NanoSIMS Analysis of Rare Earth Elements in Silicate Glass and Zircon

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In earth and environmental sciences valuable information such as the evolution of volcanic and metamorphic rocks, fractional crystallization of magma, and chemical signature of aerosol can be studied by the abundance patterns of rare earth elements (REEs) in solid samples. There are a few analytical methods of REEs with detection limits of ppm and spatial resolution of 30-40 micron such as Laser-Ablation Inductively Coupled Plasma Source-Mass Spectrometry (LA-ICP-MS), Secondary Ion Mass Spectrometry (SIMS) and Synchrotron Radiation induced X-Ray Fluorescence analysis (SR-XRF). Generally SIMS technology provides better lateral and depth resolution than LA-ICP-MS. Compared with other SIMS instruments (Cameca IMS 1280, IMS 7f, and SHRIMP), Nano-scale Secondary Ion Mass Spectrometer (NanoSIMS) shows the highest lateral resolution. We have developed a method to measure all REEs (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) abundance in silicate glass and zircon mineral by a NanoSIMS. A 2nA O- primary beam was used to sputter a 7-8 micron diameter crater on the sample surface and secondary positive ions were extracted for mass analysis using an accelerating voltage of 8 kV. A high mass resolving power of 10,000 at 10% peak height was attained to separate heavy REE from oxide of light REE with adequate flat top. A multi-collector system combined with peak-jumping by magnetic field was adjusted to detect all REEs and silicon-30 to calibrate against. Based on analytical results of NIST SRM610 glass, sensitivities of REEs vary from 3.2 cps/ppm/nA of Lu to 12.9 cps/ppm/nA of La. There is a negative correlation between secondary ion yields (SIY) of REE observed in SRM610 and the second ionisation potentials, while no correlation is apparent with the first valence. The SIYs of SRM610 show a similar trend to those in zircon standard “91500”, suggesting a lack of matrix dependency with a high mass resolution method.

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