

A New Twist on a Classic: Crush-leach Analysis of Fluid Inclusion Halogens by Inductively Coupled-Plasma Mass Spectrometry

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Bulk crush-leach analysis of fluid inclusions for halogen content has been an integral technique for determining the source of brine in a variety of basin-hosted ore systems, including Mississippi Valley-type Pb-Zn, sedimentary exhalative Pb-Zn, sediment-hosted Cu, and unconformity-related uranium deposits. We have developed a novel method for efficient extraction and analysis of bulk fluid inclusions by inductively coupled plasma-mass spectrometry (ICP-MS), effectively bypassing conventional analysis by ion chromatography. Rapid analyses and sample changes allow for halogen data collection in minutes rather than hours, in addition to multielement data including Na, K, S, I, Mg, Ca, and metals that would otherwise require multiple analyses or methods to acquire.

Ore samples were crushed and sieved to 4 mesh, then picked to produce approximately one gram of pure mineral separates. A reservoir of ultra pure 18 megaohm water is drawn through the sample housed in a ¼ inch diameter nickel crush tube, Swagelok nut, and filter assembly directly into an Agilent 8900 ICP-MS Triple Quad mass spectrometer. The system is calibrated using multi-element calibration standard solutions. Signal backgrounds monitored during crushing of the sample tube shows in real time when the leached fluids reach the spectrometer over a period of several minutes, resulting in lower uncertainties than can be achieved via laser ablation ICP-MS analysis of individual fluid inclusions. The method was validated for accuracy using fluid inclusions hosted in sphalerite from the Coy Mine in Tennessee and from the Viburnum trend in Missouri, previously analyzed by ion chromatography, with initial results yielding molar Cl/Br ratios within 1% of previous analyses.