Scanning Electron Microscopy of Maya Sierra Red Ceramics

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OBJECTIVES

- Sierra Red ceramics are the most common ceramic type found at all Preclassic Maya sites. They are recognized by their distinctive red-orange, waxy surface. This study uses scanning electron microscopy to answer three questions:
- Did the Maya add iron pigments to the slips to achieve their red color?
- Are Sierra Red ceramics a heterogeneous mixture of paste formulas that share a common slip treatment?
- How much vitrification of the clay was achieved during firing?

MATERIALS

Thirty-three Sierra Red ceramic sherds from Operation 32B (Stratigraphic Lots 16, 17, 18, 19, 20 and 23) conducted atop El Tigre—a huge Late Preclassic pyramid located at El Mirador, Petén Guatemala—were selected for study. Four additional sherds from other sites were included for comparison. The El Tigre Sierra Red ceramics showed variable amounts of surface wear (Fig.1).

Figure 1

Figure 2

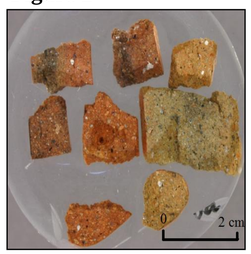


Figure 3

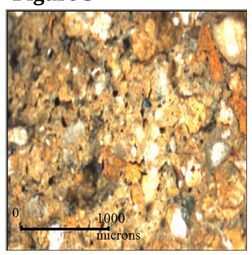


Fig. 1. Predominantly Sierra Red sherds from a Maya Preclassic context.
Fig. 2. Eight sherd cross-sections embedded in epoxy.
Fig. 3. Light microscope close-up of temper particles added to ceramic paste.

METHODS

Preparation of samples

Cross-sections were embedded in spectroscopic epoxy (Fig. 2).

Epoxy disks were polished and carbon coated.

Determination of slip thickness

The presence and thickness of a slip was determined from the backscatter images produced by a FEI Quanta 200 FEG (Fig. 4).

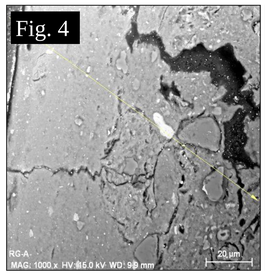
Determination of major elemental composition

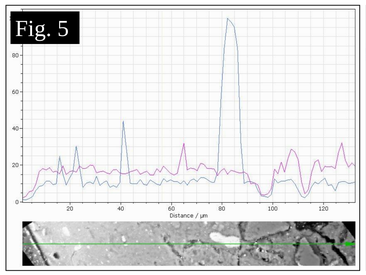
The abundance of elements in the slip, paste and temper was quantified from the intensities of X-rays emitted when a cross-section was bombarded with high-energy electrons (15kV filament voltage) (Abbott & Lack 2008: 54).

Figure 5 illustrates the concentrations of Fe and Ca recorded by the "Line Scan" tool as it passes over non-plastic inclusions.

Determination of amount of added temper

Using the SEM's "Phase Analysis" software, the percentages of added SiO_2 and $CaCO_3$ particles were determined (Fig. 6).





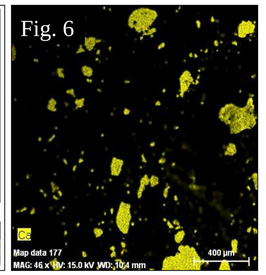


Fig. 4. Backscatter image of sherd cross-section showing paste and overlying slip on left and no evidence of vitrification.
Fig. 5. Graphic illustrating the sensitivity of the EDS detector as it passes over calcite and iron particles. The red curve represents Ca and the blue Fe containing particles.
Fig.6. EDS produced image used to determine the amount of added calcite temper.

DATA MANIPULATION

Correction for post-depositional alterations

Assuming that leaching and ion exchange occur irregularly over the ceramic material, significant deviation in Na/Al and Ca/Al ratios suggested post-depositional alteration (Abbott & Lack 2008). Data points were excluded from the calculation of compositional averages if the ratios were either double or half of the average of the companion points.

