGBZY852	1.46	22.5	35.0	3.91	99.1	333	230	2.89	156	266	95.3	<LOD	134	163	177	<LOD	<LOD	<LOD	<LOD	256	0.37	34.1	14.4
Green and Brown Painted Ware	AGBZY853	0.47	26.5	68.6	4.07	90.5	339	281	2.62	176	94.1	108	34.4	119	216	182	12.0	21.8	67.1	51.0	536	0.02	9.28	15.2
Green and Brown Painted Ware	AAG61	0.90	20.8	51.0	3.88	99.4	328	339	3.19	193	114	95.1	49.9	114	164	218	67.4	16.5	94.1	54.2	553	0.15	20.3	14.7
Green and Brown Painted Ware	AAG69	0.74	26.8	56.6	4.29	129	397	416	3.82	214	80.													

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

TYOLOGY	SAMPLE	S (%)	K (%)	Ca (%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb (%)	Tb	U
Monochrome Glazed Ware	AGBZY837	0.30	1.59	9.73	0.27	66.1	300	324	2.60	259	103	94.2	<LOD	61.2	124	66.1	<LOD	<LOD	<LOD	<LOD	<LOD	0.45	42.7	9.35
Monochrome Glazed Ware	AGBZY838	0.25	2.02	8.29	0.40	92.8	358	208	1.82	96.9	235	76.8	55.4	50.3	83.8	68.1	12.3	19.7	57.6	17.2	141	0.22	21.1	4.74
Monochrome Glazed Ware	AGBZY840	0.15	1.32	7.97	0.37	92.9	326	498	3.95	218	122	92.8	<LOD	104	262	166	24.4	27.4	115	54.0	540	0.44	32.9	10.0
Monochrome Glazed Ware	AAG19	0.44	1.88	4.13	0.43	82.0	489	546	4.42	231	107	334	58.4	103	168	160	22.7	19.7	55.9	42.8	349	0.12	15.8	9.44
Monochrome Glazed Ware	AAG20	0.41	2.43	4.95	0.46	94.9	446	500	4.03	241	87.3	263	55.2	110	175	167	25.4	24.6	85.2	48.2	496	0.07	15.3	10.4
Monochrome Glazed Ware	AAG21	0.47	1.43	6.02	0.28	90.8	263	391	5.27	280	301	146	65.6	121	333	124	28.0	36.1	118	57.2	612	3.04	230	<LOD
Monochrome Glazed Ware	AAG22	0.20	1.96	9.65	0.32	97.4	402	500	3.77	246	90.0	149	94.9	108	224	135	14.4	17.9	<LOD	20.3	330	0.73	74.7	9.37
Monochrome Glazed Ware	AAG23	0.15	2.19	8.47	0.37	114	433	590	4.30	269	135	113	70.3	122	238	142	25.1	34.4	79.5	63.6	522	0.34	38.2	16.1
Monochrome Glazed Ware	AAG24	0.20	2.80	10.5	0.35	96.6	405	523	3.82	281	67.9	146	48.2	107	209	133	14.6	26.3	76.2	59.4	502	0.21	18.5	13.4
Monochrome Glazed Ware	AAG25	0.22	1.97	9.53	0.32	80.2	339	496	3.66	233	104	115	110	106	197	149	14.3	28.9	50.7	31.7	383	0.57	57.8	12.4
Monochrome Glazed Ware	AAG26	0.24	2.09	9.91	0.36	94.7	424	499	4.03	264	76.0	187	143	114	227	138	18.7	34.7	95.0	53.6	506	0.60	58.9	14.2
Monochrome Glazed Ware	AAG27	0.14	2.21	8.64	0.32	76.0	370	556	3.46	232	85.8	133	50.1	90.9	177	132	<LOD	22.8	59.6	53.9	539	0.04	10.2	8.48
Monochrome Glazed Ware	AAG28	0.37	2.03	8.71	0.37	111	420	589	4.56	312	654	162	197	114	213	147	26.9	57.4	113	72.4	566	1.13	119	8.28
Monochrome Glazed Ware	AAG33	7.23	1.90	1.25	0.13	125	382	398	2.08	282	1320	126	12900	130	336	17.9	138	197	633	327	1800	5.68	317	<LOD
Monochrome Glazed Ware	AAG34	8.94	0.55	1.12	0.09	24.0	42.0	405	1.36	693	227	215	21900	101	136	<LOD	253	378	1210	591	3010	10.5	473	<LOD
Monochrome Glazed Ware	AAG35	0.32	1.26	6.29	0.26	91.9	326	722	5.32	393	945	212	799	135	275	98.0	40.6	41.6	152	62.5	527	2.12	171	<LOD
Monochrome Glazed Ware	AAG36	0.66	1.18	6.86	0.24	71.1	277	623	4.43	428	1510	144	839	112	226	75.6	54.8	55.5	210	124	828	2.40	158	<LOD
Monochrome Glazed Ware	AAG42	0.06	1.65	7.29	0.37	95.4	330	784	4.53	294	67.4	96.6	45.7	78.6	176	132	25.7	42.3	113	66.7	551	0.15	21.2	9.03
Monochrome Glazed Ware	AAG63	0.23	1.80	6.87	0.27	66.1	344	604	4.60	236	150	151	274	122	202	156	<LOD	21.5	<LOD	<LOD	305	0.87	88.1	9.56
