Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05041, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05041
EGU General Assembly 2008

High- and low- pressure sub-series in archaean TTGs: a case study from the mid-archaean Barberton Granite–Greenstone Terrain, South Africa.

JF. Moyen (1), **G. Stevens** (1), R. Belcher (1, 2) and A. Kisters (1)

(1) University of Stellenbosch, Private Bag X-01, Matieland 7602, South Africa, (2) Council for geosciences, Limpopo unit, PO box 620 Polokwane, South Africa

The Archaean continental crust is volumetrically dominated by sodic granitoids (and equivalent orthogneisses) known as tonalites, trondhjemites and granodiorites —TTGs—. TTGs are formed by partial melting of mafic lithologies in the garnet stability field. However, the possible geodynamic context in which they form is widely debated, two end-member processes being (1) slab melting in a "hot" subduction zone; (2) partial melting of mafic rocks at the base of a thick crust (either an oceanic plateau, or a tectonically thickened zone).

The two situations actually correspond to contrasted P–T conditions. Slab melting would occur at high depth (ca. 20 kbar), but relatively low temperatures ($\leq$ 900 C), whereas both the base of a plume-related plateau or of a tectonically thickened crust would melt at somewhat lower pressures (ca 10 kbar) but higher temperatures (perhaps 1000 C).

The wealth of published experimental data allows to investigate the characteristics of the magmas formed in both situations. In the slab melting scenario, the high-pressure, "low"-temperature magmas are Si-rich, Fe and Mg-poor; they form in equilibrium with a garnet-rich, plagioclase-free (eclogitic) residuum, and are trondhjemites and tonalites, with very high Sr/Y values (up to 450, typically 100–200). In contrast, melting in the "lower crustal" conditions results in higher degrees of melting yielding more mafic (lower Si, higher Fe and Mg) rocks in equilibrium with a moderately garnet rich, and plagioclase bearing (amphibolitic) residuum. Such magmas are quartz-diorites, tonalites and granodiorites, with lower Sr/Y ratios (50–100).

Consequently, it appears that the term “TTG” is to some degree a misnomer, as it actually encompasses rocks from (at least) two different sub-series, a “Tonalite-Trondhjemite” and a “(Diorite)-Tonalite-Granodiorite” sub-series.

In the mid-Archaean (3.5 - 3.1 Ga) Barberton Granite-Greenstone Terrain (BGGT) of South Africa, 3 cycles of “TTG” magmatism occurred at 3.55–3.51 Ga, 3.45 Ga and 3.25–3.21 Ga. Using simple geochemical criteria (SiO_2, Al_2O_3, Sr and Y contents), it is possible to classify the rocks from each groups as belonging to either of the sub-series. At 3.55–3.51 Ga, the first magmatic cycle corresponds to rocks from the low-pressure (TG) sub-series, probably reflecting accretion over an active plume, consistent with the co-eval mafic-ultramafic (komatiites) volcanism of the lower Onverwacht Group. At 3.45 Ga, the second cycle is a short-lived event of high-pressure (TT) plutonism, suggesting a short-lived subduction event during a break in the plume activity. Finally, the ca. 3.2 Ga third cycle is the most complex; composite plutons South-West of the main belt contain rocks from both sub-series, with a global trend towards the lower-pressure varieties. Structures and metamorphism during this period are consistent with a subduction–(collision)–exhumation orogen, including HP-LT metamorphism, paired metamorphic belts and late-tectonic exhumation. We propose that the heterogeneous nature of the ca. 3.2 Ga rocks reflect this complex history, and the shift from subduction to post-collision exhumation.

TTGs are a diverse group. Identification of the sub-series that make it up actually allows to trace the history of the accretion of one of the oldest continental blocks, the BGGT, from initial plume-related initiation, to peripheral growth by subduction, to its final implication in a collision orogeny and final stabilization.