Microscopic imaging of isotope ratios for rocks and minerals

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Isotopes are useful tracer in cosmo- and geo-chemistry to determine origin and circulation of elements in nature. Environmental changes could shift isotope ratios of individual phases and the variations often fixed in growing minerals. Therefore decoding of isotopic zonings of minerals using microscopy would be useful for studying historical environmental variations. Recently several technical developments of secondary ion mass spectrometry (SIMS) are tried to achieve the analysis.

One state-of-the-art approach for the isotope-microscopy is use of scanning of focused ion beam. In scanning isotope imaging, isotopic data are collected sequentially from each point of the analyzed area and images are reconstructed by the computer. *In situ* imaging of isotopes such as oxygen and carbon with high lateral resolution (~100 nm) has been developed by a Cameca Nano-SIMS instrument [e.g. 1, 2]. A precision and analyzed field are limited to 5 to 10 % level and several tens of micro-meters analyzed fields in a limited analytical time because secondary ion intensities per pixel are less than 10^6 cps due to the fine focused primary beam, which determine the lateral resolution. Another approach is use of stigmatic ion optics with two dimensional detector. About 0.5~1 μm lateral resolution with a precision of 0.5 to 1 % level for oxygen isotope ratios on a ~70 × 70 μm sample field has been achieved by a Cameca ims-1270 instrument attached with SCAPS detector [3-5]. The SCAPS is a high-efficiency stacked CMOS-type active pixel sensor, which has features including wide dynamic range, no deadtime, and direct detection of ions. In the latter case, the lateral resolution and the precision are limited by aberrations of the ion optics and primary beam density of the analyzed field, respectively. Therefore, the scanning method has advantages in high lateral resolution isotope-microscopy of small area, whereas the stigmatic method has advantages in high precision isotope-microscopy of wide area. In this talk we introduce microscopic imaging of isotopes using both tequniques and results using them.

References

[1] Messenger S. et al. (2003) *Science* **300**, 105-108. [2] Floss C. et al. (2004) *Science* **303**, 1355-1358. [3] Yurimoto H. et al. (2003) *Appl. Sulf. Sci.* **203-204**, 793-797. [4] Nagashima K. et al. (2004) *Nature* **428**, 921-924. [5] Kunihiro T. et al. (2005) *GCA* **69**, 763-773.