Monochrome Glazed Ware	AAG71	2.62	2.29	4.65	0.29	77.3	302	884	4.69	350	145	134	3920	127	156	105	101	105	309	177	971	2.99	246	<LOD
AVERAGE		1.18	1.83	7.04	0.31	87.0	349	532	3.84	292	327	155	2350	106	207	122	49.4	62.7	208	107	710	1.64	111	10.3
STDEV		2.44	0.51	2.70	0.09	21.3	93.8	154	1.09	117	433	62.5	5760	21.7	63.4	40.1	62.3	87.1	294	141	657	2.54	123	2.85
MEDIAN		0.28	1.93	7.63	0.32	92.4	351	512	4.03	267	129	145	127	109	206	133	25.4	34.4	113	58.3	527	0.59	58.4	9.50
PERCENTILE LOWER DECILE		0.14	1.19	1.54	0.14	66.1	264	331	1.85	219	68.7	92.9	48.0	62.9	125	66.1	13.9	19.7	54.9	20.0	305	0.08	15.4	6.51
PERCENTILE UPPER DECILE		3.08	2.30	9.75	0.40	111	434	728	4.75	397	983	220	6619	127	281	161	116	123	439	222	1137	3.30	253	14.0
Pottery waster	AGBZY827	0.13	1.92	9.77	0.36	89.9	242	101	1.65	55.7	41.5	56.0	62.7	37.8	78.6	35.1	<LOD	<LOD	<LOD	<LOD	<LOD	0.08	8.77	<LOD
Pottery waster	AGBZY832	0.10	2.68	7.83	0.39	93.9	234	<LOD	1.38	41.9	20.3	41.3	27.3	33.6	43.2	29.5	<LOD	<LOD	<LOD	<LOD	<LOD	0.02	<LOD	<LOD
Pottery waster	AGBZY859	0.12	2.11	11.8	0.35	91.9	410	508	3.28	295	135	171	65.0	91.2	202	130	28.0	51.9	161	116	710	0.10	21.7	12.8
Pottery waster	AGBZY864	<LOD	2.38	3.48	0.45	109	384	174	2.62	96.8	34.2	69.6	19.9	69.6	74.1	99.9	35.2	64.1	191	84.9	395	0.01	4.09	5.43
Pottery waster	AGBZY867	0.26	0.41	1.14	0.10	<LOD	<LOD	<LOD	0.12	<LOD	<LOD	<LOD	119	1.70	4.06	3.02	<LOD	<LOD	<LOD	<LOD	0.09	0.09	4.99	<LOD
Pottery waster	AGBZY868	0.17	2.24	4.91	0.40	109	284	114	1.82	70.7	19.6	58.1	<LOD	54.3	71.4	73.8	31.9	56.0	164	62.3	297	0.22	24.9	5.83
Pottery waster	AGBZY836	1.77	2.08	5.29	0.34	73.9	391	370	3.34	229	79.6	209	63.9	61.8	165	156	17.7	<LOD	57.3	39.8	389	0.02	8.14	<LOD
AVERAGE		0.43	2.00	6.31	0.34	94.6	324	253	2.03	132	55.0	101	59.6	50.0	91.2	75.3	28.2	57.3	143	75.8	448	0.08	12.1	8.02
STDEV		0.66	0.73	3.70	0.11	13.2	79.9	179	1.15	105	44.9	70.7	35.2	28.8	68.9	56.4	7.59	6.21	58.9	32.5	181	0.07	8.92	4.14
MEDIAN		0.15	2.11	5.29	0.36	92.9	334	174	1.82	83.8	37.9	63.9	63.3	54.3	74.1	73.8	30.0	56.0	163	73.6	392	0.08	8.46	5.83
Incised Sgraffito Ware	AGBZY841	0.88	2.70	9.32	0.38	102	352	431	2.89	193	106	133	271	139	186	188	12.5	21.9	74.5	50.0	528	0.24	22.9	14.1
Incised Sgraffito Ware	AGBZY843	1.84	2.55	3.17	0.36	61.7	281	848	4.56	260	266	205	4120	136	141	123	71.7	110	320	189	1100	2.48	125	<LOD
Incised Sgraffito Ware	AGBZY844	0.10	2.13	8.04	0.29	61.8	280	428	3.30	187	87.7	106	<LOD	112	429	154	16.0	20.8	61.3	49.3	483	0.12	19.2	9.72
Incised Sgraffito Ware	AGBZY846	0.07	2.61	4.05	0.44	113	169	678	3.96	90.8	70.4	94.6	<LOD	120	91.9	197	17.0	30.7	51.1	31.8	597	0.2	31.2	10.2
AVERAGE		0.72	2.50	6.15	0.37	84.6	271	596	3.68	183	133	135	2197	127	212	166	29.3	45.9	127	80.0	678	0.76	49.6	11.3
Fine Sgraffito Ware	AGBZY842	1.48	2.68	3.11	0.45	112	370	421	3.07	218	115	107	1590	141	157	174	25.4	35.4	150	81.1	694	0.86	51.8	12.0
Fine Sgraffito Ware	AAG57	1.50	2.45	2.28	0.40	100	144	596	4.05	93.9	99.2	122	1020	134	74.6	135	<LOD	24.1	57.2	27.3	550	0.39	33.7	11.6
AVERAGE		1.49	2.57	2.70	0.43	106	257	509	3.56	156	107	115	1306	138	116	155	25.4	29.8	104	54.2	622	0.63	42.8	11.8
Slip Painted Ware	AAG58	1.32	2.63	2.14	0.44	95.2	383	456	45.6	207	106	129	1600	135	114	168	36.8	38.9	142	91.4	678	8.11	78.6	11.1
Slip Painted Ware	AAG59	2.22	2.36	3.11	0.43	124	510	731	60.5	287	150	158	1750	156	149	105	38.3	57.8	148	99.4	774			

