Lu-Hf isotopic systematics of subducted ancient oceanic crust: Roberts Victor eclogites

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The possible role of eclogite in mantle melting received increasing attention during the last years. However, this entity is difficult to constrain by theoretical modelling as effects of subduction and mantle metasomatism that are likely to change the composition of subducting oceanic crust are not well known. Eclogite xenoliths from the Roberts Victor kimberlite, South Africa, were among the first for which an origin as subducted altered oceanic crust was proposed. This hypothesis is based on oxygen isotopic studies as well as on trace element characteristics that revealed striking similarities to oceanic gabbros and basalts that experienced seawater alteration at different temperatures. Many of the Roberts Victor eclogites yield late Archean ages (2.7 to 3.2 Ga, by different methods) and $Hf_{(CHUR)}$ model ages from this study confirm these. Thus, they may represent some of the earliest oceanic crust available for study.

Here, we report on Lu-Hf isotopic data from an ongoing study on diamondiferous and non-diamondiferous eclogitic xenoliths. The data are combined with evidence from $\delta^{18}O$, major and trace elements as well as Sr and Nd isotopic ratios to arrive at constraints on the reservoir of subducted oceanic crust within the Earth´s mantle and to speculate on its role in melting processes. The samples show a large range of ε_{Hf}- and ε_{Nd}- values of -9.2 to 166 and -22 to 484, respectively, at the time of kimberlite eruption (120 Ma). Most samples plot below the mantle array, but the variation extends to more unradiogenic ε_{Nd}- values, typical of continental crust. These very unradiogenic samples show evidence of cryptic metasomatism, unrelated to the kimberlite, that affected the Sm-Nd isotopic system, while the Lu-Hf system remained undisturbed. Two eclogites have extremely radiogenic Nd and Hf isotopic composition, very unradiogenic, identical $^{87}Sr/^{86}Sr$ ratios of 0.70091 and depleted trace element patterns, indicating that these samples are residues of melting early in their history. Our first results show that the reservoir of subducted oceanic crust in the mantle may have a very variable composition. However, given the good correlation between Nd and Hf isotopes in terrestrial basalts, the contribution of eclogite melts to these basalts has to be relatively minor.

Comparison of isotope dilution and laser ablation REE measurement of Geochemical Standard Reference Materials

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The rare earth elements (REE) are important to our understanding of many geochemical processes, including mantle evolution, origin of volcanic and metamorphic rocks, sedimentary systems, and oceanography. In many of these systems, REE abundances vary on small spatial scales. In such cases, it is often important to use in situ micro-analysis techniques such as laser ablation ICP-MS (LA-ICP-MS) or secondary ion mass spectrometry (SIMS), where it is possible to analyse REE abundances with high spatial resolution. However, in situ analysis relies heavily on homogeneous matrix-matched standards such as the NIST- 610 and 612 glasses. Uncertainties in accepted values for these standard glasses translate directly to the accuracy in measured REE abundances. For high precision REE analyses, particular where the anomalous behaviour of individual REE is used as a tracing tool (e.g. Eu, Ce anomalies) uncertainties in accepted standard values may contribute to considerable inaccuracy. One way to test the accuracy of LA-ICP-MS analysing method is to compare the data with high precision data obtained from isotope dilution (ID). We present isotope dilution MC-ICP-MS analysis of REE in a number of geochemical reference materials: NIST- 610, 612, and 614, BIR-1, BCR-1, BCR-2, BHVO-1, BHVO-2, BHVO-2G, SCR-2G, W-2, and WS-E powders and glasses. We also present data from LA-ICP-MS Quadrupole analyses of glass reference materials. Our data shows that there are discrepancies between LA-ICP-MS and isotope dilution data, an artefact inherited from calibration and not from isobaric interferences.

Laser micro-sampling (offline) for ID and $^{143}Nd/^{144}Nd$ analyses is also a potentially powerful tool for rapid and precise high spatial resolution analysis of the REE and Sm-Nd isotopic compositions. Little is known about possible mass fractionation of REE laser ablation sampling. With this technique it may also be possible to decouple elemental fractionation occurring in the plasma from fractionation occurring during laser ablation. As such, we have explored the potential of offline laser sampling of silicate glasses and minerals directly into acid spiked with Sm-Nd or REE mixture spikes and subsequent analysis by MC-ICP-MS after chemical separation of LREE.