Pottery Production, Landscape and Economy of Roman Dalmatia

Interdisciplinary approaches

edited by

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Cover illustrations: Mahućina Bay, Lopar – Rab island (photo: G. Skelac) (front); Crikvenica pottery (courtesy of Crikvenica City Museum) (back)

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Contents

Mineralogical analyses of Roman pottery from Dalmatian workshops and potential clays sources

Anita Grizelj

Abstract

In this contribution preliminary mineralogical analysis on selected pottery, clay and fired clay samples from eastern Adriatic Roman pottery workshops and possible raw material sources will be presented. Results shed light on their mineralogical composition, as well as possible firing temperatures of ancient pottery.

Keywords: X-ray diffraction, clay, Roman pottery, Roman Dalmatia

Introduction[1]

Within the project 'RED – Roman Economy in Dalmatia: production, distribution and demand in the light of pottery workshops' (IP-11-2013-3973) pottery sherds and clayey material from four locations (Crikvenica, Plemići bay near Ražanac, Podšilo and Mahućina bays on Rab Island) were analysed. They are relative to local production and supposed raw materials samples. The pottery and ceramics samples were selected on the bases of typology, so to represent the typical material of each workshop (Figure 1). Only in the case of Crikvenica the sampling strategy included a wider array of types and classes. The raw material samples were selected after reconnaissance, during which possible sources of clayey materials were sampled. Again, only in the case of Crikvenica several locations were taken into consideration for raw material sampling (Slani potok, Igralište site, Guljanov dolac), while for the purpose of this study a sample from the Slani potok outcrop was selected. Along with locally sampled pottery samples, in the case of Crikvenica a set of samples derived from distribution (Aquileia) were analysed as well, two of which are with a great degree of certainty to be regarded as products of this workshop (see Gaddi and Maggi 2017 and Maggi in this volume).

The main aim of the analysis was to determine the mineralogical composition of pottery samples and potential raw materials, as well as to determine whether the sampled clayey materials are suitable for pottery production and what might have been the firing temperatures.

Methods

Mineralogical analysis of clayey materials included X-ray powder diffraction (XRPD) analyses on pottery samples and clayey materials as potential raw materials. Clayey materials analysed on random mounts of bulk samples and oriented mounts of the <2 μm fraction. Oriented mounts of the <2 μm fraction were record after the following treatments: a) air drying, b) saturation with K^+ and Mg^{2+}, c) ethylene-glycol solvation, d) heating to 400°C and 550°C. Pottery sample analysed on random mounts of bulk samples. Philips vertical goniometer (type X`Pert) equipped with Cu tube was used with the following experimental conditions: 45 kV, 40 mA, PW 3018/00 PIXcel detector, primary beam divergence 1/4°, continuous scan (step 0.02 °2θ/s). Determination of the temperature of pottery firing included drying modelled clayey materials at room temperature for 4 days and firing at temperatures ranging from 700 to 850°C. The X-ray interpretation was performed using High Score Plus (2016) calculations and PDF-4 / Minerali 4.5 (2016) databases.

Results and conclusions

Results of the analysis are shown in Tables 1-3 and Figures 2-4.

The mineralogical analyses of all clayey materials show that the main mineral components are quartz, swelling clays (smectite/I-S or rarely vermiculite) and illite/muscovite. Calcite is present in samples from Crikvenica and Plemići. Among the swelling clays smectite is dominant in samples from Crikvenica, Plemići and Podšilo, while vermiculite is dominant in samples from Mahućina. Feldspar and kaolinite are present in a lesser quantity in all samples (Table 1, Figure 2). Quartz is the main mineral which is regularly present in all pottery samples. Pottery samples along with quartz contain also some of these minerals: illite/muscovite, calcite, feldspar, hematite and clinopyroxene.

Results of mineralogical analyses point out that in some cases the clays collected from sources identified in the sites' environs could be utilised in pottery production.

