In-situ $^{143}Nd/^{144}Nd$ in LREE-rich minerals via LA-MC-ICPMS

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We have developed an *in-situ* laser ablation multiple-collector inductively coupled mass spectrometry (LA-MC-ICPMS) technique to measure Sm-Nd isotopic systematics in light-rare-earth (LREE) enriched accessory minerals. Accurate and precise (< 0.003%) Nd-isotopic ratios can be analysed in common accessory minerals such as monazite, allanite, and titanite at spatial resolutions ranging from 16 to 150 microns. These minerals can also be dated via ion-microprobe or quadrupole LA-ICPMS. Sm-Nd and U-Th-Pb isotopic data can, therefore, be combined at the same analytical scale to investigate grain-scale variations in $\varepsilon_{Nd}(t)$. We briefly describe several geological application of this new approach.

In-situ $^{143/}Nd /^{144}Nd$ and Sm/Nd ratios were collected for polyphase monazite in the Palaeoproterozoic granulite-facies gneisses that host the Challenger Au Mine, Gawler Craton, SA. Successive growth domains are large enough to analyze by LA-MC-ICPMS with a 22 μm laser spot. This dataset reveals that previous conventional garnet-whole-rock Sm-Nd measurements underestimate $\varepsilon_{Nd}(t)$ values and depleted mantle model ages for the gneisses owing to apparent closure of the garnet Sm-Nd isotopic system ca. 40 Myr after the peak of metamorphism.

We also tested this method on allanite associated with Na-Ca-Fe alteration from a Fe-oxide-Cu-Au (IOCG) prospect in the Curnamona Province, NSW. Owing to the high Sm and Nd content of allanite, precision of < 25 ppm (< 0.5 ε_{Nd} units) can be achieved for laser spot sizes of 50 μm. Previous conventional Sm-Nd studies of similar styles of alteration using garnet and epidote[1] obtained an isochron age of ca. 1575 ± 26 Ma with a spectrum of $\varepsilon_{Nd}(t)$ values between -4.1 to -6.3. In contrast, our *in-situ* data reveal that relict allanite cores formed at 1626 ± 20 Ma with $\varepsilon_{Nd}(t)$ between -4.5 to -6.0 whereas epidotized rims formed at ca. 1550 ± 50 Ma and have more enriched $\varepsilon_{Nd}(t)$ between -6.2 to -7.3. The identification of two potential fluid sources as recorded by these fossil Nd-isotopic variations points to a complex interplay between magmatism, metamorphism, and regional metasomatism.

These test cases highlight the benefits of determining Nd-isotopic variations at the same scale as textural and mineralogical observations. Future work will be aimed at developing homogeneous reference standards, and integrating this technique into regional metallogenic studies.

References

[1] Kent, A. et al. (2000) *Lithos* **54,** 33-62.