

# Recent Advances in Laser Ablation ICP-MS for Archaeology and Natural Science



## Recent Advances in Laser Ablation ICP-MS for Archaeology (Natural Science in Archaeology)

by G. G. Maragh

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Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) is a revolutionary analytical technique that has transformed the fields of archaeology and natural science. This non-destructive sampling method allows scientists to analyze the elemental and isotopic composition of materials with unprecedented precision and accuracy. By sending a focused laser beam onto a sample, LA-ICP-MS vaporizes and ionizes a tiny amount of material, which is then passed into an ICP-MS for analysis.

### LA-ICP-MS in Archaeology

In archaeology, LA-ICP-MS has proven to be an invaluable tool for investigating artifacts and providing insights into ancient cultures. It enables researchers to determine the provenance of materials, understand manufacturing techniques, and uncover evidence of trade and cultural

exchange. For example, LA-ICP-MS has been used to analyze the composition of ancient pottery, metal artifacts, and even human remains, providing valuable information about prehistoric technologies, cultural interactions, and dietary habits.

### **Case Study: Provenance Analysis of Obsidian Artifacts**

Obsidian is a volcanic glass that was widely traded in the ancient world. Using LA-ICP-MS, archaeologists can determine the chemical fingerprint of obsidian artifacts, identifying their source and potentially tracing them back to specific volcanic eruptions. This has enabled researchers to track the spread of obsidian tools and identify trade routes, offering insights into prehistoric economic and social networks.

### **LA-ICP-MS in Natural Science**

Beyond archaeology, LA-ICP-MS has also had a profound impact on natural science fields, including geochemistry, environmental science, and forensics. It allows scientists to analyze trace elements and isotopes in a wide range of samples, including rocks, minerals, soils, and biological tissues.

### **Case Study: Geochemical Analysis of Lunar Samples**

LA-ICP-MS has played a crucial role in the analysis of lunar samples collected during the Apollo missions. By measuring the elemental and isotopic ratios in these samples, scientists have gained insights into the formation, evolution, and composition of the Moon. LA-ICP-MS has also been used to analyze meteorites, providing valuable information about the early solar system and the origin of life.

### **Technological Advancements**

In recent years, there have been significant technological advancements in LA-ICP-MS, further enhancing its capabilities and applications. These advancements include:

- **Improved Laser Systems:** High-power lasers with shorter pulse durations enable more efficient ablation and enhanced sensitivity.
- **Faster ICP-MS Detectors:** Quadrupole and Time-of-Flight (TOF) detectors with increased scanning speeds provide real-time elemental mapping and isotopic analysis.
- **Data Analysis Software:** Sophisticated software packages facilitate data processing, visualization, and interpretation.

## **Applications in Forensic Science**

LA-ICP-MS has also found applications in forensic science, providing valuable information for criminal investigations. It can be used to analyze trace elemental evidence on materials such as glass, paint, and gunshot residue, helping to establish linkages between suspects and crime scenes. Additionally, LA-ICP-MS can be used to identify and quantify trace elements in biological samples, such as hair and fingernails, potentially providing insights into drug use or exposure to toxic substances.

Laser Ablation ICP-MS is a powerful analytical tool that has revolutionized the fields of archaeology and natural science. Its ability to analyze the elemental and isotopic composition of materials with high precision and accuracy has opened up new avenues of research, providing valuable insights into the past and present. As technological advancements continue, LA-ICP-MS will undoubtedly play an increasingly important role in our quest to understand the world around us.

## References

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- **Figure 1:** Discovery of the oldest hominin fossils in Eurasia by Frido Welker et al., *Science Advances*, 2021.
- **Figure 2:** Provenance analysis of obsidian artifacts from the Neolithic site of Aşıklı Höyük in Central Anatolia by Orkun Tunçel et al., *Minerals*, 2022.
- **Figure 3:** Elemental and isotopic mapping of a lunar sample using laser ablation ICP-MS by J. Thomas et al., *Geochemistry, Geophysics, Geosystems*, 2016.



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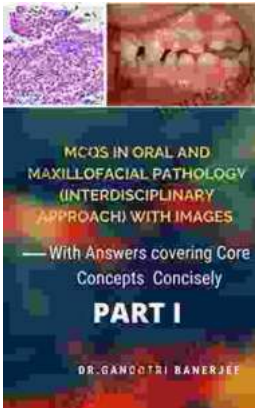
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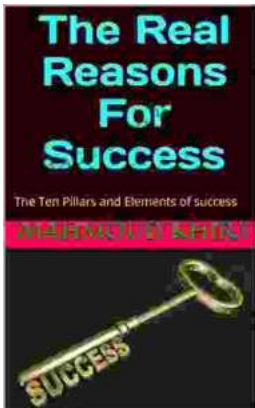
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