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

TYOPOLOGY	SAMPLE	S (%)	K (%)	Ca (%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb (%)	Th	U
Monochrome Glazed Ware	MYT172	0.32	2.37	1.45	0.40	105	130	508	3.40	71.9	52.9	99.3	206	147	223	185	20.1	40.7	109	72.2	900	0.60	34.1	13.1
Monochrome Glazed Ware	MYT173	< LOD	2.37	1.21	0.43	95.2	113	627	3.43	76.9	52.4	95.1	< LOD	141	214	191	16.5	16.8	82.5	53.2	757	0.02	18.2	11.5
Monochrome Glazed Ware	MYT174	1.18	1.05	14.1	0.17	52.0	66.1	512	2.46	119	390	86.7	576	100	469	147	51.4	70.0	174	111	1000	1.12	46.9	9.82
Monochrome Glazed Ware	MYT189	0.51	1.17	1.99	0.21	58.2	41.6	454	2.99	142	162	81.7	870	127	231	81.3	52.4	115	239	148	1090	2.73	184	< LOD
Monochrome Glazed Ware	MYT190	0.05	2.24	3.81	0.33	86.4	92.2	334	3.43	78.5	23.0	80.1	< LOD	141	263	126	< LOD	18.4	< LOD	18.0	346	0.05	15.8	14.3
Monochrome Glazed Ware	MYT193	0.22	2.18	9.36	0.30	59.7	32.1	353	2.57	55.4	37.1	104	< LOD	158	236	175	15.9	24.5	76.5	52.4	638	0.11	23.7	17.6
Monochrome Glazed Ware	MYT198	0.22	1.06	30.3	0.15	31.4	39.7	646	2.29	81.0	134	85.7	< LOD	89.5	200	158	31.7	34.0	109	74.7	649	0.31	37.9	12.7
Monochrome Glazed Ware	MYT199	0.13	1.97	4.65	0.39	89.1	203	744	3.82	166	222	86.5	< LOD	99.1	201	173	41.7	29.4	88.5	42.5	474	0.50	< LOD	< LOD
Monochrome Glazed Ware	MYT200	0.06	0.95	2.30	0.19	55.8	109	775	3.46	134	97.5	239	77.7	149	98.0	212	< LOD	< LOD	73.2	41.3	749	0.01	17.2	11.9
Monochrome Glazed Ware	MYT201	0.04	0.34	2.83	0.04	< LOD	< LOD	< LOD	0.18	< LOD	< LOD	< LOD	3.70	18.1	146	80.0	< LOD	< LOD	< LOD	< LOD	< LOD	0.00	< LOD	3.51
Monochrome Glazed Ware	MYT206	0.39	2.60	4.74	0.42	105	269	707	4.29	193	92.2	131	235	116	226	141	16.8	25.9	79.1	54.7	568	0.29	35.0	9.77
Monochrome Glazed Ware	MYT212	< LOD	2.47	1.40	0.42	96.4	138	674	3.16	84.2	29.9	83.5	< LOD	136	221	199	13.3	19.2	69.8	43.7	697	0.01	19.1	14.6
Monochrome Glazed Ware	MYT213	< LOD	3.08	0.76	0.62	152	207	396	4.63	91.7	44.5	117	33.4	166	124	253	21.3	39.7	87.3	62.9	735	0.02	14.6	16.1
Monochrome Glazed Ware	MYT216	0.28	2.10	1.45	0.43	105	143	811	3.81	88.3	103	109	73.5	145	207	203	33.0	42.5	98.5	72.7	848	0.31	46.3	15.9
Monochrome Glazed Ware	MYT224	0.61	1.25	5.96	0.16	49.4	71.4	1070	4.60	569	302	290	1190	162	312	89.3	41.4	78.2	99.3	64.6	557	3.31	192	< LOD
Monochrome Glazed Ware	MYT225	0.54	1.69	2.99	0.30	77.8	107	340	3.81	50.0	116	126	1360	174	75.2	185	37.3	36.9	90.7	45.6	654	0.63	50.2	10.8
Monochrome Glazed Ware	MYT231	0.23	2.07	6.25	0.45	122	188	470	3.66	88.9	43.8	117	< LOD	134	94.5	220	17.0	26.0	76.4	50.5	629	0.16	16.4	< LOD
Monochrome Glazed Ware	MYT232	0.75	1.37	2.66	0.26	63.2	93.7	900	4.61	220	65.4	116	497	134	285	114	48.6	97.2	167	105	762	3.59	104	< LOD
Monochrome Glazed Ware	MYT235	0.07	1.66	1.12	0.32	71.6	95.0	461	3.22	35.0	29.8	93.2	17.6	139	215	203	< LOD	< LOD	< LOD	< LOD	253	0.02	13.1	10.7
Monochrome Glazed Ware	MYT240	0.67	0.84	0.57	0.35	64.3	101	506	4.70	120	2030	153	756	84.1	78.3	203	< LOD	52.2	58.7	28.1	384	2.73	136	< LOD
Monochrome Glazed Ware	MYT220	0.37	0.56	0.26	0.48	94.6	103	121	1.57	90.0	753	91.6	255	78.9	49.6	256	22.9	24.1	70.5	44.0	486	0.85	78.6	7.68
Monochrome Glazed Ware	MYT246	0.23	1.82	1.31	0.29	62.8	92.7	668	3.27	83.0	680	120	163	138	215	164	35.9	44.3	137	84.0	852	0.51	39.9	13.7
AVERAGE		0.36	1.69	4.62	0.32	80.8	116	575	3.30	126	260	119	421	126	199	171	30.4	44.0	105	63.5	668	0.81	56.2	12.1
STDEV		0.29	0.72	6.61	0.13	28.4	59.7	220	1.07	112	454	52.5	441	35.9	93.6	50.1	13.5	27.5	45.3	30.5	211	1.15	55.2	3.50
MEDIAN		0.28	1.76	2.48	0.33	77.8	103	512	3.43	88.9	97.5	104	235	137	215	180	31.7	36.9	88.5	54.0	654	0.31	36.5	12.3
PERCENTILE LOWER DECILE		0.05	0.64	0.63	0.15	49.9	40.1	335	1.79	51.1	29.8	82.1	12.0	80.5	76.1	83.7	15.3	18.4	69.8	29.4	354	0.01	14.7	6.43
PERCENTILE UPPER DECILE		0.75	2.56	12.7	0.47	119	206	882	4.62	215	738	222	1260	165	304	243	51.6	97.2	174	110	983	3.14	179	16.6
Polychrome Sgraffito Ware	MYT164	0.91	1.30	8.26	0.16	42.9	81.9	632	2.14	103	50.6	75.6	1030	75.2	345	136	40.5	35.9	157	104	797	1.34	< LOD	< LOD
Polychrome Sgraffito Ware	MYT192	0.37	1.66	3.58	0.25	67.8	77.5	394	3.12	80.5	77.9	83.5	352	130	251	99.1	23.2	56.0	72.2	51.3	639	1.37	118	12.1
Polychrome Sgraffito Ware	MYT194	0.37	1.04	1.23	0.16	44.6	69.4	487	4.22	66.7	159	106	683	158	168	119	< LOD	25.8	< LOD	< LOD	389	1.68	123	< LOD
Polychrome Sgraffito Ware	MYT175	0.11	2.04	3.85	0.33	93.6	167	617	3.61	136	263	80.3	146	129	256	167	32.8	44.6	102	76.6	784	0.36	37.4	8.26
Polychrome Sgraffito Ware	MYT209	< LOD	2.14	5.36	0.40	111	194	640	3.83	145	64.5	99.7	49.2	93.0	160	157	16.8	30.0	105	63.8	565	0.01	12.8	9.82
Polychrome Sgraffito Ware	MYT217	0.27	1.20	7.85	0.22	54.7	124	853	2.03	84.0	78.4	84.1	113	67.4	275	177	< LOD	< LOD	< LOD	25.8	515	0.11	13.1	12.3
Polychrome Sgraffito Ware	MYT229	0.43	1.22	11.4	0.15	45.3	51.0	276	2.98	70.6	78.6	112	240	161	188	140	27.7	34.9	141	84.1	804	0.80	73.4	10.8
Polychrome Sgraffito Ware	MYT219	0.11	1.73	4.56	0.31	91.5	107	600	3.40	142	37.1	98.5	151	146	266	163	19.5	39.4	120	79.2	785	0.32	33.3	15.0
AVERAGE		0.37	1.54	5.76	0.25	68.9	109	562	3.17	104	101	92.5	346	120	239	145	26.8	37.7	116	69.3	660	0.75	58.7	11.4
STDEV		0.27	0.41	3.23	0.09	26.5	50.0	176	0.77	33.0	74.8	13.3	342	36.8	62.8	26.4	8.84	9.70	30.2	25.2	158	0.64	46.8	2.30
MEDIAN		0.37	1.48	4.96	0.24	61.3	94.5	609	3.26	94.0	78.2	91.3	196	130	254	149	25.5	35.9	113	76.6	712	0.58	37.4	11.5
Polychrome Marbled Ware	MYT165	0.15	1.67	10.6	0.22	41.7	92.8	512	1.59	70.1	85.7	55.3	32.3	64.5	272	164	26.3	32.4	105	65.3	646	0.09	14.4	10.0
Polychrome Marbled Ware	MYT197	0.48	1.85	7.30	0.32	99.3	170	1020	4.82	168	556	114	378	106	234	144	32.5	98.5	167	97.6	806	1.27	112	12.7
Polychrome Marbled Ware	MYT208	0.06	1.86	4.59	0.29	68.7	130	369	2.27	101	40.6	49.1	10.9	98.8	227	163	18.7	29.5	74.4	55.2	570	0.01	7.10	9.84
Polychrome Marbled Ware	MYT211	0.07	1.75	11.8	0.26	68.2	122	599	2.12	112	34.9	65.5	< LOD	77.3	263	182	30.5	39.0	105	79.6	681	0.06	15.5	9.5
AVERAGE		0.19	1.78	8.59	0.27	69.5	129	625	2.70	113	179	71.0	140	86.7	249	163	27.0	49.9	113	74.4	676	0.36	37.3	10.5
Polychrome Painted Ware	MYT166	0.27	1.74	2.83	0.37	90.0	162	789	3.73	121	57.4	148	46.4	116	220	208	19.4	40.9	95.2	57.0	772	0.23	25.9	10.5
Polychrome Painted Ware	MYT215	0.58	0.30	2.15	0.03	< LOD	23.6	161	0.49	82.0	294	34.9	650	55.4	596	< LOD	55.2	85.8	184	103	409	2.04	207	< LOD
Polychrome Painted Ware</																								

