Extending the utility of multi-dynamic MC-TIMS by optimal use of redundant data

RYAN B ICKERT[1,2]; RASIKA S MAHAJAN[2]; JOHN CARTER[2]; VINCENT GALLAGHER[2]; ANNE KELLY[2]; DARREN F. MARK[2]

[1] ryan.ickert@glasgow.ac.uk
[2] Scottish Universities Environmental Research Centre, Rankine Avenue, East Kilbride, G75 0QF

As MC-TIMS (multi-collector thermal ionization mass spectrometry) is pushed to a relative repeatability of 10^{-6} (ppm), small effects associated with cup efficiency and amplifier gains become more important. The classical method of dealing with these systematic effects is to use a so-called "multi-dynamic" analytical routine, wherein ion beams are switched between different cups, and the combined effects of mass-bias correction (requiring an invariant isotope ratio) and measurement of the isotope ratio of interest (one of which is part of the invariant ratio) cancel any linear- and isotope-independent effects on the intensity measurements. While a powerful technique, it has limitations. The main problem is that it is constrained to only the subset of isotope ratios that have the correct "geometry" such that the invariant pair and the pair of interest can share collectors: not every isotope system of interest is amenable to the classical multi-dynamic treatment. In order to extend this high-accuracy technique, we extend the linear system of equations approach of Albarede et al. (2004) to TIMS analyses where the mass bias is not at steady state. By switching beams between large enough numbers of cups, sufficient redundant data is collected so that the apparent linear efficiencies for each cup-amplifier assembly (the quantity cancelled by multi-dynamic algorithms), and other quantities of interest, such as mass-bias corrected isotope ratios, can be calculated. For example, by rotating ^{202}Pb-^{205}Pb spiked Pb ion beams between six collectors, we show that is possible to recover four Pb isotope ratios, apparent linear efficiencies for each cup-amplifier assembly, and mass-independent effects (*sensu* McLean, 2014) on ^{205}Pb and ^{207}Pb. In principle, this has the same accuracy as conventional multi-dynamic analyses, but has the advantage of recovering the true cup factors and the mass-independent correction factors. We also succesfully apply this technique to measurement of Sr isotopes (^{84}Sr and ^{86}Sr-^{88}Sr) and demonstrate an application to Nd isotopes (^{142}Nd-^{146}Nd). *Albarede et al., 2004; GCA v.68 p2725-2744. McLean, N.M. 2014; GCA v.124 p237-249.*