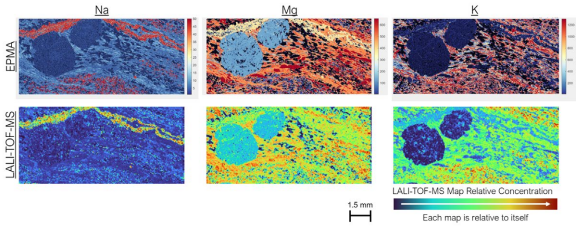
Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37596



High-Sensitivity Geochemistry Outside the Lab Using an Innovative Laser Ablation Laser Ionization (LALI) Mass Spectrometry Technique

ELLEN S WILLIAMS, PEYTON WILLIS, ANDREW LAROCHE AND JEFFREY WILLLIAMS

Exum Instruments

Today's extraction industries increasingly depend on high-sensitivity analytical tools to detect trace elemental signatures. Such results help characterize mineral composition, locate valuable ore pockets, and inform processing strategies. These insights typically rely on techniques like Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Electron Probe Microanalysis (EPMA). These high-performance instruments must operate in laboratories far from the field, and they require highly trained experts to prepare samples, maintain complex systems, and interpret the results.

Addressing the limitations of conventional analytical instruments, a new technique combines Laser Ablation Laser Ionization with Time of Flight Mass Spectrometry (LALI-TOF-MS). LALI-TOF-MS offers rapid, high-sensitivity geochemical characterization outside of the traditional laboratory environment. The ionization source, LALI, uses two lasers to first ablate material from a solid sample's surface and then ionize the neutral particles present in the ablated material. The laser ablation process allows direct analysis of solid materials, from ground rock samples to cores, without the complicated sample preparation procedures of other techniques that require liquid sample introduction. The ionization laser targets the neutral particles created by ablation, which are more representative of the sample's constituents than plasma-generated ions. Overall, LALI results in more reliable elemental verification and reduces sample matrix effects. After ionization the TOF mass analyzer creates a full mass spectrum at each laser spot. This facilitates multi-element quantification and elemental mapping.

This work demonstrates LALI-TOF-MS as a promising new technique for geochemical analyses. The system delivers trace-level quantitative results from lithium to uranium, which are not easily acquired by other field-deployable techniques like X-Ray Fluorescence (XRF). In addition to bulk elemental analysis, LALI-TOF-MS provides elemental mapping over areas up to 90 mm by 90 mm. The elemental map's resolution is determined by the ablation laser's spot size, which is adjustable from 5-150 microns. Investigating the spatial distribution of valuable elements and their mineral hosts is a critical part of resource characterization. LALI-TOF-MS combines laboratory-grade trace elemental sensitivity and elemental mapping of geologic materials with a compact, robust system capable of operating in the field office.