Spectroscopic Investigation of Pottery Sherds from Guatemala

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1. Abstract

- Pottery sherds collected from five sites in lowland Guatemala (Ixlu, Flores, Nixtun Chi'ich, Zacpeten, and Tayasal) were investigated using Powder X-ray fluorescence (p-XRF), Fourier Transform-Infrared spectrometry (FT-IR), X-ray Diffraction (XRD), and Scanning Electron Microscopy / Energy dispersive X-ray Analysis (SEM / EDX). P-XRF revealed presence of macro-elements (Ca, K, Al, P, Si, Cl, S, Mg) and microelements (Mn, Nd, Pr, Ba, Zn). FTIR revealed aliphatic ν(C-H), carbonyl ν(C=O), hydroxyl ν(O-H) functional groups. These functional groups give insight into the structure of lipids present in the matrix of the sherds. XRD revealed the presence of calcite, magnesium calcite, quartz, and pyrolusite crystalline phases. The EDX data shows the presence of Ca, Al, Si, Fe, Mg, O, and C. The spectroscopic analyses revealed similarities in the elemental composition in the pottery sherds. These findings suggests that the Maya potters used similar materials and firing techniques when making pottery.

2. Objectives for study

- To determine the elemental composition of Maya pottery sherds.
- To determine crystalline phases present in the pottery sherds.
- To gain insight on the lives of the Maya people through pottery analysis.

3. Location of Pottery Sites

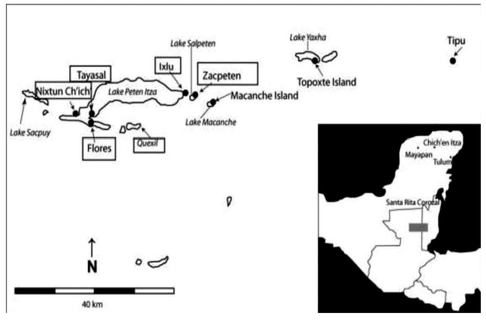


Figure 1. Map of Guatemala sites: Nixtun Chi'ich, Tayasal, Flores, Ixlu, and Zacpeten.

4. Pottery Sherds

Figure 2a. Sherd sample #48 from Tayasal.

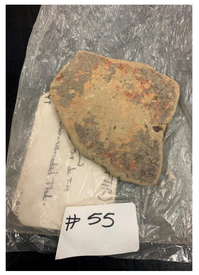


Figure 2b. Sherd sample #55 from Tayasal.

5. Materials and Methods

Analytical techniques

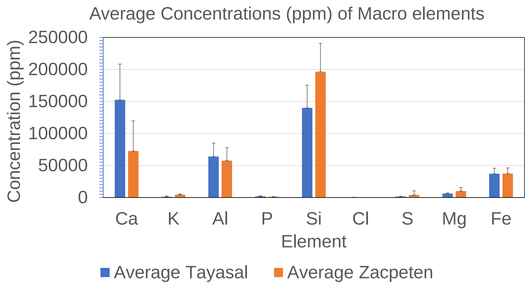
1. Powder X-Ray Fluorescence (P-XRF)
2. Fourier Transform Infrared Spectroscopy (FT-IR)
3. Powder X-ray Diffraction
4. Scanning Electron Microscopy / Energy Dispersive X-ray Analysis

Instrumentation

1. Niton XL 3t X-Ray Fluorescence Analyzer
2. Perkin Elmer Spectrum 100 Fourier-Transform Infrared
3. Bruker D8 Advanced X-ray Diffractometer
4. JEOL SEM-JSM 600

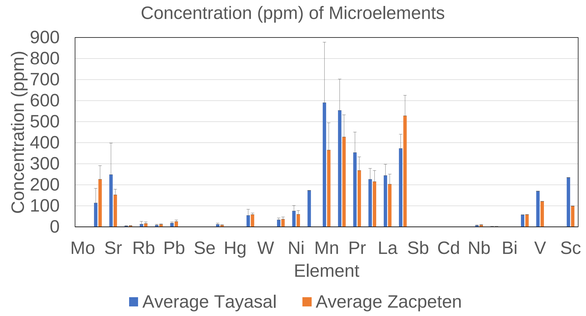
6. Results (p-XRF)

