Acquiring exceptional HFSE and REE abundances in A-type granites

WJ COLLINS[1], R.H. SMITHIES[2], C.L. KIRKLAND[1]

1 The Institute for Geoscience Research, Dept. of Applied Geology, Curtin University, Perth, WA 6845, Australia.
[2]Geological Survey of Western Australia, 100 Plain St, East Perth, WA 6004, Australia

The distinctive trace element features of most A-type granites reflects an ultimate origin by dehydration melting during lithospheric extension, usually in deep crustal hot zones isolated from the influence of water-fluxing in suprasubduction zones. Nonetheless, examination of two spatially-related A-type magmatic systems from central Australia illustrates major contrasts in trace element behaviour. The older (1220-1150 Ma) Pitjantjatjara supersuite (ferroan charnockite) acquired its elevated HSFE (400-500 ppm Zr) and REE concentrations as deep crustal (6-8 kbar) intermediate-composition partial melts (60-65 wt.% SiO2). By contrast, the younger (~1090-1040 Ma) Warakurna volcanic system, of supervolcano proportions, acquired exceptionally high REE and HFSE concentrations (e.g, 800-1000 ppm Zr)) in more discrete, generally high-silica (>70 wt.% SiO2), parental melt batches. The contrasting magmatic systems are considered to reflect increasing geochemical refinement of the crust during sequential emplacement of hot tholeiitic magmas. The early, voluminous Pitjantjatjara plutons were generated by melting and mixing of isotopically evolved, dehydrated crust with the basaltic magmas, and were emplaced throughout the crustal column. By contrast, the younger Warakurna granitic system formed at upper-crustal levels, evident from their very light δO^{18} values, during emplacement of hot, widespread tholeiitic melts (Warakurna LIP). Their extreme HFSE and F (maximum >5000ppm) contents reflect small degree crustal melting of the pre-existing, A-type Pitjantjatjara-type crust under UHT conditions. Yellowstone is a comparable modern example. At these shallow levels, magma temperature during melt generation exerts the dominant control on trace element concentrations, and fluorine has minor if any influence, except under near- to sub-solidus conditions, when it may become a significant rare metal transporter at the late magmatic to hydrothermal stage.