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

TYPOLOGY	SAMPLE	S (%)	K (%)	Ca(%)	Ti (%)	V	Cr	Mn	Fe (%)	Ni	Cu	Zn	As	Rb	Sr	Zr	Sn	Sb	Te	Cs	Ba	Pb(%)	Th	U
Iznik Ware	MYT168	0.68	0.45	2.12	0.05	< LOD	< LOD	67.1	0.43	55.5	107	27.3	656	26.0	95.1	8.42	164	389	134	68.6	431	1.77	113	9.18
Iznik Ware	MYT170	0.49	0.35	1.51	0.05	21.2	< LOD	100	0.39	52.6	52.1	25.7	402	28.0	94.9	< LOD	434	158	128	60.7	286	1.75	241	< LOD
Iznik Ware	MYT214	0.47	0.51	1.53	0.07	< LOD	< LOD	< LOD	0.43	< LOD	167	54.7	257	26.0	74.9	< LOD	336	361	120	58.3	277	1.30	211	7.93
AVERAGE		0.55	0.44	1.72	0.06	21.2	< LOD	83.6	0.42	54.1	109	35.9	438	26.7	88.3	8.42	311	303	127	62.5	331	1.61	188	8.56
Kütahya Ware	MYT179	0.22	0.24	2.66	0.02	10.7	198	359	0.35	< LOD	709	30.2	589	29.5	487	< LOD	26.2	47.7	< LOD	< LOD	< LOD	1.72	88.3	< LOD
Kütahya Ware	MYT181	0.17	0.35	1.14	0.04	14.9	< LOD	< LOD	0.40	< LOD	62.7	53.0	324	10.9	55.5	20.3	< LOD	< LOD	< LOD	< LOD	< LOD	1.12	80.2	< LOD
Kütahya Ware	MYT184	0.40	0.39	0.69	0.04	< LOD	19.5	< LOD	0.32	< LOD	163	93.0	187	25.3	47.0	10.6	36.0	91.5	150	67.7	307	1.54	94.8	< LOD
Kütahya Ware	MYT188	0.44	0.78	5.34	0.08	19.3	< LOD	389	1.00	111	1320	170	2220	30.2	69.1	< LOD	78.6	53.5	137	57.4	278	3.99	185	< LOD
Kütahya Ware	MYT169	0.66	0.34	1.32	0.06	18.0	56.5	149	0.56	75.2	59.4	17.7	293	25.6	85.2	< LOD	35.1	108	133	59.4	1210	1.73	146	< LOD
Kütahya Ware	MYT195	0.42	0.37	1.45	0.04	16.8	< LOD	< LOD	0.40	34.8	< LOD	52.9	561	14.9	46.7	< LOD	28.5	< LOD	< LOD	< LOD	< LOD	1.65	99.6	< LOD
Kütahya Ware	MYT218	1.10	1.29	5.25	0.24	83.2	153	1140	4.03	165	69.3	172	726	102	221	140	57.2	61.5	195	121	950	1.69	139	9.77
Kütahya Ware	MYT230	4.51	0.25	2.50	0.03	48.6	< LOD	300	0.84	397	3390	315	21750	< LOD	< LOD	< LOD	577	736	1940	930	3640	25.2	942	< LOD
Kütahya Ware	MYT239	0.16	0.49	0.60	0.03	9.90	< LOD	< LOD	0.27	32.6	40.0	65.3	121	24.4	19.7	9.61	74.3	30.1	100	43.9	212	0.47	32.9	< LOD
Kütahya Ware	MYT241	0.38	0.54	0.74	0.04	14.8	< LOD	146	0.48	176	100	118	2270	41.2	62.6	< LOD	31.9	76.6	148	81.3	380	2.97	286	19.3
Kütahya Ware	MYT242	0.97	0.44	2.28	0.05	28.7	< LOD	195	0.33	< LOD	73.8	97.6	433	13.4	60.8	27.7	25.3	47.7	83.7	31.5	201	1.01	70.9	< LOD
AVERAGE		0.86	0.50	2.18	0.06	26.5	107	382	0.82	142	598	108	2680	31.7	116	41.6	97.0	139	360	174	897	3.92	197	14.5
STDEV		1.35	0.32	1.86	0.07	24.6	68.9	381	1.19	126	1190	88.3	7010	28.6	61.5	62.6	178	238	638	307	1170	7.84	280	6.74
MEDIAN		0.44	0.44	1.45	0.04	18.7	56.5	248	0.48	111	86.9	97.6	561	25.5	61.7	19.2	36.0	69.1	143	63.6	344	1.69	139	14.5
Miletus Ware	MYT167	< LOD	1.95	6.06	0.35	114	153	659	3.39	127	54.4	86.6	47.1	86.8	173	141	13.4	22.3	49.4	45.8	519	0.01	12.7	9.19
Miletus Ware	MYT204	0.05	1.98	4.34	0.34	114	195	744	3.84	148	68.8	99.2	67.6	101	192	152	< LOD	39.2	103	79.0	661	0.04	13.7	8.60
Miletus Ware	MYT226	0.05	2.20	5.12	0.38	124	191	737	3.99	132	63.5	105	54.9	102	210	150	< LOD	19.0	78.7	60.2	613	0.05	12.9	10.8
AVERAGE		0.05	2.04	5.17	0.36	117	180	713	3.74	136	62.2	96.9	56.5	96.6	192	148	13.4	26.8	77.0	61.7	598	0.03	13.1	9.53
Zeuxippus Ware Subtype	MYT196	0.05	2.23	4.99	0.48	133	144	597	4.04	121	43.3	104	< LOD	133	105	200	16.3	29.3	101	70.2	712	0.04	15.1	15.4
Zeuxippus Ware Subtype	MYT233	0.04	1.45	0.93	0.55	149	705	941	4.83	370	35.7	76.9	21.2	69.4	102	183	< LOD	18.9	51.7	36.7	437	0.05	8.90	6.57
Zeuxippus Ware Subtype	MYT238	0.05	2.12	4.76	0.35	79.0	130	707	3.43	115	41.2	170	41.2	139	237	181	25.4	36.3	87.7	57.7	783	0.04	18.4	12.5
AVERAGE		0.05	1.93	3.56	0.46	120	326	748	4.10	202	40.1	117	31.2	114	148	188	20.9	28.2	80.1	54.9	644	0.04	14.1	11.5
Glazed White Ware IV	MYT203	0.17	0.63	4.63	0.07	< LOD	< LOD	149	0.33	< LOD	36.0	24.1	9.64	5.24	76.1	13.4	< LOD	< LOD	< LOD	< LOD	68.0	0.01	< LOD	< LOD
Elaborate Incised Ware	MYT234	< LOD	0.69	0.42	0.82	168	173	391	9.84	84.6	91.3	190	44.4	45.8	54.0	261	27.6	36.0	127	80.2	608	0.04	< LOD	6.05
Monochrome Painted Ware	MYT176	0.24	1.62	3.80	0.28	68.7	94.8	959	3.52	77.3	40.9	111	50.8	146	212	196	28.4	44.0	122	63.9	808	0.22	27.7	14.8
Monochrome Painted Ware	MYT210	0.39	1.31	1.73	0.23	73.0	108	590	3.72	89.8	132	184	771	150	189	127	30.6	47.0	138	77.5	767	1.51	93.7	14.4
AVERAGE		0.32	1.47	2.77	0.26	70.9	101	775	3.6	83.6	86.5	148	411	148	201	162	29.5	45.5	130	70.7	788	0.87	60.7	14.6
Maiolica	MYT227	0.11	1.53	12.64	0.24	67.6	72.3	669	3.03	94.4	49.2	102	< LOD	98.0	462	129	36.1	39.2	117	71.7	556	0.25	32.6	13.6
Maiolica	MYT236	< LOD	1.91	14.34	0.27	68.6	82.5	696	3.03	73.0	80.0	140	27.6	108	481	139	18.7	25.3	107	55.1	582	0.08	15.0	10.9
AVERAGE		0.11	1.72	13.5	0.26	68.1	77.4	683	3.03	83.7	64.6	121	27.6	103	472	134	27.40	32.30	112	63.4	569	0.17	23.8	12.3
Rouletted/Veneto Ware	MYT178	0.36	1.96	0.43	0.41	114	204	207	6.13	300	307	96.7	522	161	123	201	31.9	50.8	115	83.0	816	0.86	52.8	< LOD
Porcelain	MYT180	< LOD	2.10	0.81	0.04	< LOD	< LOD	484	0.52	37.5	< LOD	61.4	6.09	378	60.6	55.9	25.8	28.4	74.7	52.1	249	0.00	7.72	38.6
Porcelain	MYT185	0.15	1.15	1.99	0.01	< LOD	26.1	345	0.42	< LOD	41.9	28.6	35.2	345	67.9	38.9	16.7	20.2	68.5	35.2	153	0.05	10.7	22.7
Porcelain	MYT186	0.04	0.77	0.58	0.03	9.49	37.0	370	0.86	35.4	< LOD	77.9	< LOD	385	40.3	46.4	39.1	42.0	119	70.7	343	0.00	8.82	18.3
Porcelain	MYT221	0.04	0.40	1.12	0.03	10.3	33.1	198	0.21	40.4	54.3	38.8	76.8	7.08	357	37.4	19.0	19.6	61.2	36.9	221	0.04	7.74	6.55
Porcelain	MYT222	0.06	1.00	0.59	0.04	13.3	34.3	435	0.84	54.7	< LOD	65.7	15.8	373	36.7	49.8	24.7	38.6	86.0	64.2	351	0.01	7.01	36.7
Porcelain	MYT223	0.93	0.95	0.81	0.02	< LOD	42.1	< LOD	0.87	49.9	< LOD	38.7	1700	267	61.5	64.3	28.7	42.8	133	81.4	502	0.76	51.8	15.5
Porcelain	MYT183	0.02	1.56	0.82	0.03	10.3	< LOD	385	0.48	31.0	< LOD	63.2	< LOD	398	61.5	48.6	28.0	19.1	73.4	42.4	197	0.01	9.62	18.6
AVERAGE		0.21	1.13	0.96	0.03	10.9	34.5	370	0.60	41.5	48.1	53.5	368	308	97.9	48.8	26.0	30.1	88.0	54.7	288	0.12	14.8	22.4
STDEV		0.36	0.55	0.49	0.01	1.68	5.84	97.6	0.26	9.05	8.77	18.1	748	140	115	9.36	7.30	10.9	27.3	17.9	119	0.28	16.4	11.5
MEDIAN		0.05	1.00	0.81	0.03	10.3	34.3	378	0.52	39.0	48.1	61.4	35.2	373	61.5	48.6								