[1] This contribution aims at presenting only some of the results obtained by mineralogical analysis, while the complete analytical results will be presented on another occasion, as some data are still being processed.

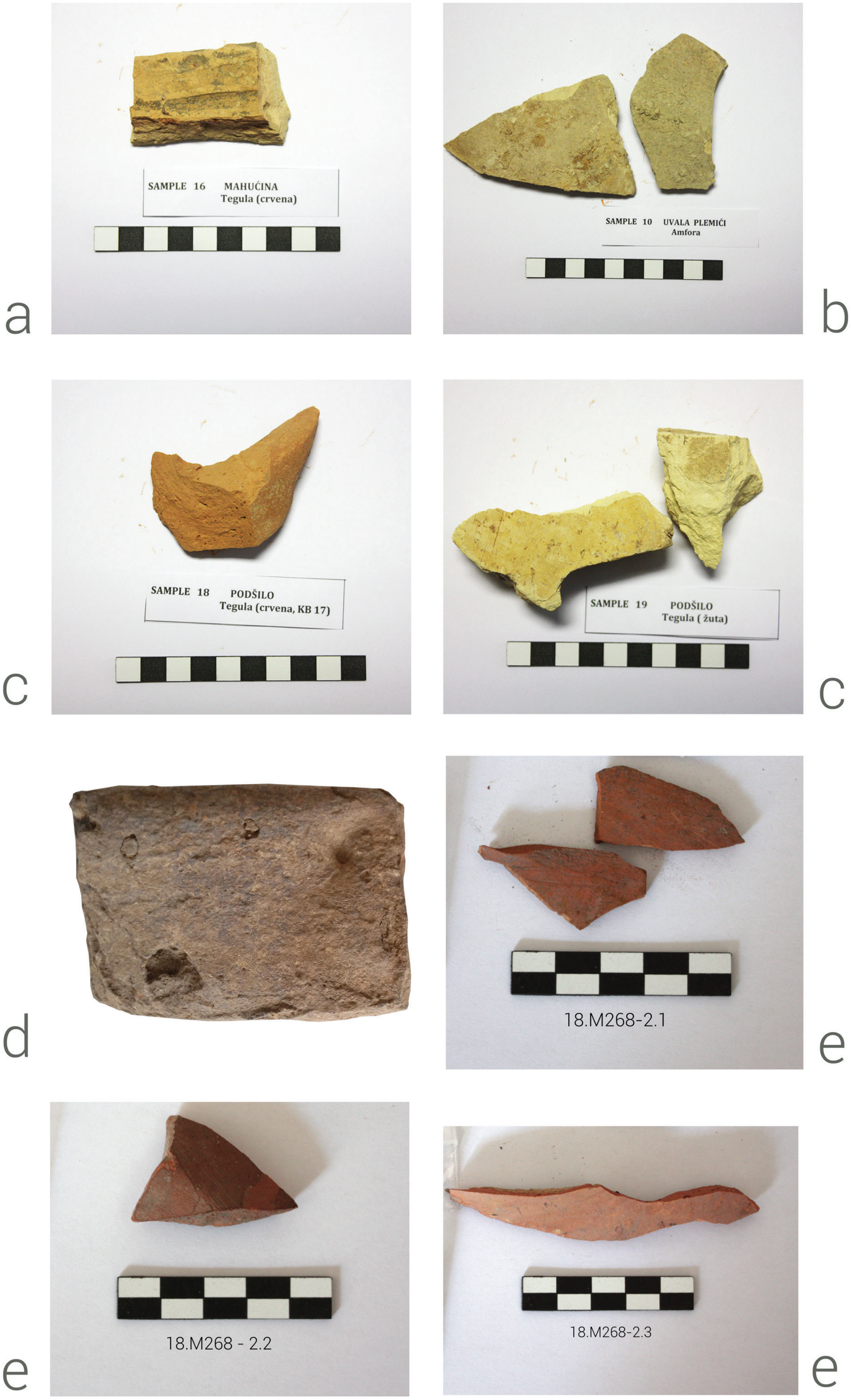


Figure 1. Selected samples (a. Mahućina tegula, N-17, sherd; b. Plemići amphora, PL-1, sherd; c. Podšilo 1 tegula, Podšilo 2 tegula, sherds; d. Crikvenica *spica* – overfired, U-396; e. Aquileia amphora 2.1, Aquileia amphora 2.2, Aquileia amphora 2.3, sherds) (photos: B. Šiljeg, G. Lipovac Vrkljan).

