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Validation of LA-ICP-MS fluid inclusion analysis with synthetic fluid inclusions

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ABSTRACT

Laser ablation—inductively coupled plasma—mass spectrometry (LA-ICP-MS) has become recognized as a sensitive, efficient, and cost-effective approach to measuring the major-, minor-, and trace-solute compositions of individual fluid inclusions in minerals. As a prerequisite for the routine analysis of natural inclusions in our laboratory, the precision and accuracy of the technique was assessed using sets of multi-element synthetic fluid inclusions. Five multi-element standard solutions were prepared, and incorporated as fluid inclusions in quartz crystals at 750 °C and 7 kbar. Fluid inclusions were ablated with a 193 nm ArF excimer laser and analyzed with a quadrupole ICP-MS, equipped with an octopole reaction cell for the removal of Ar-based interferences. The internal standard used in all cases was Na. Analytical precision for K, Rb, and Cs is typically better than 15% RSD, whereas Li, Mg, Ca, Sr, Ba, Mn, Fe, Cu, Zn, and Cl analyses are typically reproducible within 30% RSD. Measured concentrations approximate a Gaussian distribution, suggesting that analytical errors are random. Analyses for most elements are accurate within 15%. Limits of detection vary widely according to inclusion volume, but are 1 to 100 μg/g for most elements. These figures of merit are in excellent agreement with previous studies. We also demonstrate that, over the range investigated, precision and accuracy are insensitive to inclusion size and depth. Finally, the combination of our LA-ICP-MS analyses with microthermometric data shows that charge-balancing to NaCl-H_2O equivalent chloride molality is the most valid approach to LA-ICP-MS data reduction, where chloride-dominated fluid inclusions are concerned.