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

Sample	Pottery types	Na2O (%)	MgO (%)	Al2O3 (%)	SiO2 (%)	P2O5 (%)	K2O (%)	CaO (%)	TiO2 (%)	V (PPM)	Cr (PPM)	Mn (PPM)	Fe2O3 (%)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Zr (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Nd (PPM)	Pb (PPM)	Th (PPM)
AAG29	Polychrome Painted Ware/Maiolica	0.73	4.36	13.98	50.00	0.225	2.73	15.41	0.751	102	469	663	6.33	30	323	121	151	62	169	23	140	383	25	61	33	7056	51
AAG30	Polychrome Painted Ware/Maiolica	0.79	3.86	12.76	53.19	0.158	2.49	14.53	0.694	98	419	635	5.88	23	288	133	150	76	160	21	146	334	29	56	23	4159	30
AAG66	Polychrome Painted Ware/Maiolica	0.55	5.01	16.73	50.98	0.181	3.33	11.82	0.844	137	574	734	7.33	35	433	151	122	119	210	26	130	449	29	67	27	2840	21
AAG67	Polychrome Painted Ware/Maiolica	0.78	4.45	14.94	48.27	0.197	3.12	16.27	0.737	123	485	760	6.41	29	354	96	113	77	214	23	130	412	31	61	33	6560	48
AAG37	Polychrome Sgraffito Ware	1.16	4.74	17.53	50.85	0.129	2.03	14.20	0.854	163	538	638	7.64	31	419	353	128	82	175	24	104	373	34	62	35	9621	69
AAG43	Zeuxippus Ware Subtype	1.43	2.32	18.40	56.56	0.187	3.61	6.34	0.795	115	147	903	6.64	21	98	58	98	129	116	28	158	609	35	68	31	2125	16
AAG47	Zeuxippus Ware Subtype	0.66	2.89	14.77	57.62	0.382	2.75	8.72	0.795	108	293	1184	6.66	29	258	85	105	102	128	27	184	416	34	78	31	782	10
AAG48	Zeuxippus Ware Subtype	0.65	2.80	14.46	57.02	0.364	2.69	9.40	0.780	102	280	1195	6.44	27	250	82	99	98	135	26	180	431	31	62	30	802	12
AAG69	Green and Brown Painted Ware	0.85	3.66	16.80	58.17	0.286	3.56	7.71	0.840	129	400	480	6.40	31	284	90	123	134	207	33	180	438	37	78	35	548	12
BYZ853	Green and Brown Painted Ware	0.95	3.60	15.68	60.06	0.233	3.41	7.23	0.826	107	378	382	5.70	26	243	106	117	125	219	28	191	468	37	71	30	472	11
AAG60	Polychrome Sgraffito Ware	0.49	4.73	17.44	53.63	0.161	3.17	10.47	0.878	153	582	592	7.86	36	426	75	149	131	190	26	138	444	27	64	27	2358	18
BYZ842	Fine Sgraffito Ware	0.86	3.33	16.30	59.19	0.232	3.50	6.80	0.835	121	392	326	5.53	25	255	78	103	127	152	31	179	430	36	72	38	1052	13
BYZ841	Incised Sgraffito Ware	0.85	3.49	16.20	56.05	0.226	3.45	7.87	0.827	126	399	582	5.81	27	277	88	109	125	185	29	175	487	39	74	34	2961	22
BYZ846	Incised Sgraffito Ware	1.74	2.22	17.98	60.63	0.225	3.31	5.15	0.822	106	159	869	6.50	24	100	73	96	105	92	33	201	598	37	74	35	1424	16
AAG44	Painted Ware	1.45	2.38	18.92	56.60	0.224	3.66	6.09	0.803	122	152	851	6.79	19	102	69	92	136	127	32	155	634	39	71	31	425	13
BYZ836	Pottery waster	1.63	4.47	16.20	56.10	0.130	2.09	10.48	0.830	139	494	509	7.54	35	357	64	124	110	221	27	156	403	30	68	32	261	10
AAG68	Spanish Lustre Ware	0.54	4.44	16.36	50.36	0.173	3.24	12.72	0.821	126	533	687	6.57	37	395	62	205	131	235	25	131	447	26	50	27	461	10
AAG70	Maiolica	1.29	3.36	14.56	49.86	0.237	2.53	17.22	0.665	113	131	812	5.97	20	74	118	115	96	488	25	135	356	30	56	36	2380	18

Table 25 WDXRF analysis of pottery fabrics from the Athenian Agora in Attica. Major, minor elements (%) and trace elements were given in ppm.