Sample	Bulk							Clay minerals				
	Qtz	Ill/Ms	Cal	Dol	KFs	Pl	clays	S/ I-S	Ver	Ill/Ms	Kln	Chl
Mahućina	XXX	+				X	X	X	XX	+	XX	
Podšilo	XXX	X	XX			X	X	XXX	X	+	X	
Plemići	XX	X	XXX	?	?	+	X	XXX	X	+	X	
Crikvenica	X	X	X	?		+	X	XXX	X	+	X	

XXX – dominant, XX – abundant, X – subordinate, + – traces (<1%), ? – probably present, Qtz – Quartz, Ill/Ms – Illite/Muscovite, Cal – Calcite, Dol – Dolomite, KFs – K-feldspar, Pl – plagioclase, S/I-S – Smectite/Illite-Smectite, Ver – Vermiculite, Kln – Kaolinite, Chl – chlorite.

Table 1. Semiquantitative content of bulk samples and clay minerals in the <2 μm fraction obtained by XRD (author: A. Grizelj).

Sample	Qtz	Ill/Ms	Pl	Hem	CaO	Gel	$Ca\text{-}SiO_4$
Mahućina -850	XXX	+	+				
Podšilo -850	XXX	+	XX				
Plemići -700	XX	+	+		XX		
Plemići -800	XXX	+	+		XX		
Plemići -850	XX	+	+	?	X	X	+
Crikvenica -700	XX	XX	X		+		
Crikvenica -800	XX	XX	X		+		
Crikvenica -850	XXX	X	XX				

XXX – dominant, XX – abundant, X – subordinate, + – traces (<1%), ? – probably present, Qtz – quartz, Ill/Ms – Illite/Muscovite, Pl – Plagioclase, Hem – Hematite, CaO – Lime, Gel – Gehlenite.

Table 2. Semiquantitative content of clayey material samples after firing at 700-850°C obtained by XRD (author: A. Grizelj).

	Sample	Qtz	Ill/Ms	Cal	KFs	Pl	Hem	cpx	Cor
Podšilo1 tegulae	Pod-1	X		X		+	+	XX	?
Podšilo 2 tegulae	Pod-2	XX	XX		+	XX		X	?
Plemići amphora	PL-1	XX	XX	XX	+	+	+		
Mahućina tegulae	N-17	XX		X		+		XX	
Crikvenica spicae (overfired)	U-396	XX				XXX		X	?
Crikvenica KTS 1 fabric CRI2 (5218)	5218	X			X	XX	X		
Aquileia – 268-2.1	AQ-268-2.1	XXX	+			XX			
Aquileia – 268-2.2	AQ-268-2.2	XXX	+			XX			
Aquileia – 268-2.3	AQ-268-2.3	XX			X	XX		X	

XXX – dominant, XX – abundant, X – subordinate, + – traces (<1%), ? – probably present, Qtz – quartz, Ill/Ms – Illite/Muscovite, Cal – Calcite, KFs – K-feldspar, Pl – Plagioclase, Hem – Hematite, cpx – clinopyroxene, Cor- cordierite.

Table 3. Semiquantitative content of pottery samples obtained by XRD (author: A. Grizelj).

