Provenance Identification and Hydration Depth Profiling of Obsidian via Laser-Induced Breakdown Spectroscopy (LIBS)

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Laser-Induced Breakdown Spectroscopy (LIBS) is a rapidly maturing analytical technique that offers unparalleled flexibility and applicability for elemental determination. It is a minimally-destructive method using a pulsed laser to ablate the surface of a material and create a microplasma that emits photons that allow for simultaneous detection of multiple elements of all atomic weights.

Preliminary investigation has demonstrated significant potential for LIBS as a tool for conducting provenance analysis of obsidian samples through the use of multivariate techniques like Principal Component Analysis (PCA). Furthermore, hydration depth profiling can be conducted concurrently with provenance analysis and was shown to have promise for accurate measurement of artifact age with minimal sample damage. Utilizing LIBS for both determinations offers an alternative to using destructive petrographic techniques, which is of great value to the analysis of samples with historical significance.

In this study, the LIBS methodology for simultaneous provenance identification and hydration depth profiling of obsidian artifacts is optimized to both provide ample data for analysis as well as maintain sample integrity for preservation. The accuracy and effectiveness of PCA modeling is assessed across multiple sites of origin, and the resolution and reproducibility of the hydration measurement is investigated in detail to determine its efficacy in obtaining reliable depth profiles and thus successful determination of artifact age.