In-situ LA-MC-ICPMS Sm-Nd dating using REE-enriched accessory minerals

CHRIS MCFARLANE[1,2] AND MALCOLM MCCULLOCH[1]
1. Australian National University, Research School of Earth Sciences, Mills Rd., Canberra Australia ¶ 2. University of New Brunswick, Department of Geology, Fredericton, NB, E3B 5A3 Canada
<crmm@unb.ca>

Whereas Sm-Nd isochron ages have conventionally been obtained using combinations of dissolved and purified whole rock and major-mineral aliquots analyzed by TIMS, the recent development of precise and accurate LA-MC-ICPMS Sm-Nd analyses of REE-enriched accessory minerals provides a potentially rapid method to date high-temperature magmatic and metamorphic crystallization events. Monazite, allanite, titanite, and apatite, which together comprise the bulk of the LREE budget of most crustal rocks, have all been successfully analyzed for Sm-Nd using LA-MC-ICPMS at spatial resolutions raging from 16 µm (monazite) to 150 µm (apatite). For these laser crater sizes, precision better than 50 ppm (2σ) can typically be achieved on $^{143}Nd/^{144}Nd$. This technique was originally developed to combine in-situ SHRIMP U-Pb ages and Sm-Nd systematics to investigate isotopic inheritance at the grain scale. However, the technique can also be used to obtain relatively precise Sm-Nd isochron ages independent of external calibrations, matrix corrections, or time-consuming isotope dilution. By analyzing a range of (presumed) cogenetic LREE-enriched accessory minerals from the same rock to obtain a range of Sm/Nd, a sufficient number of data points can be collected in a single analytical session to define a statistically robust isochron age. In the example presented here, a fresh granite sampled from the Morila Mine, Mali, was dated at 2093 ± 6 Ma (1σ) based on an upper intercept of near-concordant SHRIMP U-Pb data for oscillatory zoned zircon. Allanite and apatite separated from the same rock were analyzed for Sm-Nd using LA-MC-ICPMS. The range of $^{147}Sm/^{144}Nd$ both between allanite (~0.07) and apatite (up to 0.16) and within each group of analyses provides a sufficient spread of Sm/Nd to calculate a reasonably precise Sm-Nd isochron age of 2097 ± 36 Ma (1σ). This demonstrated precision and accuracy combined with the ability to target accessory minerals in thin section (unknowns and standards can be mounted separately), can, therefore, be exploited as a geochronological and Sm-Nd isotope tracer tool to help guide interpretations for the origin and evolution of Proterozoic and older rocks.

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