The mineralogical composition of clayey material and clayey material after firing suggests that the possible firing temperatures were 800-850°C. These conclusions are based on presence of minerals such as illite in almost all pottery sherd samples and in some cases presence of calcite. According to Maritan *et al.* (2006) and Maggetti *et al.* (2011) illite and calcite are stable in firing clayey material onto temperature of 825-850°C. The formation of lime during the firing of calcareous clayey raw material suggests that raw material for fine pottery were probably purified.

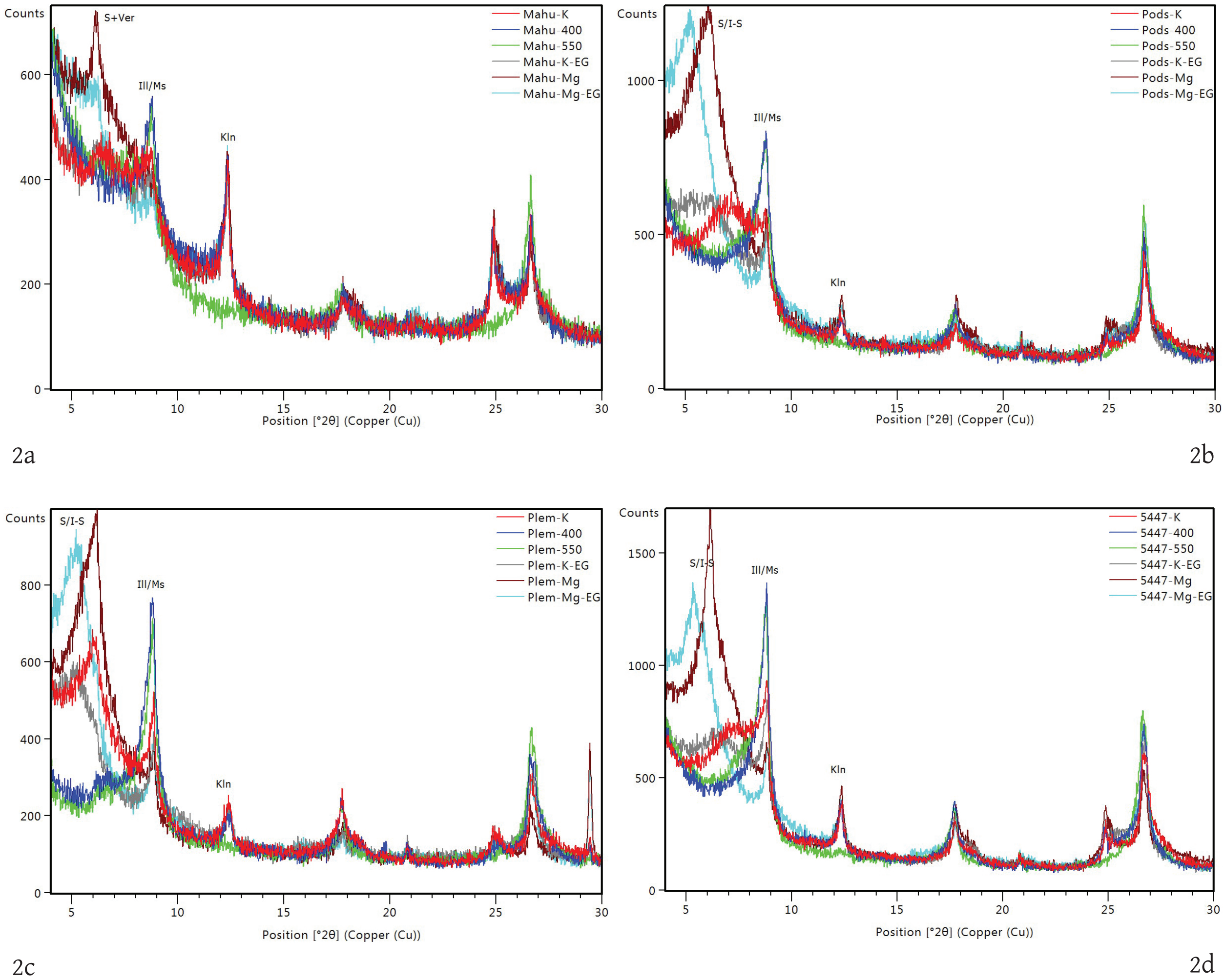


Figure 2. X-ray powder diffraction patterns of Clayey material samples, fraction < 2 µm recorded after the following treatments: red and brown: saturation with K+ and Mg2+, grey and light blue: ethylene-glycol solvation, blue and green: heating to 400°C and 550°C. a. Mahućina, b. Podšilo, c. Plemići, d. Crikvenica.

