Highly-evolved silicic magmas: Volcanic vs. plutonic conundrums

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Evaluating the origins of highly-evolved silicic magmas and relations between granites and rhyolites is guided by 2 considerations: (1) Very low Sr and Ba of high-Si rhyolites (HSRs) and evolved granitoids require extensive fractional crystallization; (2) $SiO_2 \geq 77$ wt% in HSRs implies shallow crustal fractionation; highly evolved granites have a wider range of SiO_2, reflecting equilibration at a range of P. Thus evolved shallow granites may be trapped equivalents of HSRs, but disparity in volume and possibly geochemistry may suggest otherwise. Glazner *et al.* (2008 Geology) note that REE patterns in Sierran aplites ("U": MREE depletion, sphene effect) are distinct from those of HSRs in large ignimbrites ("seagull:" straight, large Eu anomaly), and infer that large plutons and HSRs are probably not related.

The voluminous Miocene magmatic suite of the Colorado River region includes highly-evolved granites and rhyolites (small-volume to giant Peach Springs Tuff). Increasing depletion in Sr and Ba correlates generally with depletion of MREE (transition from seagull to U patterns), providing evidence for a common fractionation pathway involving sphene (more evident in volcanic glasses than whole-rock volcanics – cf. Bachmann *et al.* 2005 CMP: Fish Canyon Tuff).

Compositional variability in evolved silicic magmas reflects environments of crystal growth (especially accessories) but does not distinguish between shallow granites and HSRs. Greater volumes of the largest HSR ignimbrites than of evolved granites in plutons may reflect the importance of the effectiveness of melt extraction and its influence on chamber stability (cf. Bachmann & Bergantz 2008 Elements)

The 2.74–2.66 Ga Kenogamissi complex (Abitibi): Evolving sources of plutons mirroring geodynamics

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The Late-Archaean Kenogamissi complex, in the SW Abitibi Subprovince (Canada) is a large plutonic complex emplaced between 2740 and 2660 Ma, synchronous with the formation of the surrounding greenstone belts. P-T conditions for orthogneiss in the complex are in the amphibolite-facies (P = 7-8 kbar), well above the pressures recorded by the surrounding greenstones. Thus the Kenogamissi Complex includes the mid-crustal component of the Abitibi Along with geochronological, geochemical and structural data, the evolution of the Abitibi is now believed to include plume-related volcanism with discrete episodes of subduction-related magmatism, leading to magmatic accretion of a plateau or LIP before ~2690 Ma, followed by collision and folding.

The pre-2700 Ga plutonic rocks comprise three groups of tonalites: a 2740 Ma tonalite-diorite association (Rice Lake batholith, Chester complex); a younger composite gneiss unit, with enclaves of 2735 Ma tonalites and diorites in a 2720 Ma tonalitic to trondhjemitic matrix (Gogama orthogneiss); and 2710 Ma leucotonalite plutons (Regan tonalite). The post-2700 Ga association include several 2700-2695 Ma biotite granodiorite plutons (McOwen, Roblin) and a 2682 Ma hornblende granodiorite (Neville pluton). A 2660 Ma pink granite (Somme pluton) represents the latest Archaean plutonic event.

O-isotope, major and trace element geochemistry reveal the petrogenetic evolution of the different groups. The diorite-tonalite units can be derived by partial melting of mafic rocks at the base of a thick plateau-like crust, whereas the leucotonalites and trondhjemites require melting of a mafic source at greater depth (ca. 20 kbar). This is consistent with the accretion of a thick oceanic plateau or LIP, re-melting of its base, and limited subduction-related (slab melt) inputs. The granodiorites require a crustal source, and reflect syn-collisional melting of the previously accreted crust. Sanukitoids at 2685 Ma require both crustal and mantle-derived components, reflecting partial melting of a mantle metasomatized during the previous subduction events. The latest granites, at 2660 Ma, are purely crustal melts that reflect the thermal relaxation of the Abitibi orogenic crust.