

Infracrustal and supracrustal granites – The Nanjing separation

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In 1974 we proposed that granites are derived from two contrasting sources, igneous and sedimentary, giving the I- and S-type granites. At the 1982 Nanjing Symposium on Granites and their Metallogenic Relations we suggested that the terms “infracrustal” and “supracrustal” describe the two types in a more fundamental way. This *Nanjing separation* has not been widely taken into account by later workers and, for example, it is hard to reconcile with suggestions that I- and S types are transitional, parts of a spectrum of granites.

Since our initial studies of eastern Australian granites in the 1960's, we have realized that the I-type granites were derived from rather homogeneous sources, which cannot have been supracrustal or volcanic rocks. This understanding predated our recognition of the S-type granites. Such a conclusion is required by the extremely strong correlations between elements, typical of the low-temperature I-type granite suites.

Inter-element correlations are relatively poor among granites of S-type suites and isotopic compositions can be quite variable. For example, ten initial Sr isotopic values for the Jilamatong Granodiorite, exposed over an area of 101 km² and formed from a single batch of S-type magma, range from 0.7111 to 0.7153. Also, the more mafic S-type granites contain supracrustal enclaves carried from depth, whereas mafic enclaves that were derived from igneous rocks are rare.

We provide examples of these contrasting patterns of geochemical behaviour. The origin of the source rocks of the supracrustal granites is clear, with debate about the proportions of introduced mantle components.

The infracrustal granites, generally developed by partial melting of crust, must have had a major and often dominant ultimately mantle-derived source combined in some way with a crustal component, shown by isotopic compositions ($Sr_i = 0.704-0.710$; $\epsilon_{Nd} = +4$ to -9 ; $\delta^{18}O = +6$ to $+11$ in the Lachlan Fold Belt for granite suites in which the more mafic rocks contain hornblende). Chemical and isotopic relationships show that such variations cannot have been a result of large-scale magma mixing/mingling, or of assimilation during evolution of the magmas. The evidence strongly indicates that the observed isotopic compositions and specific chemical features of granite suites were also characteristics of rather homogeneous source rocks before partial melting. The precise way in which those features were acquired remains a problem. The possibility that many I-type granite source rocks resulted from prior mixing between mantle-derived melts and melted crust should be considered.

Surface analytical studies of feldspar surface reaction with U(VI)

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Feldspar minerals are thermodynamically unstable in the near-surface environment and their surfaces are well known to react readily with aqueous solutions, leading to incongruent dissolution at low pH values, but congruent dissolution at neutral and high pH values. Interactions with mineral surfaces are an important control on the environmental transport of trace elements and detrital feldspars are abundant in soils and sediments.

The interaction of U(VI) ions with the feldspar surface has been studied. Sorption experiments with uranyl ion (UO_2^{2+}) at pH 2, 6 and 10 were carried out and measurable uptake, generally through surface complex formation, was only found at pH 6 and 10. Reacted surfaces were analysed by X-ray photoelectron spectroscopy and secondary ion mass spectrometry. At pH 6 and at an initial U(VI) concentration above 21.0 μ M, precipitation of a surface phase was observed by atomic force and scanning electron microscopies, and this was identified as becquerelite ($Ca[UO_2]_3O_2(OH)_3 \cdot 2.8H_2O$) by grazing incidence X-ray diffraction. Secondary ion mass spectrometry showed diffusion of uranium into the altered surface layer.