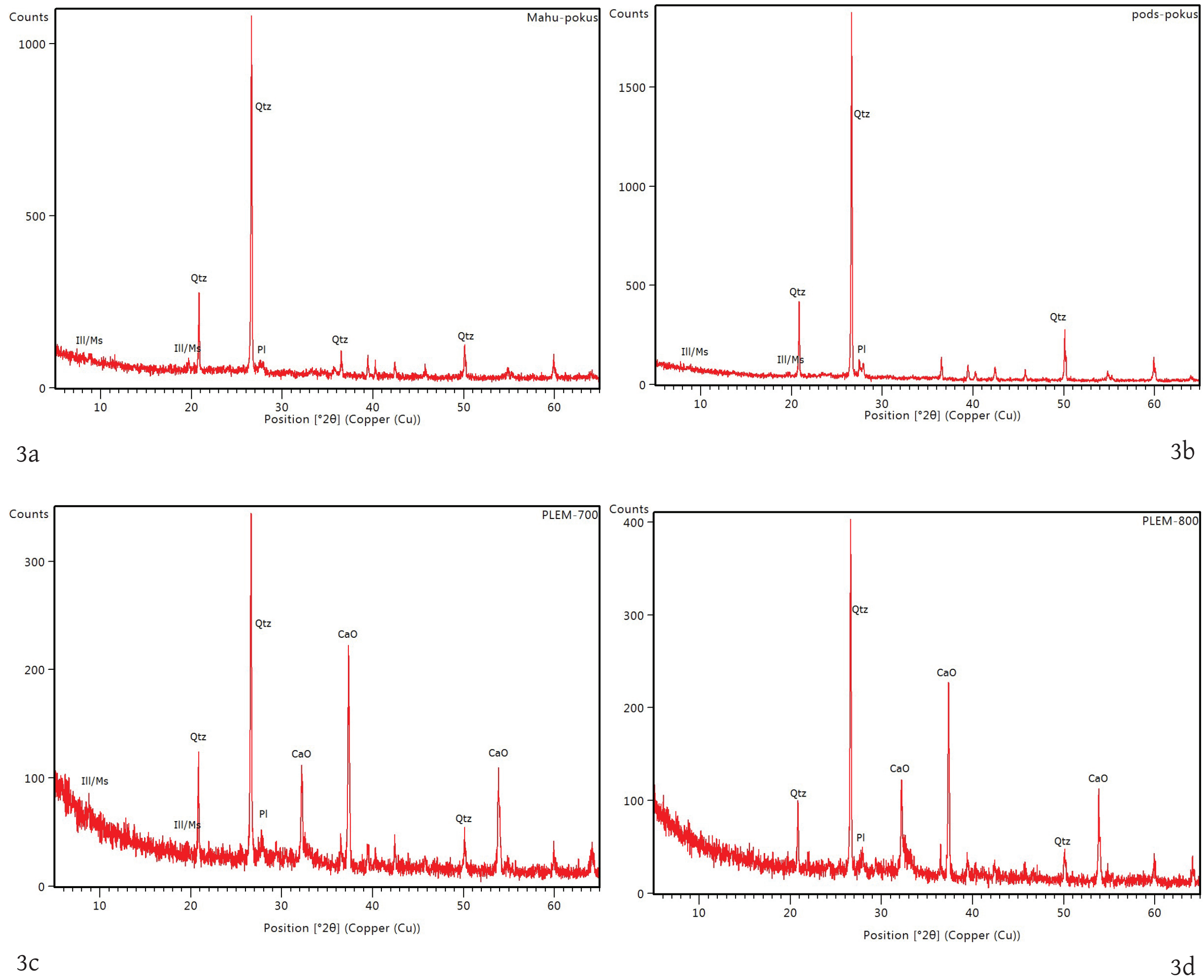
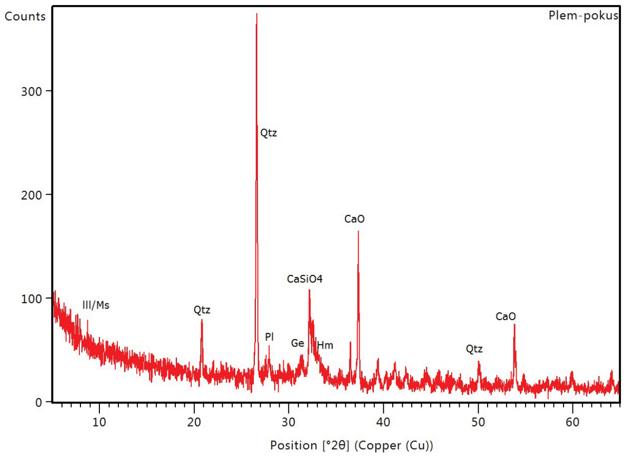


