

Methods for preparation of low mass chlorine samples for planetary, space, and nuclear forensic applications

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The volatile element Cl can be lost during high temperature events like those occurring during planetary formation and evolution, causing fractionation of its two stable isotopes ³⁵Cl and ³⁷Cl. Chlorine isotope variations (reported as $\delta^{37}\text{Cl}$, in per mil, relative to Standard Mean Ocean Chloride) can serve as an important tracer of these events, but the loss of Cl leads to small remaining masses. Commonly used techniques for stable chlorine isotope analysis, secondary ion mass spectrometry (SIMS) and isotope ratio mass spectrometry (IRMS), require at least 20 micrograms, but more often > 100 micrograms of Cl. We present methods for preparation of micrograms of Cl to be used with our recently developed accelerator mass spectrometry (AMS)-based technique for determining stable Cl isotope ratios, which has also been used to improve ³⁶Cl analyses. More complete collection and reduction of Cl loss is achieved through co-precipitation of Cl with Br as Ag(Cl+Br) followed by re-dissolution and separation with ion chromatography. This technique can be coupled with our AMS-based technique to enable analyses of 1 microgram of Cl accurate to ~1 per mil, with precision of ~3-4 per mil, similar to SIMS results and capable of resolving large variations in astromaterials. Initial experiments outlining the details of the method and impacts on the final sample will be presented and discussed along with initial tests to further reduce minimum sample masses and potential applications in planetary science, space science, and nuclear forensics. Prepared by LLNL under Contract DE-AC52-07NA27344, this is LLNL-ABS-2001277.