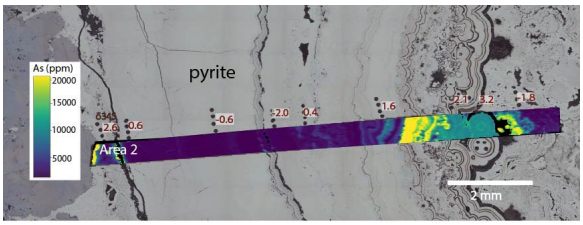
Goldschmidt 2026 Abstract
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In situ sulfur isotopes in texturally characterized pyrite, pyrrhotite, arsenopyrite and chalcopyrite by LA-ICPMS/MS for application in sulfide bearing systems

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The demand for in situ sulfur isotopes analysis has increased in recent years. Yet, no rapid method for collecting high-resolution texturally-constrained data with minimal sample preparation time has been available. In this study, we develop an analytical technique using LA-ICP-MS/MS to rapidly acquire in situ $\delta^{34}S$ measurements in thin section-hosted sulfides by removing interferences on the ^{32}S and ^{34}S mass via mass shifting after O_2 gas reaction. New reference materials have been petrographically and chemically characterized, prior to being analysed by both high-precision bulk SF6 isotope ratio mass spectrometry (IRMS) and in situ secondary ion mass spectrometry (SIMS) S isotope methods. The new reference materials include Iberia pyrite ($\delta^{34}S$ = 8.9 ± 1.1‰; $\Delta^{33}S$ = -0.02 ± 0.015‰), Sullivan pyrite ($\delta^{34}S$ = 6.0 ± 0.6‰; $\Delta^{33}S$ = -0.05 ± 0.015‰), 1869 chalcopyrite ($\delta^{34}S$ = 9.4 ± 0.2‰; $\Delta^{33}S$ = -0.03 ± 0.015‰), Pierre pyrrhotite ($\delta^{34}S$ = 4.7 ± 0.2‰; $\Delta^{33}S$ = -0.01 ± 0.015‰), and Montpellier pyrrhotite ($\delta^{34}S$ = 3.3 ± 0.2‰; $\Delta^{33}S$ = 0.18 ± 0.015‰), and Nico arsenopyrite ($\delta^{34}S$ = 4.4 ±0.4‰; $\Delta^{33}S$ = –0.00 ± 0.015‰). Tested analytical conditions indicate that internal error is minimized when spot size is at least 80 microns, integration time is ≥20 seconds, fluence is 2 J/cm2, and the laser firing repetition rate is ≥18 Hz. At these conditions the reproducibility of the primary reference material during each analytical run approximates ±1.5–2.0 ‰. The method was tested on sulfides previously measured by SIMS, with δ34S values yielded being within-error of these, confirming the robustness of the technique. The grain-scale S isotope variation can be overlain on trace element maps in order to make interpretations on the nature of metal and sulfur reservoirs in sulfide bearing systems. This study opens new analytical opportunities for rapid in situ sulfur isotope analysis in petrographically-characterized thin sections in various sulfide-bearing geological systems.