Figure 3. X-ray powder diffraction patterns of clayey material samples after firing a. Mahućina 850°C, b. Podšilo 850°C, c. Plemići 700°C, d. Plemići 800°C, e. Plemići 850°C, f. Crikvenica 700°C, g. Crikvenica 800°C, h. Crikvenica 850°C.



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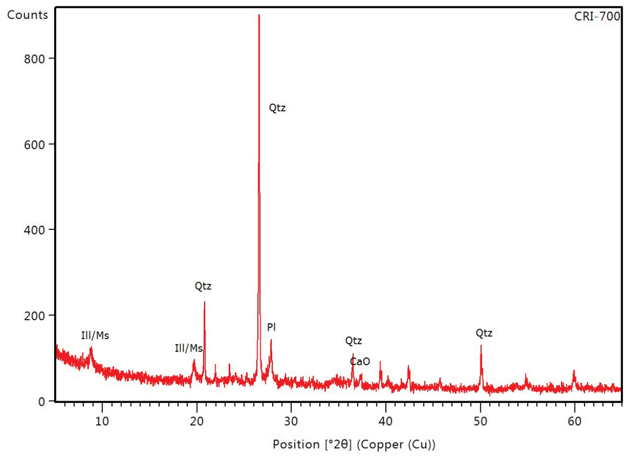

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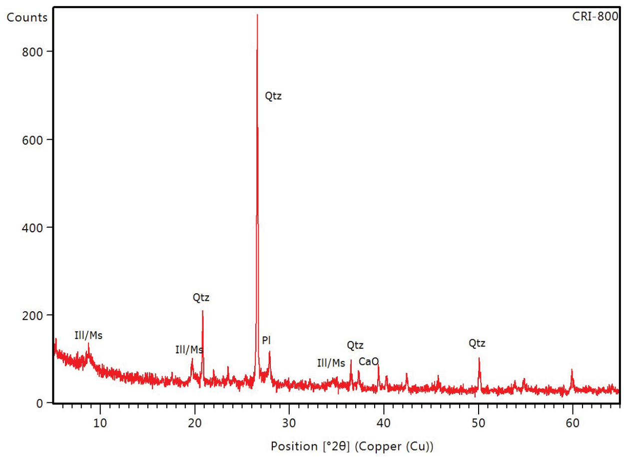

