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Mineral-whole rock isotope fidelity in granitoids? A comparative study of Hf-Nd-O isotopes in apatite, titanite and zircon.

EMILIE BRUAND[1], MIKE FOWLER[2], CRAIG STOREY[2], BRUNO DHUIME[3] AND RÉGIS DOUCELANCE[4]

[1]Laboratoire Geo-Ocean, CNRS, Université de Bretagne Occidentale, France

[2]University of Portsmouth

[3]CNRS-UMR5243, Géosciences Montpellier, Université de Montpellier

[4]Université Clermont Auvergne

Presenting Author: emilie.bruand@univ-brest.fr

It is well-established that lanthanide rare earth elements (REEs) have the potential to record the nature and source characteristics of their host magmas, in both whole-rock and their minerals. Accessory minerals that concentrate REEs are especially useful in crustal evolution studies, both for their elemental and isotopic information; the classic and unrivalled example being zircon. Approaches using a single radiogenic isotopic system, or one radiogenic and one stable isotope system (e.g., Hf and O) in one REE-bearing mineral (usually zircon) are common, but those involving multiple isotopes in several minerals remain scarce despite offering many advantages. Importantly, the latter approaches also allow comparingdifferent techniques and provide evidence on whether isotopic systems were disturbed by secondary processes. This contribution documents several isotopic systems within the abundant accessory mineral of Caledonian high Ba-Sr granitoids from Northwest Scotland. We present a multi-isotope study of titanite, zircon and apatite from two localities(Strontian and Rogart), which were selected for their contrasting whole-rock isotopic signatures - the former deriving from a depleted mantle source, whereas the latter derived from a strongly enriched mantle source. New in-situ Sm-Nd in titanite and apatite and Hf in zircon isotope data are discussed and compared with in-situ oxygen isotope data previously published for the same samples. An internal consistency is observed for Nd isotopes in apatite and titanite. Nd isotopes values for both minerals strongly correlate with Hf isotopes in zircon. Isotopic data at the mineral scale confirm the Strontian and Rogart source characteristics previously defined from whole-rock isotope data, with the Rogart having a more enriched signature than the Strontian source along the “Caledonian Parental Magma Array”(CPMA). Importantly, the contribution of sediments in the CPMA source(s) can be estimated from a diagram combining Sm-Nd isotopic signatures and $(La/Sm)_N$ in apatite and titanite. Overall, we demonstrate that detailed petrogenetic records are not only available in zircons but also in magmatic titanite and apatite, and we suggest that integrated multi-mineral approaches have potential to maximise constraints from in-situ mineral isotope geochemistry.