i.) Concentration of Macro elements Present in Pottery Sherds



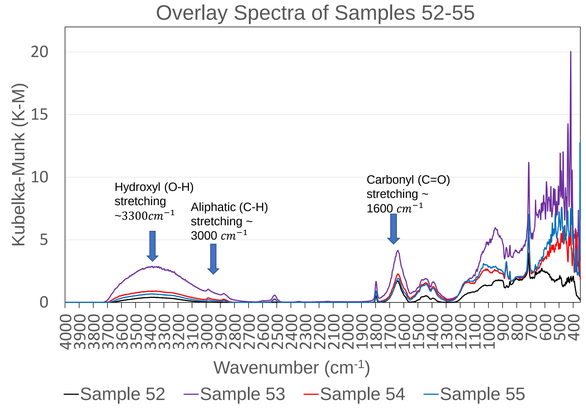
6. Results (p-XRF, Cont'd)

ii.) Concentration of Microelements Present in Pottery Sherds



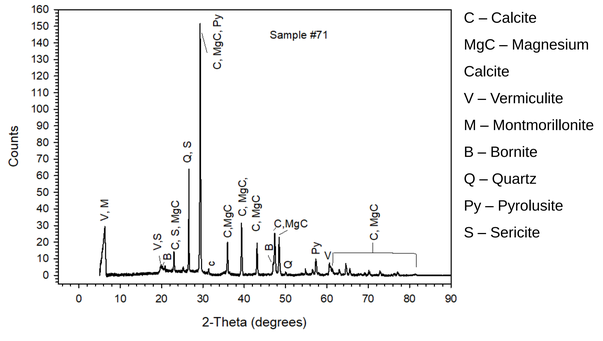
7. Results (FT-IR)

iii.) Overlay Spectra of Samples 52-55



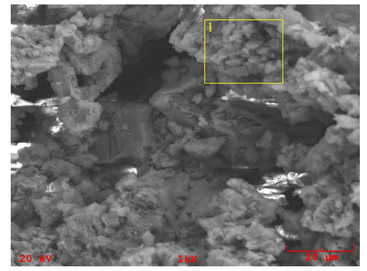
8. Results (XRD)

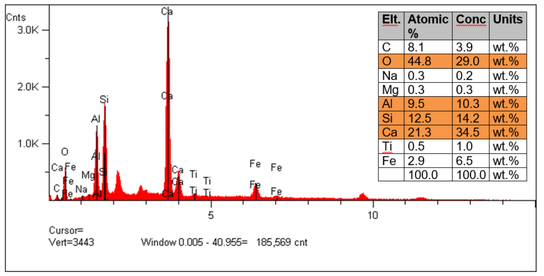
iv.) Crystalline phases present in sample 71 from Zacpeten



9. Results (SEM / EDX)

v.) SEM / EDX spectra of Sample 52





Elt.	Atomic %	Conc	Units
C	8.1	3.9	wt.%
O	44.8	29.0	wt.%
Na	0.3	0.2	wt.%
Mg	0.3	0.3	wt.%
Al	9.5	10.3	wt.%
Si	12.5	14.2	wt.%
Ca	21.3	34.5	wt.%
Ti	0.5	1.0	wt.%
Fe	2.9	6.5	wt.%
	100.0	100.0	wt.%

10. Conclusions

- P-XRF revealed elemental composition of macroelements (Ca, K, Al, P, Si, Cl, S, Mg) and microelements (Mn, Nd, Pr, Ba, Zn.)
- FTIR revealed aliphatic ν(C-H) below 3000 cm^{-1}, carbonyl ν(C=O) around 1640-1750 cm^{-1}, hydroxyl ν(O-H) around 3300 cm^{-1}. These functional groups reveal no significant difference between sherds.
- XRD shows the presence of calcite, magnesium calcite, quartz, and pyrolusite crystalline phases.
- The compositional data suggests the pottery sherds are made using similar components and techniques.

11. References

1. Leslie G. Cecil, "Central Peten blue pigment: A Maya blue source outside of Yucatan, Mexico," J. Archaeol. Sci. Rep 37 (5) (2010) (PP 1006–1019.)
2. Kefa K. Onchoke, Pressley S. Nicholson , Leslie G. Cecil, Robert B. Friedfeld, Josephine Taylor, Wayne P. Weatherford, "Comprehensive Structural and Compositional Investigation of Maya Pottery Samples from Lake Petén Itzá, Guatemala", J. Archaeol. Sci. Rep. 36 (2021) 102767 (PP 1-10)

12. Acknowledgments

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