$^{36}Cl/^{35}Cl$ by LG-SIMS: Quantifying the Dynamic Range on NaCl

Heather S Cunningham[1], Mindy M. Zimmer[1], Paula Peres[2], Natalie E. Sievers[1], James Bowen[1], Kellen Springer[1], April Carman[1]

[1] Pacific Northwest National Laboratory, Richland, Washington 99352 * corresponding author: heather.cunningham@pnnl.gov
[2] Cameca, 92622 Gennevilliers-Cedex, France

Nuclear irradiation leaves an isotopic fingerprint of activation products in non-natural ratios and abundances. The challenge of accurate measurement of these isotopic ratios lies with the large dynamic range (>$10x10^{-6}$) between the major and minor isotopes. Traditionally these ratios have exclusively been quantified on accelerator mass spectrometry (AMS). However, higher fluence from nuclear irradiation results in grater activation and ratios that are measurable by conventional mass spectrometry, like large geometry ion mass spectrometry (LG-SIMS). Improvements in hardware (electronics and ion detectors), as well as innovative instrument designs (high transmission at high mass resolving power) have further expanded the analytical potential. The benefits of SIMS analyses over AMS include smaller sample volume in an unaltered solid state, allowing for higher throughput and identification of material heterogeneity. We aimed to quantify the dynamic range on the Cameca ims 1280-HR by measuring $^{36}Cl/^{35}Cl$ in irradiated NaCl. Grains of unirradiated and irradiated NaCl and NIST 975 NaCl were pressed into indium and gold coated. Cl isotope measurements were made on a Cameca ims 1280-HR, which was tuned to 7000 MRP (83% transmission) to separate the ^{35}ClH interference on ^{36}Cl. Replicate $^{37}Cl/^{35}Cl$ measurements on a Durango apatite standard produced a precision of 0.5‰ (2σ). Measurements of ^{32}S and ^{34}S were made on all materials to subtract the irresolvable ^{36}S interference, but ^{36}S was below the limits of detection in the NaCl grains. $^{36}Cl/^{35}Cl$ isotopic measurements on the irradiated NaCl ($7.4x10^{-7}\pm1.6x10^{-8}$) were similar to TIMS measurements ($7.7x10^{-7}\pm1.5x10^{-9}$). Moreover, $^{36}Cl/^{35}Cl$ on the unirradiated NaCl was three orders of magnitude lower ($1.2x10^{-10}\pm6x10^{-11}$), demonstrating that LG-SIMS is capable of very large dynamic range measurements. These results open opportunities for fingerprinting other geologic and nuclear isotopic systems by SIMS.