Statistical analysis

Possible subdivisions in the assemblage were suggested by finding multimodality in histograms and scatter plots and from cluster and factor analysis (Shennan 1997: 255).

RESULTS

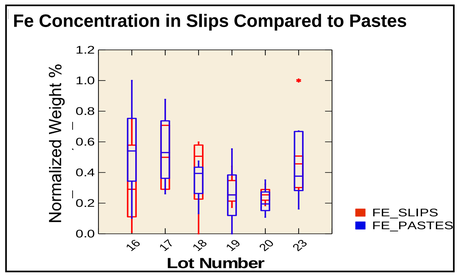


Fig. 7. Box plot comparing Fe concentrations in Slips to Fe concentrations in Pastes.

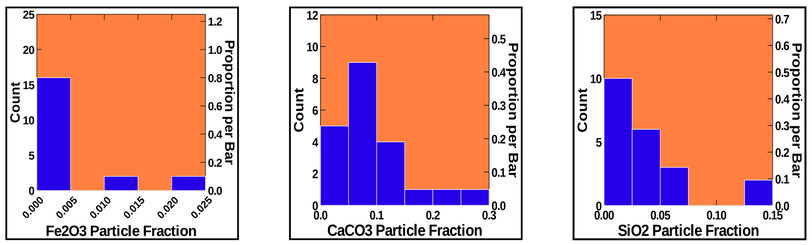


Fig. 8. Histograms showing the fraction of $CaCO_3$, SiO_2 and Fe_2O_3 particles added to Sierra Red ceramics.

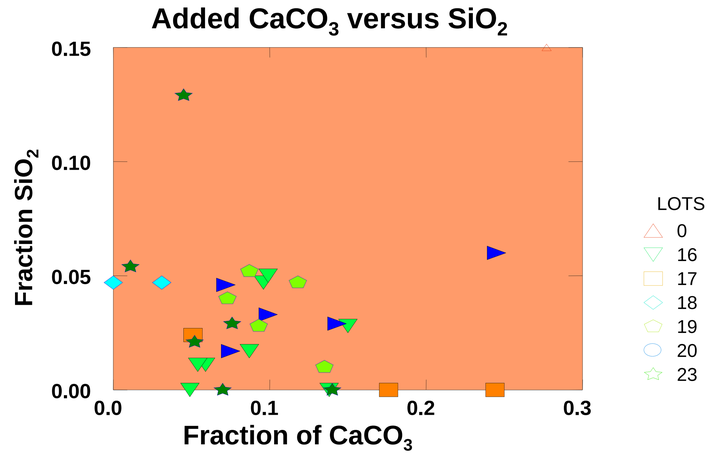


Fig. 9. Scatter plot illustrating the amount of calcite and sand temper used in the manufacture of Sierra Red ceramics. Sorted by stratigraphic lots.

CONCLUSIONS

Regarding Slips

- There is no evidence that additional iron was added to enhance slip color.
- The absence of particulate inclusions in the slip suggests that slip clay was prepared by deflocculating the raw clay.
- The exterior slip is generally thicker than the interior.

Regarding Tempers

- The amount of added calcite temper varied from 0.1 to 32.5 % of the ceramic volume.
- Small amounts of SiO_2 (sand) and iron oxide were present in several sherds (0 to 15% and 0 to 2%, respectively).
- The Sierra Red ceramics can be subdivided according to the amount and type of added temper. At present, no archaeological significance can be attached to these subgroups (Bishop and Beaudry 1994: 420).

Regarding Firing Temperature

- The lack of vitrification seen in cross-sections indicates that the firing temperature was low (below about 800°C), i.e., below the temperature where $CaCO_3$ becomes unstable but above the temperature where iron oxides are converted to hematite.

REFERENCES

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