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

Sample	Pottery types	Na2O (%)	MgO (%)	Al2O3 (%)	SiO2 (%)	P2O5 (%)	K2O (%)	CaO (%)	TiO2 (%)	V (PPM)	Cr (PPM)	Mn (PPM)	Fe2O3 (%)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Zr (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Nd (PPM)	Pb (PPM)	Th (PPM)
CH084	Champlevé Ware	1.62	2.46	19.96	58.34	0.161	3.67	4.98	0.853	137	173	931	7.26	21	103	73	104	91	15	31	155	597	39	79	39	9770	70
CH124	Champlevé Ware	1.68	2.40	19.29	60.50	0.171	3.57	4.77	0.853	130	157	916	7.06	21	103	119	102	128	83	33	186	615	40	77	37	2205	16
CH092	Champlevé Ware	1.51	2.63	19.83	56.56	1.170	3.71	5.76	0.811	130	163	964	7.32	21	104	132	155	134	132	30	145	655	35	76	36	1748	16
CH155	A&A amphora	1.43	2.58	20.95	56.89	0.166	3.93	4.75	0.865	136	176	982	7.76	24	128	53	115	151	99	31	153	647	41	70	38	35	14
CH160	Günseşin 3 Amphora	1.83	2.59	20.21	58.46	0.143	3.71	5.46	0.862	121	164	922	7.34	22	107	54	108	139	102	31	168	626	35	71	32	32	13
CH162	Günseşin 2 Amphora	1.26	2.64	21.69	55.52	0.248	3.97	5.46	0.864	138	176	1004	8.13	26	129	47	119	154	103	30	143	667	36	75	31	39	13
CH089	Splashed Ware	1.73	2.35	18.46	59.29	0.176	3.54	4.60	0.820	118	150	854	6.67	21	96	63	101	124	100	31	179	581	38	75	37	224	12
CH094	Slip-Painted Ware	1.45	2.61	20.64	58.07	0.200	3.85	4.29	0.854	131	177	1001	7.75	23	119	120	111	131	70	31	148	629	39	71	38	2769	20
CH121	Slip-Painted Ware	1.54	2.57	19.66	58.71	0.158	3.60	5.71	0.865	121	156	958	7.41	20	108	98	110	115	66	33	160	611	38	79	37	5755	42
CH095	Green and Brown Painted Ware	1.85	2.57	19.43	57.92	0.157	3.52	5.52	0.841	132	165	926	7.06	23	105	79	93	124	88	32	173	606	40	69	34	2228	17
CH136	Brown Painted Ware	1.47	2.63	20.70	56.98	0.148	3.82	5.53	0.861	136	158	1000	7.71	22	113	72	110	144	91	32	156	649	34	70	37	1808	16
CH113	Incised Sgraffito Ware	1.44	2.52	20.64	57.61	0.309	3.79	4.76	0.859	126	161	965	7.54	23	111	129	117	130	92	32	153	643	44	77	38	2832	21
CH114	Incised Sgraffito Ware	1.45	2.75	20.87	56.81	0.330	3.84	5.19	0.838	141	161	1025	7.68	24	107	78	121	143	93	31	145	667	35	71	39	2596	19
CH133	Incised Sgraffito Ware	1.86	2.37	17.90	61.72	0.157	3.24	5.66	0.837	121	156	875	6.44	21	101	96	93	126	103	34	224	566	37	75	42	374	13
CH098	Painted Fine Sgraffito Ware	1.70	2.58	19.55	58.77	0.261	3.56	5.04	0.846	116	166	928	7.04	23	109	341	103	135	119	33	171	671	41	84	34	319	12
CH127	Fine Sgraffito Ware	1.64	3.27	14.12	67.52	0.083	1.77	1.76	1.009	118	892	1256	8.67	53	601	59	91	77	129	33	210	321	35	79	32	151	11
CH104	Painted Ware	1.06	3.71	15.56	51.27	0.242	3.10	11.97	0.691	109	289	999	6.11	25	194	61	101	109	164	27	171	505	34	69	34	2537	19
CH102	Polychrome Marbled Ware	0.88	2.98	17.85	58.15	0.202	2.95	7.76	0.849	111	152	1093	7.49	24	103	99	123	130	222	27	139	431	36	74	34	700	11
CH103	Polychrome Marbled Ware	0.91	3.16	18.86	58.77	0.196	2.88	6.41	0.882	124	176	1102	7.81	23	121	284	128	130	216	31	148	491	41	75	36	203	16
CH099	Zeuxippus Ware	1.32	3.37	14.41	59.87	0.241	2.44	8.37	0.796	111	227	980	6.65	23	156	70	92	99	266	26	165	358	27	66	24	183	8
CH101	Zeuxippus Ware	1.36	3.83	14.68	60.05	0.241	2.39	8.42	0.814	120	233	1135	6.69	23	156	55	95	81	222	26	163	403	23	62	27	4235	31
CH106	Glazed Frit Ware	1.83	0.83	6.41	88.57	0.218	1.15	1.27	0.230	39	16	101	0.38	5	5	69	8	25	478	10	72	555	16	33	21	698	12
CH107	Glazed White Ware II	0.58	0.76	23.28	69.05	0.160	1.65	0.52	0.670	103	163	83	3.57	10	51	103	58	51	51	17	189	333	32	48	20	966	12
CH100	Diáymoteicho Ware	1.68	3.20	14.00	63.35	0.159	2.66	6.59	0.719	97	258	776	6.40	21	146	85	81	90	197	24	175	430	25	52	26	875	9
CH135	Diáymoteicho Ware	1.42	2.75	20.19	58.80	0.197	3.68	3.95	0.860	132	202	1002	7.52	23	124	64	118	127	77	32	166	625	41	78	36	2516	19
CH082	Roulette/Veneto Ware	1.44	2.53	21.35	57.99	0.165	4.01	3.63	0.872	137	170	979	7.87	25	112	46	114	147	81	30	152	672	39	78	33	1939	16
CH085	Roulette/Veneto Ware	1.57	2.54	19.27	57.66	0.174	3.64	5.60	0.815	120	151	954	7.00	23	101	157	102	132	98	30	150	617	34	67	32	1874	15
CH154	Maiolica	0.76	3.29	12.63	44.48	0.356	1.59	23.03	0.587	82	109	1167	5.09	19	70	88	99	53	620	24	113	328	26	55	28	3336	24

Table 26 WDXRF analysis of pottery fabrics from Chalcis in Euboea. Major, minor elements (%) and trace elements were given in ppm.

