An Attempt at the Characterization of Chemical Components of Geological Samples and Mayan Pottery Samples Through Raman Spectroscopy

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ABSTRACT

SUNY Geneseo has recently purchased a Raman spectrometer in order to quantitatively study the chemistry of the individual phases of samples. The spectrometer is able to examine the changes in bonding environments in both mineral and pottery samples. In particular, the Raman spectrometer was used to study Bronze Age tin slag associated with the Adirondacks in order to determine the connection between color and chemistry. This experiment consisted of determining the necessary settings on the Raman spectrometer in order to examine the desired qualities. The goal was to be able to distinguish between the various inclusions and components in a given sample of tin slag to determine possible environmental impacts. In addition to tin slag samples, Maya pottery samples were also studied with the goal of identifying the components. Raman spectroscopy is particularly useful in the study of pottery samples because it allows for quick and non-destructive quantitative examination. The final goal of this project is to identify differences between stylistic types and the geological locations where various samples of pottery were made.

BACKGROUND

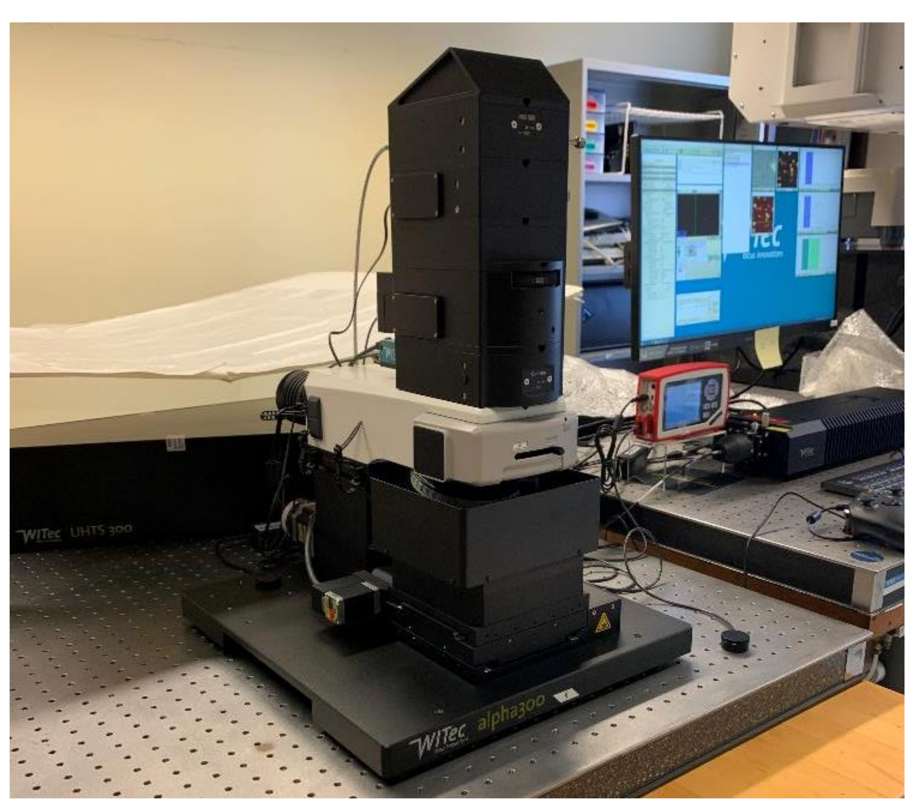


Figure 1.
The WITec Alpha 300 Raman Spectrometer.

Raman Spectroscopy is a non-destructive analysis technique which informs the user about the chemical structure, phase, molecular interactions and crystallinity of a sample. It obtains data by observing the small amount of light that is scattered after a high intensity laser light source is shown on a molecule. This data can be interpreted to determine structure, phase, and strain by analyzing the different refracted wavelengths.

Raman spectroscopy is highly appealing to a variety of fields because it is non-distructive, time efficient, able to examine particles on the scale of microns, and is both qualitative and quantitative. For mixed samples, such as the ones examined here, peaks are visible for each different material apparent in the sample.

