LA-ICP-MS systematics in sulphides: challenges, developments, and perspectives

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Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is routinely applied as a reliable and cost-efficient technique in chemical and isotopic research in broad realms of Earth Sciences. LA-ICP-MS has been extensively used and continues to be applied for quantitative measurement of compositional variations within sulphide minerals as well as the recent attempts to develop novel methodologies to measure sulphides' isotopic variations. LA-ICP-MS methodologies in sulphides need to be carefully refined to achieve optimal accuracy and precision. When this optimization is achieved LA-ICP-MS can be used to measure ppb-level concentrations for heavy and precious elements with <50 μm spatial resolution. In addition, the time-resolved analysis of the LA-ICP-MS allows visualization of elements profiles to detect the occurrence of micro-inclusions in the subsurface as a common feature occurring in sulphides.

However, the crystal-chemical composition of sulphide phases presents challenges for LA-ICP-MS analysis. In general, the high weight proportion of metals in sulphides and the presence of high concentrations of firstrow transition metals and sulphur, lead to polyatomic interferences at higher masses. Besides, mineral specific characterizations such as bond strengths, melting point, and thermal conductivity of each sulphide mineral demands controlled ablation conditions. Moreover, choices of suitable internal and external standardization protocols, as well as meticulous data reduction strategies, are further required to treat LA-ICP-MS data of sulphides.

Herein, LA-ICP-MS refined methodologies in key sulphides are presented. The modifications in methodology include an assessment of optimized ablation conditions, choice of external and internal standards, and improvement of data reduction strategies. Data acquisition was optimized by adjusting spot size (based on textural criteria and required accuracy and precision), energy density, and ablation times and background intervals. Sulphides such as galena, arsenopyrite, and tetrahedrite are susceptible to melting using high energy density excimer lasers. Scanning electron microscope (SEM) topography images obtained after ablation of individual sulphide minerals show the effect of laser fluence on the formation of melted domains which can be minimized by decreasing the fluence. Therefore, ablation conditions should be adjusted to suit the particular sulphide mineral under investigation. This helps to reduce the effects of melt/condensate droplets in the ablated sites and enhance the system sensitivity and effects of matrix mismatches as well. The LA-ICP-MS systematics in sulphides needs further refinements which in some parts can be achieved by new laser technology and greater cooperation and knowledge transfer among the LA-ICP-MS community.

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