Cluster Dendrogram for Solution HClust.18

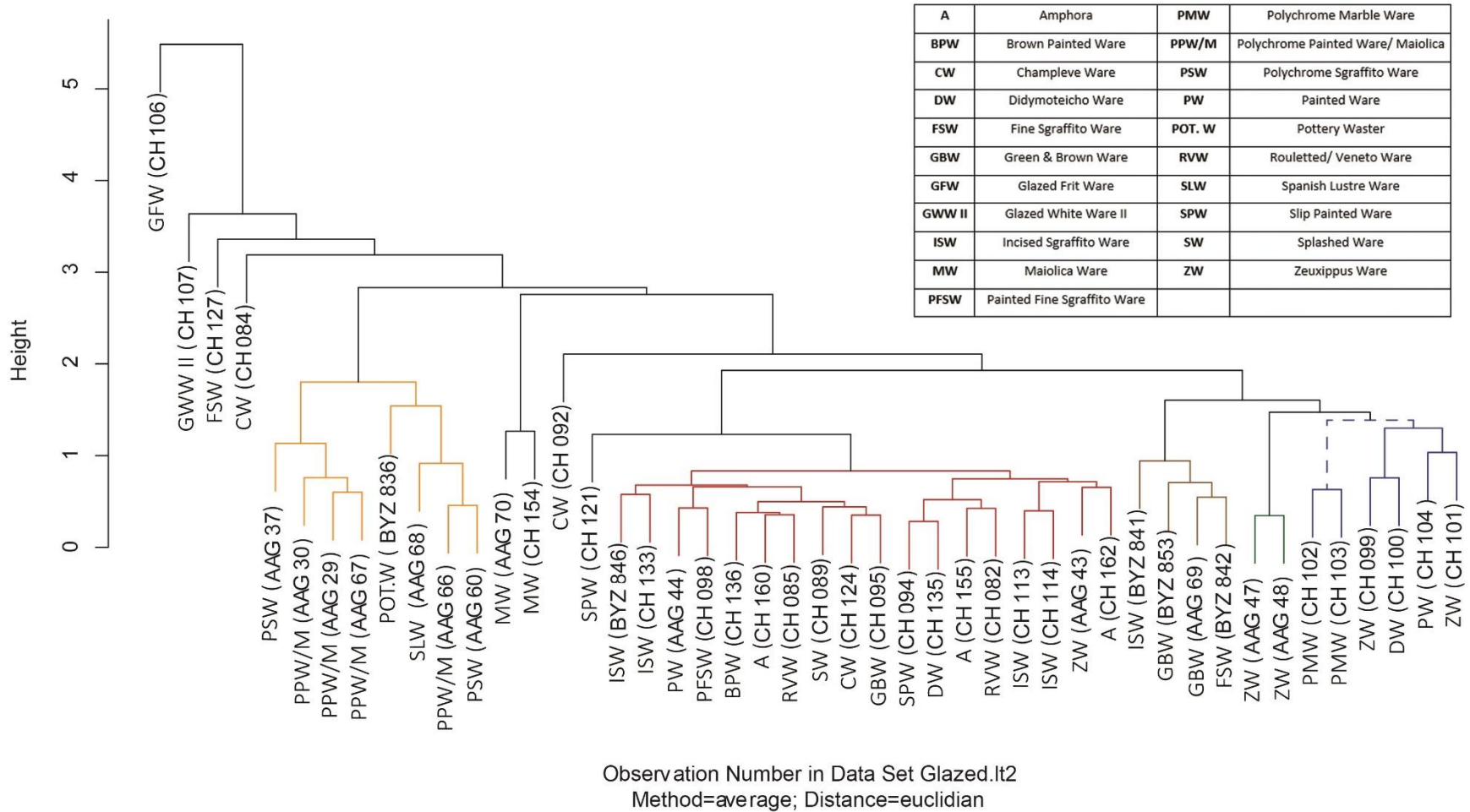


Figure 108 WD-XRF Hierarchical Clustering of the samples from Chalcis in Euboea and the Athenian Agora in Attica: For normalization the element concentrations were log-ratio transformed with the Fe concentrations as common divisor.

CHAPTER 7: X-RAY FLUORESCENCE SPECTROSCOPY

Sample	Pottery types	Na2O (%)	MgO (%)	Al2O3 (%)	SiO2 (%)	P2O5 (%)	K2O (%)	CaO (%)	TiO2 (%)	V (PPM)	Cr (PPM)	Mn (PPM)	Fe2O3 (%)	Co (PPM)	Ni (PPM)	Cu (PPM)	Zn (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Zr (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Nd (PPM)	Pb (PPM)	Th (PPM)
MYT176	Monochrome Painted Ware	2.79	2.88	18.30	63.21	0.179	3.28	2.45	0.816	110	121	1158	6.41	18	72	49	102	139	217	30	208	700	38	80	34	1944	21
MYT208	Polychrome Marbled Ware	1.72	2.09	12.67	64.85	0.456	2.82	7.76	0.634	72	193	554	4.14	15	101	51	58	105	265	19	170	487	26	44	25	363	9
MYT211	Polychrome Marbled Ware	1.66	0.78	1.63	86.41	0.221	0.45	1.79	0.079	19	46	95	0.63	3	5	112	12	16	14	44	11	69	3	3	10	14718	106
MYT194	Polychrome Sgraffito Ware	1.65	2.65	18.87	61.94	0.117	3.49	3.80	0.690	109	121	389	6.74	17	82	72	96	153	167	27	144	646	38	70	34	4107	30
MYT209	Polychrome Sgraffito Ware	1.56	2.27	12.43	57.53	0.917	2.52	15.83	0.644	80	193	814	4.49	17	107	42	79	88	324	23	172	456	27	57	24	208	12
MYT217	Polychrome Sgraffito Ware	1.71	3.51	13.88	58.83	0.270	2.52	8.61	0.713	119	245	878	6.28	22	153	58	81	40	142	20	144	524	26	59	26	10486	76
MYT228	Polychrome Painted Ware	1.64	1.52	6.37	79.50	0.232	1.13	6.07	0.322	35	88	781	2.28	9	47	104	31	17	106	21	75	312	16	31	14	8114	59
MYT187	Painted Ware	1.17	3.28	14.31	52.86	0.734	1.82	13.82	1.408	162	149	900	8.45	24	63	57	110	53	731	31	279	668	40	68	38	54	6
MYT191	Painted Ware	0.89	3.19	15.12	63.08	0.282	2.70	7.08	0.804	122	202	839	6.73	26	149	79	103	105	182	26	165	368	39	63	30	193	13
MYT243	Tripod stilt	1.22	1.99	17.81	66.01	0.131	3.60	0.39	0.989	129	339	264	8.09	30	257	32	100	144	162	33	243	452	45	101	41	1097	17
MYT244	Tripod stilt	1.05	1.94	17.33	58.07	0.336	3.10	7.37	0.809	111	197	672	6.07	16	78	44	98	136	193	30	203	773	44	90	42	329	15
MYT245	Pottery waster	0.68	2.12	22.29	55.13	0.262	4.57	4.11	1.036	140	198	374	6.56	18	90	43	107	206	129	34	250	890	43	76	38	529	17
MYT196	Zeuxippus Ware Subtype	0.76	1.96	19.04	61.29	0.184	3.20	3.13	0.947	137	160	832	7.37	23	113	66	113	132	109	31	201	528	38	87	38	967	14
MYT233	Zeuxippus Ware Subtype	1.59	3.15	14.65	67.13	0.087	1.93	1.75	1.037	126	822	1352	8.80	54	610	52	96	87	123	32	211	358	34	77	38	906	13
MYT178	Roulette/Veneto Ware	0.87	2.46	20.70	60.49	0.113	3.98	0.51	0.996	135	254	208	9.52	31	419	43	100	166	125	32	206	567	46	89	40	720	19
MYT182	Glazed Frit Ware	1.30	6.49	16.45	51.12	0.198	2.55	14.14	0.617	109	88	519	5.15	17	48	1221	93	30	84	28	134	555	34	76	38	9389	68
MYT227	Maioica	1.03	3.07	12.51	45.11	3.062	2.19	21.22	0.568	88	117	803	5.21	13	63	145	135	92	545	24	118	334	27	62	25	1822	14
MYT236	Maioica	1.00	3.86	12.52	44.34	2.405	2.26	20.71	0.568	84	116	821	5.19	14	65	75	111	88	517	24	115	388	33	58	22	1672	13
MYT177	Monochrome and One Colour Sgraffito Ware	0.87	2.77	19.29	61.38	0.512	3.64	0.68	0.959	133	368	348	9.63	35	480	34	112	153	141	33	200	571	43	81	41	485	17
MYT234	Elaborate Incised Ware	0.47	3.25	22.94	56.81	0.113	1.01	0.66	1.882	209	169	310	12.75	20	76	107	211	50	62	39	261	230	48	105	56	258	8
MYT203	Glazed White Ware IV	0.26	0.39	0.52	95.23	0.055	0.11	2.57	0.027	0	16	119	0.26	6	5	28	7	17	75	6	18	44	3	0	7	110	2
MYT167	Miletus Ware	0.95	2.84	12.97	61.19	0.287	2.36	8.45	0.696	109	170	864	5.64	25	129	65	88	87	188	24	142	374	25	47	27	233	10
MYT226	Miletus Ware	0.89	3.56	14.90	59.09	0.236	2.80	7.42	0.762	138	200	882	6.65	26	148	74	112	109	235	25	152	470	27	53	31	472	12
MYT204	Miletus Ware	0.84	3.43	15.74	59.43	0.281	2.97	6.87	0.798	143	211	843	7.09	28	161	73	111	112	225	26	157	340	31	61	29	179	10
MYT168	Iznik Ware	1.64	0.90	1.71	89.07	0.111	0.46	3.23	0.077	18	31	93	0.68	4	6	127	10	17	15	44	11	81	3	10	10	14712	106
MYT170	Iznik Ware	1.55	0.71	1.73	91.47	0.169	0.54	1.99	0.094	19	62	108	0.69	9	9	50	15	17	15	37	23	92	8	6	17	11914	86
MYT214	Iznik Ware	1.67	2.90	12.77	58.67	0.247	2.27	14.58	0.686	77	206	811	4.43	18	106	142	67	63	301	22	188	574	33	61	26	2036	15
MYT179	Kütahya Ware	0.96	2.55	1.11	92.03	0.160	0.35	3.76	0.040	14	80	154	0.52	6	37	14	13	29	443	15	23	74	13	1	13	2565	20
MYT184	Kütahya Ware	1.27	0.45	1.77	94.23	0.095	0.71	0.85	0.088	9	45	218	0.55	8	12	114	31	17	15	42	17	73	9	5	16	14126	102
MYT218	Kütahya Ware	1.47	2.69	20.89	54.54	0.188	4.01	5.35	0.833	131	178	948	7.81	21	120	223	101	147	97	29	135	640	37	80	31	1485	14