I. SLAG SAMPLE

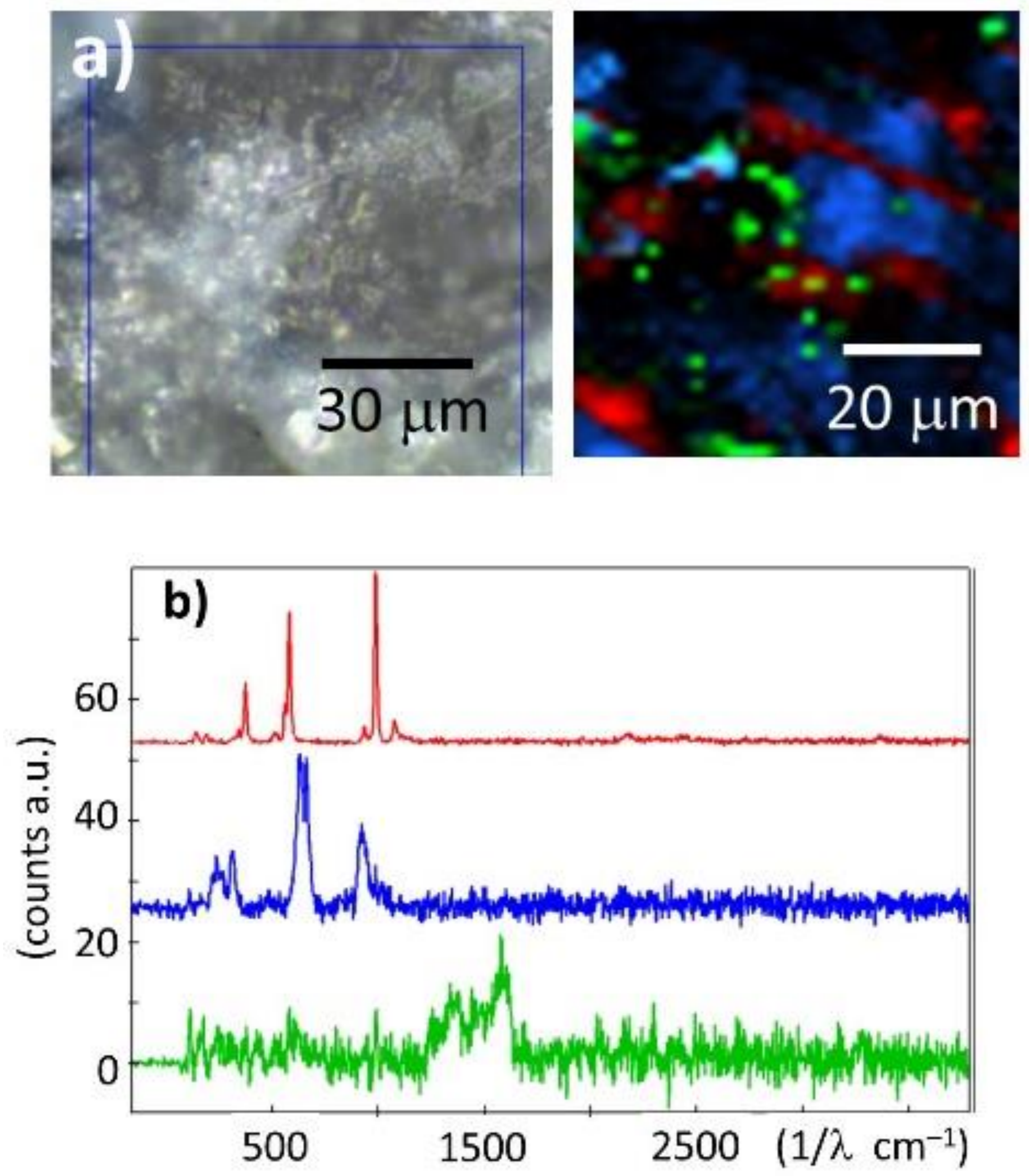
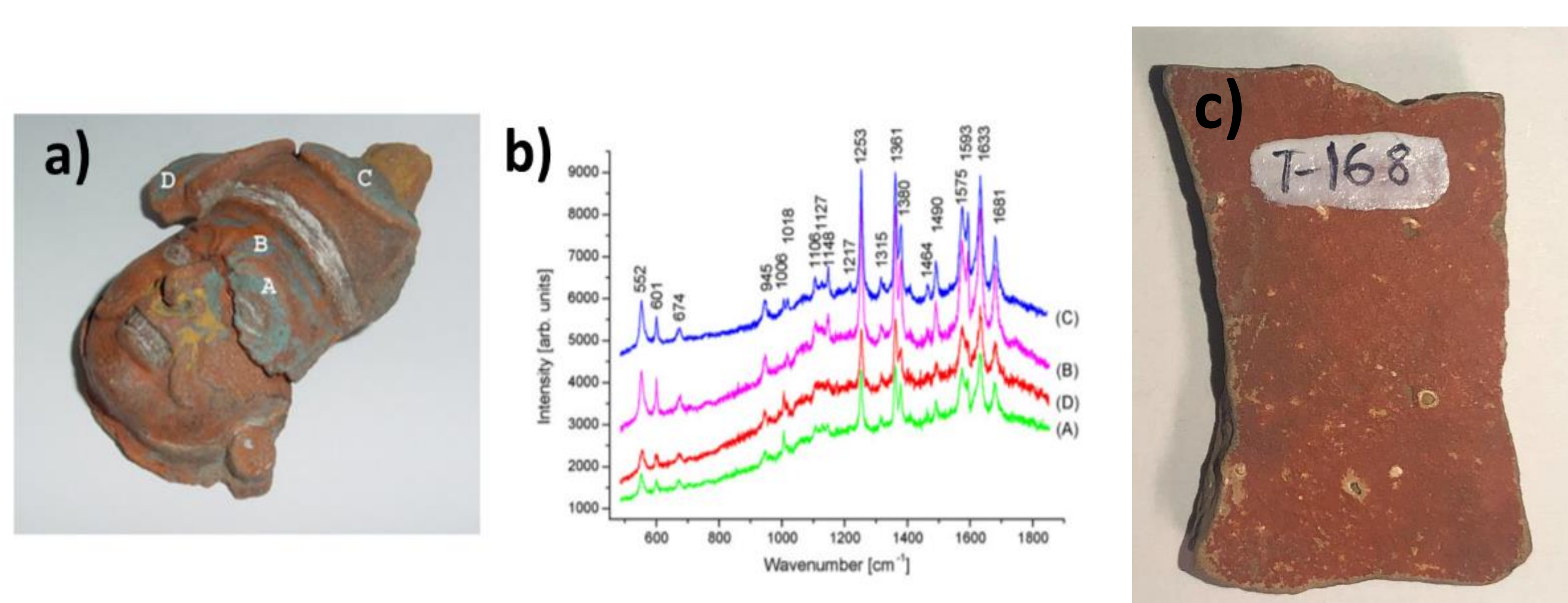