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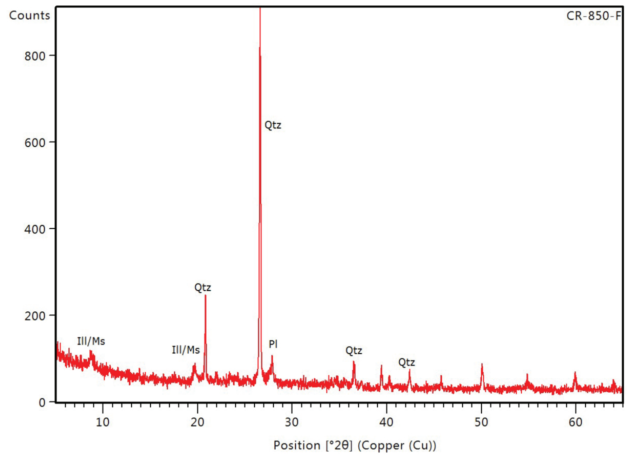

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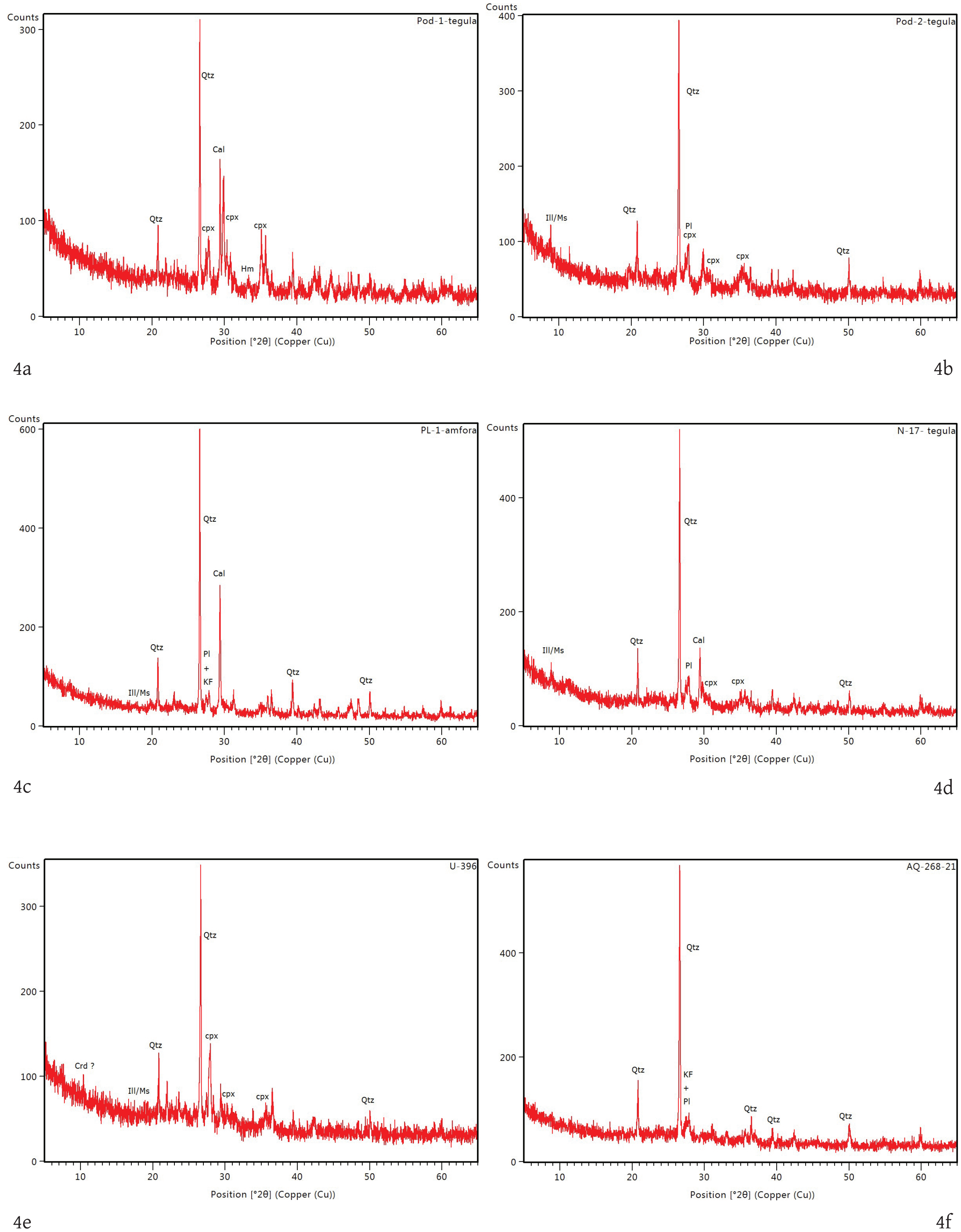
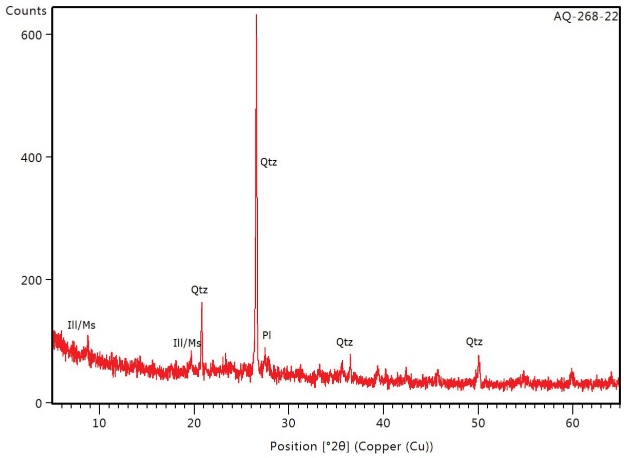


