Neodymium isotope equilibration during crustal metamorphism revealed by in situ microanalysis of REE-rich accessory minerals

J. HAMMERLI[1], A.I.S. KEMP[2] AND C. SPANDLER[1]*

[1]School of Earth and Environmental Sciences, James Cook University, Townsville, Australia, 4811
[2]Centre for Exploration Targeting, University of Western Australia, Perth, Australia
(* correspondence: Carl.Spandler@jcu.edu.au)

Radiogenic isotopes are widely used to investigate crustal evolutionary processes, however recent claims of Nd and Sr isotope disequilibrium during anatexis question the reliability of such information. To test Nd isotope equilibrium during metamorphism, we have conducted an in situ Sm-Nd isotope study (by LA MC-ICP-MS) of apatite, allanite, titanite, xenotime and monazite in metasedimentary rocks of different metamorphic grade. Our study site is the Mount Lofty Ranges, South Australia, which represents a well-characterized Cambro-Ordovician LP/HT metasedimentary sequence, with metamorphic conditions ranging from ~350˚C to partial melting (~700˚C) at ~0.4 GPa.

Our results show that apatite retains an original, probably detrital, highly variable Nd isotopic signature until at least 500 ˚C before being isotopically homogenized, irrespective of textural context within the rock. Once equilibrated, apatite retains its Nd isotope signature throughout anatexis. In contrast, allanite and titanite are equilibrated at temperatures as low as 350 to 400 ˚C. REE-rich accessory minerals in high-grade rocks (~600 ˚C) show very similar initial εNd values at the time of metamorphism. We conclude that under these metamorphic conditions Nd isotope disequilibrium between crustal melts and metasedimentary sources is unlikely. Intra-grain Nd isotope zoning of monazite indicates that partial melting was open system, involving the injection of externally-derived melt into migmatites. This process, likely to be common in anatectic terranes but not always obvious at hand-specimen scale or from bulk rock geochemical data, can produce isotope variation that could potentially be misinterpreted as disequilibrium between the melt and its protolith.