Figure 2. a) Left: a white light image of iron slag. Right: a Raman image of the same sample. b) The Raman spectra representative of the corresponding locations. Taken from literature.

The chemical composition and mineralogy of slag samples was examined. These physical properties are important to understand because they can inform individuals on the devitrification process of particular samples to indicate when harmful elements will be released into the environment. These results can inform potential intervention project in the future.

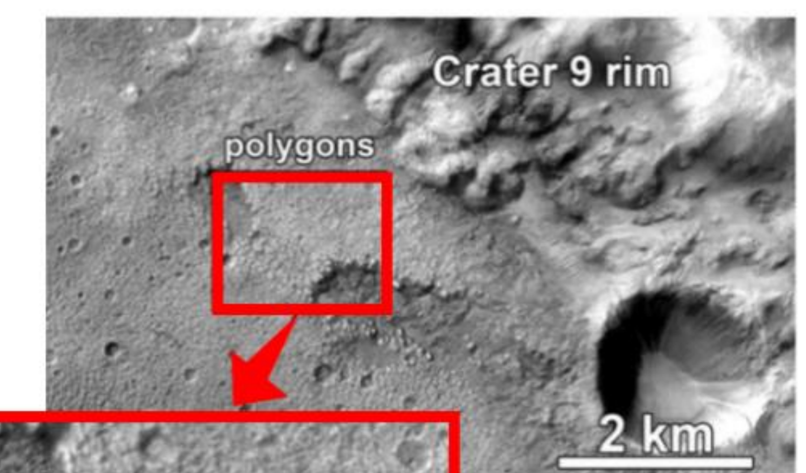
II. POTTERY SAMPLE

Figure 3. a) A sample of maya pottery with locations of four blue spots measured labeled A-D. b) Raman spectra of those same four locations.[1] c) the sample being examined at SUNY Geneseo for pigment and mineral analysis.



Raman Spectroscopy can be used to examine the different pigment, clay, and tempering components and found in artifacts such as pottery samples. The identification of these components can inform researchers how these pigments moved from their point of origin to their point of use.

III. "MARTIAN" SAMPLE



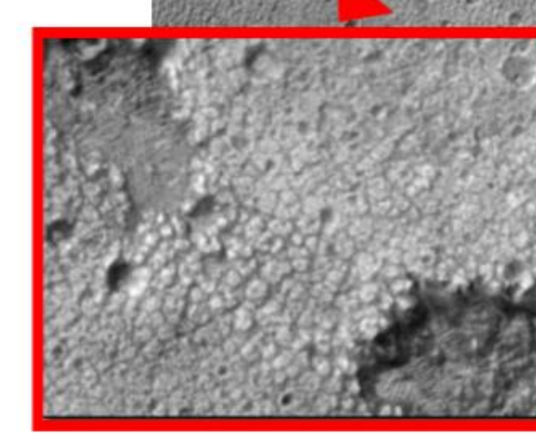


Figure 4. An image of crater 9 on mars. The illustrated polygons may represent a formerly hydrated surface

Mars analog samples from specific terrestrial localities can be used as comparisons for the composition of the Martian crust. In particular, Icelandic samples can be characterized using Raman spectroscopy in order to evaluate their mineral signatures associated with basaltic hydration. Comparison of these samples will help to indicate the presence of water on Mars.

The Raman Spectrometer can also be used to identify organic compounds preserved as endoliths.

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REFERENCES

[1] Wiedemann, H.G., Brzezinka, K.-W., Witke, K. & Lamprecht, I. Thermal and Raman-spectroscopic analysis of Maya Blue carrying artefacts, especially fragment IV of the Codex Huamantla. *Thermochimica Acta* **456** 56–63 (2007).