Elemental Analysis of Bucchero Pottery using Laser Induced Breakdown Spectroscopy

Luke Douglass and Mary Kate Donais Chemistry Department, Saint Anselm College
David George Classics Department, Saint Anselm College

Abstract

Elemental analysis was conducted on bucchero, a type of ancient Etruscan ceramic, using portable laser induced breakdown spectroscopy (LIBS). The analysis was conducted exc situ using a portable instrument at the excavation laboratory. The analysis compared two colors of bucchero (grey and black) from two archaeological sites (Cavita 254 and Crocifisso Del Tufo). Analysis of the spectral data permitted the identification of characteristic elements in the ceramics: Si, Al, Na, Fe, Ca, Mn, Ti, Sr, C, and Li. Principle component analysis of the LIBS intensity data showed that grey bucchero with and without inscriptions group separately. And all black bucchero group together.

Results

<table>
<thead>
<tr>
<th>Element</th>
<th>Emission Peak (nm)</th>
<th>Element</th>
<th>Emission Peak (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si</td>
<td>288.16</td>
<td>Mn</td>
<td>478.34</td>
</tr>
<tr>
<td>Al</td>
<td>394.4</td>
<td>Ti</td>
<td>499.11</td>
</tr>
<tr>
<td>Na</td>
<td>589.59</td>
<td>Sr</td>
<td>407.78</td>
</tr>
<tr>
<td>Fe</td>
<td>404.58</td>
<td>C</td>
<td>247.86</td>
</tr>
<tr>
<td>Ca</td>
<td>396.85</td>
<td>Li</td>
<td>670.79</td>
</tr>
<tr>
<td>Mg</td>
<td>518.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6: Emission Lines of Observed Elements

Conclusions

• Figure 7 Intensity Data Not Normalized
  - Cavita grey with inscriptions (red ellipse) and Cavita grey without inscriptions (green ellipse) are distinct and separate each other
  - Crocifisso grey is a separate group (purple ellipse)
  - Cavita black and crocifisso black group together

• Figure 8 Intensity Data Normalized to Si
  - Cavita grey with inscriptions (red ellipse) mostly but not completely separated from Cavita grey without inscriptions (green ellipse)
  - All other groups clustered together

• Figure 9 Intensity Data Normalized to Si with Averaging
  - Similar groupings as those found in Figure 7
  - Less data points

• Figure 10 Intensity Data Normalized to Ca
  - Similar group as those found in Figure 7
  - More tightly clustered groups

• Connecting to the Archaeology
  - The separation of Cavita with inscriptions and Cavita without inscriptions implies these different ceramic groups were brought from "somewhere else" and that they were dedicatory.
  - The Crocifisso grey sherd, which are a very small set, are a separate groups from all others which implies they may be sourced locally.
  - All black bucchero cluster together, implying their production for a specific use, likely funerary.

Acknowledgements

Dr. Donais is thanked for her guidance during this project. Dr. George is also thanked for his archaeology expertise for aiding in the collection of samples.

SciAps is thanked for loan of the portable LIBS spectrometer and for their aid in overcoming various obstacles related to our field work. Saint Anselm College Chemistry and the Ariel family are thanked for making this research possible through the Father Michael Custer Summer Research Grant.