Performance of Multiple Faraday Collectors with 10^{12} Ω amplifiers and Multiple Ion Counters for the Measurement of Isotope Ratios of Picogram size Pb via TIMS

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While typical ion-counting peak hopping methods using a single Daly detector or a single secondary electron multiplier (SEM) have proven very effective in analyzing small Pb samples by TIMS, the measurements often require long acquistion times, typically of several hours. Here we evaluate static multi collector determination of isotope ratios of Pb samples ranging between 100 to 1 pg using Faraday detection systems equipped with 10^{12} Ω feedback resistors in the current amplifier system and a multiple ion counting system installed in a Triton *Plus* TIMS at the U of A.

Faraday cup measurements using 10^{12} Ω amplifiers require precise measurement of long baselines for optimal repeatability (defined as internal precision or the precision of a single run) and intermediate precision (defined as the closeness of the replicated measurements over an extended period of time) of pg size Pb samples. In our system, using a 20 min baseline before and after the measurement, we achieved a repeatability of 0.02-0.03% (2SE) and an intermediate precision of 0.05% (2SD) on $^{207}Pb/^{206}Pb$ $^{208}Pb/^{206}Pb$ in as little as 1 hour for samples containing between 80 and 10 pg Pb, which is equivalent to the performance obtained from 4-5 hour long single SEM peak hopping analyses of larger sized (10.0-0.5 ng) samples.

The main uncertainty in MIC detection mode is the relative instability of the detector yields, which is 0.1-0.3% (2SD; following a 1 hour detector stabilization period). Using a correction from an average yield value measured before and after sample analysis, we achieved a repeatability of 0.03%-0.06% (2SE) and an intermediate precision of 0.18%-0.23% (2SD) on $^{207}Pb/^{206}Pb$ for 80 to 10 pg loads. For sample sizes between 10 and 1 pg, which were only measured in MIC mode as the ^{204}Pb intensity is below detection limit in Faraday mode, repeatability and internal precisons are 5-10 times worse than larger samples measured in MIC mode.

A Faraday array equipped with 10^{12} Ω amplifiers performs very well for sample size down to 10 pg, producing data that is 4-5 times better than MIC. In contrast, the MIC system offers considerable promise for tracer Pb work in the sub 10 pg Pb analyte range where data with few % level of accuracy and precision are useful.