Column Matrix Effects in the Mass Spectrometer and the Effects on Isotope Analyses

Jennifer Piper

Senior Thesis
San Diego State University

Advisor: Dr. Aaron Pietruszka

Abstract

Mass spectrometry can be used to analyze radiogenic and stable isotopes in order to determine the concentrations of different isotopes in a sample, ages of rocks, and sample correlations. Multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS) has become the preferred method for isotope analysis compared to other methods because it is very precise, the plasma can ionize any element, and there is less time required for each analysis. One of the downfalls of isotope analysis using MC-ICP-MS is that it induces an instrumental mass-dependent fractionation (instrumental mass bias) that needs to be corrected for. This instrumental mass bias is primarily due to the extremely high temperatures of the plasma, which causes a spread in ion energy during ionization and transport within the mass spectrometer.

Instrumental mass bias in the MC-ICP-MS can be corrected using one of two main techniques (1) standard sample bracketing (SSB) or (2) double spiking. SSB is commonly favored, but it is more susceptible to matrix effects that result in inaccurate results. Many different types of matrix effects in the MC-ICP-MS have been identified and corrected for. Spectral matrix effects, or isobaric interferences, result from the occurrence of an element that overlaps in mass with the isotope of interest. Non-spectral matrix effects can create differences in the measured isotope ratios of a sample and the standard.

In a recent study, a new and possibly uncontrollable matrix effect was found that is thought to have come from the separation and purification of molybdenum using an anion exchange resin. It was shown that the collection of a pure Mo-free solution that had been passed through an anion exchange resin and subsequently added to a Mo standard appeared to be isotopically lighter than expected when compared to the same untreated Mo standard. Many tests were performed to try and correct for this "column matrix effect" but all have failed.

The purpose of this experiment is to test for the presence of this column matrix effect in measurements of radiogenic isotopes of U, Th and Pb to see if it affects elements other than molybdenum. In all of the experiments, the standards run with the addition of a column matrix appear to have a higher signal intensity than the untreated standards. However, this effect does not seem as significant when comparing the isotopic ratios of the treated and untreated standards. Based on the data obtained from this experiment, it can be said that there is a column matrix effect for U, Th, and Pb and it is produced from the resin that is used in the column chemistry.