Table 27 WDXRF analysis of pottery fabrics (ppm) from the Castle of Mytilene in Lesvos.

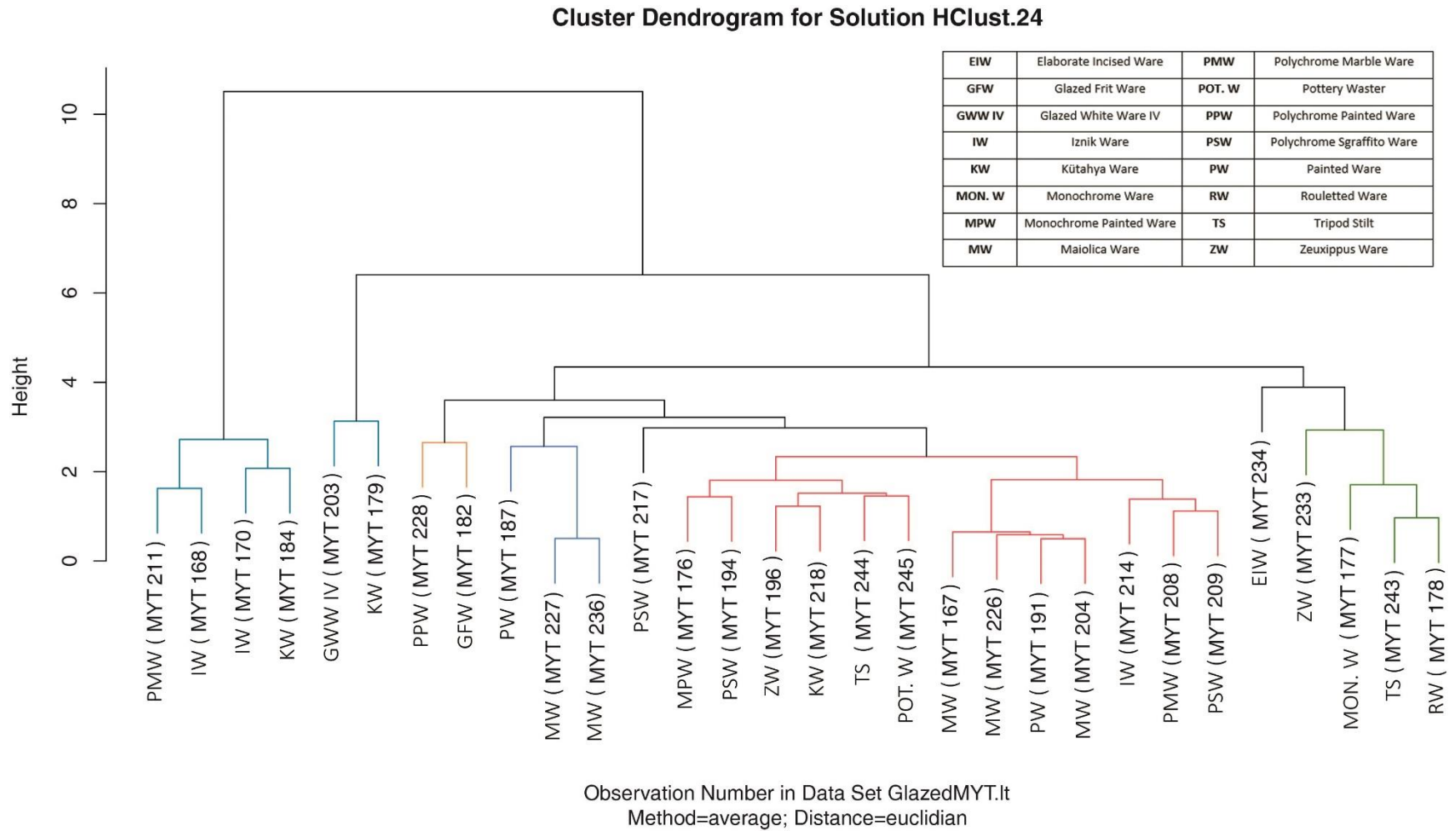


Figure 109 WD-XRF Hierarchical Clustering of the samples from Mytilene in Lesvos: For normalization the element concentrations were log-ratio transformed with the Fe concentrations as common divisor.