

Separation of Cu, Fe, and Zn from complex aqueous solutions for isotopic measurement

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The advent of multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) has facilitated the routine measurement of Cu, Fe, and Zn stable isotopic ratios. However, the application of Cu, Fe, and Zn isotopic measurements to natural waters is limited by our ability to efficiently separate these elements from complex matrices.

We have developed a method for the separation of Cu, Fe, and Zn from complex aqueous solutions and from each other using anion-exchange chromatography and hydrochloric acid media. This separation can be performed in a single elution, and was tested using a suite of stream samples impacted by acid mine drainage with widely varying Cu : Fe : Zn ratios and major and trace element abundances. The separations produced Cu, Fe, and Zn isolates from a single sample of sufficient purity to be directly analyzed using a MC-ICP-MS. Unwanted major (e.g., Ca, K, Mg, Na) and trace (e.g., Al, Ba, Ce, Cr, Cs, Ga, La, Li, Mn, Ni, Pb, Rb, Si, Sr, Ti, V, Y) cations and anions (e.g., SO₄) were efficiently eliminated from the stream samples, and were not detected in the individual metal isolates. Moreover, we found no Cu in the Fe or Zn isolates, no Fe in the Cu or Zn isolates, and no Zn in the Cu and Fe isolates. Within analytical uncertainty, 100% of each element was recovered. Procedural blanks were free from contamination (i.e., below detection on an ICP-MS), except for ~20 ng of Zn, about 0.15% of the total Zn isolated.

This separation method is important, because for the first time it allows for the separation of all three metals from a single complex sample in a single elution without the use of additional purification steps that ultimately contribute to analytical uncertainties.