Geophysical Research Abstracts
Vol. 16, EGU2014-4506, 2014
EGU General Assembly 2014

Generating contrasting granitic melts from the same source: the ca. 3.1 Ga Heerenveen and Mpuluzi batholiths, South Africa

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The Mpuluzi and Heerenveen batholiths of the Barberton Granite—Greenstone Terrain (BGGT), South Africa, belong to the post-tectonic, ca. 3.1 Ga GMS (granite—monzogranite—syenite) suite. They are complex batholiths formed by successive intrusion phases; and they include a range of granitoid phases, defining at least three main magmatic series: (1) leucogranites and granites; (2) quartz-monzonites and syenogranites; (3) tonalites and relatively mafic granodiorites. Despite their close spatial and temporal association, each series is very distinct geochemically, demonstrating the coexistence of various magma types. The emplacement sequence starts with leucogranites, moving on to (slightly porphyritic) granites forming the bulk of the batholiths; to late leucogranites, syenogranites/monzonites and dark granodiorites emplacing in late, syn-magmatic shear zones.

However, despite the clear emplacement sequence and the well identified, successive emplacement phases, the isotopic characteristics of the GMS batholiths are strikingly homogeneous. Zircons from 18 samples of the Mpuluzi and Heerenveen batholiths, representative of all phases and magmatic series, were dated and analysed for Hf isotopes. Regardless of the relative age and petrological type, they demonstrate emplacement ages identical within error (3106 $\pm$ 8 Ma); and, perhaps more surprinsingly, similar Hf isotopic values ($\epsilon_{Hf}(T) = -1.5 \pm 0.7$, corresponding to model ages of ca. 3520 Ma). This would suggest that a diverse range of granitoids, ranging from leucogranites to syenites, including both peraluminous and metaluminous compositions, and spanning both sodic and potassic compositions ($0.9 < Na_2O/K_2O < 2.5$), were all generated concomitantly (or in short succession) from the same source, or from isotopically similar sources.

The lack of mafic components, associated with the crustal signature of all granitoids, implies a crustal source for the GMS granites. Regionally, both TTG plutonic rocks (Steynsdorp pluton and component of the Ancient Gneiss Complex of Swaziland, ACG), and felsic volcaniclastics and amphibolites of the Theespruit formation emplaced at ca. 3.52 Ga, and represent potential sources. In all geochemical diagrams, the different rock types do not define single trends; rather, each magmatic series define its own, individual trend, precluding the different facies to be represent a single differentiation (or mixing) series.

We suggest that the various component of the GMS granitoids mirror fast melting of a composite crust. Melting of the Theespruit volcaniclastics resulted in the generation of leucogranites and granites. Melting of amphibolitic portions of the Theespruit group yielded granodiorites and tonalites. Finally, the syenogranites are the result of melting of dry lithologies – either a dry tonalitic basement (ACG), or melt-depleted portions of Theespruit volcaniclastics, that lost melt due to the extraction of the leucogranites and granites.