Figure 4. X-ray powder diffraction patterns of pottery samples a. Pod-1 tegulae, b. Pod-2 tegulae, c. PL-1 amphora, d. N-17 tegulae, e. U-396, f. AQ-268-2.1, g. AQ-268-2.2, h. AQ-268-2.3, i. 5218.



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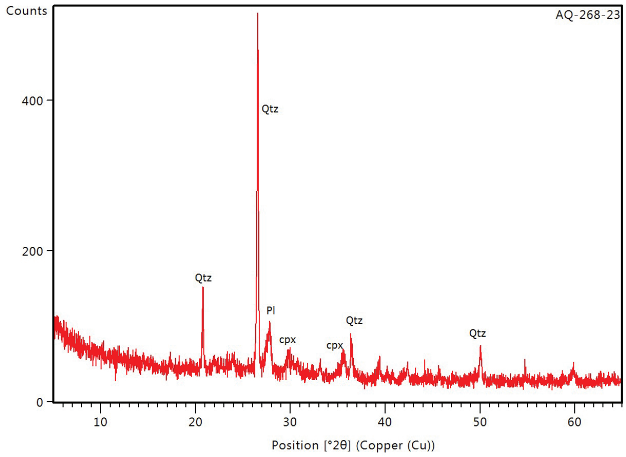

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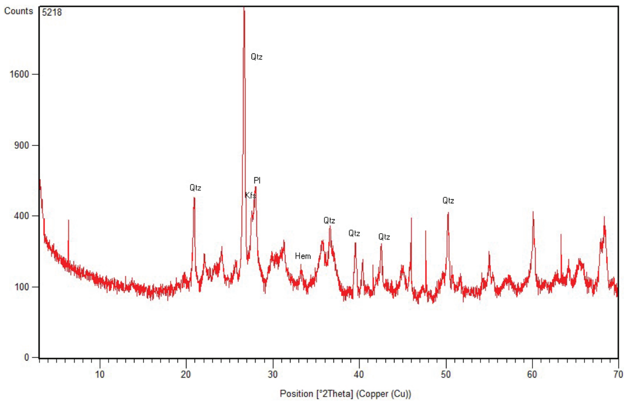

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Figure 4. Continued.

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