In-situ determination of Nd isotope ratios in apatite

R. DOUCELANCE[1], E. BRUAND[1], S. MATTE[1], C. BOSQ[1], D. AUCLAIR[1], A. GANNOUN[1]

[1] Université Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France

The Samarium-Neodymium isotope systematics relies on the radioactive decay of the long-lived ^{147}Sm isotope to the radiogenic ^{143}Nd (half-life of 106 ± 0.8 Gyr). Its application as a source tracer and/or a chronometer covers a wide range of geological subjects dealing with the differentiation and history of the Earth and other planets. The Nd isotopic ratios are classically determined on bulk rocks and/or mineral separates by thermal ionization (TIMS) or plasma source mass spectrometry (MC-ICP-MS), after acid digestion of the samples and chemical separation of Nd from the other elements by ion-exchange resin chromatography. However, in-situ measurements are also possible by coupling the MC-ICP-MS instrumentation to a laser ablation system. In this case, the determination of the isotopic compositions is made quicker, being free from the steps of dissolution and chemical separation. Most importantly, it gives the possibility of considering much finer scales of heterogeneity than bulk-rock analyses, at the level of a few tens of micrometers.

The in-situ measurement of isotopic compositions of Nd is aimed at minerals rich in this element. Apatite is an ideal candidate as its Nd concentrations are generally greater than several hundred of ppm, and it is an ubiquitous phase in most rocks (magmatic, metamorphic and sedimentary), giving its analysis a wide field of applications.

Here, we present new Sm-Nd results acquired on the Thermo Scientific™ Neptune Plus™ instrument at the Laboratoire Magmas et Volcans (LMV), France, on apatite grains from carbonatites. We detail the different corrections needed to obtain accurate and precise Nd isotopic ratios with a focus on the laser (size of the spot, energy and frequency) and MC-ICP-MS parameters (X skimmers vs. H skimmers) and their influence of the measurements. We also show the necessity for external standardisation (here we used the Durango apatite) in order to obtain both accurate Nd isotopic compositions and Sm/Nd chemical ratios. Finally, we demonstrate that our best measurements are obtained when considering raster analysis rather than individual spots. From a more general point of view, this contribution also aims to help geochemical labs to implement an in-situ analysis protocol for Nd isotope ratios.