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GEOCHEMISTRY AND PETROGENESIS OF THE GRANITOIDS OF THE BARBERTON MOUNTAIN LAND, SOUTH AFRICA

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The Barberton Mountain Land, situated in the Kaapvaal craton of southern Africa, is a well preserved pre-3.0 Ga granite-greenstone terrane. The greenstone belt consists of a sequence of mafic to ultramafic lavas and metasedimentary rocks emplaced/deposited between 3.5 and 3.2 Ga. The granitoid rocks were emplaced over a 500 Myr time-span and can be divided into two suites. The TTG suite (emplaced ca 3.5 - 3.2 Ga) contains tonalites, trondhjemites and granodiorites; and the GMS suite (emplaced ca 3.2 - 3.1 Ga) includes granites, monzogranites and a small syenite-granite complex.

Geochemically, the TTGs are typically low- to medium-K, metaluminous I-type granites, Their chondrite-normalised rare-earth-element (REE) patterns show two trends. The majority of plutons are LREE-enriched, HREE-depleted and with small or no Eu anomalies, whilst the Steynsdorp and Doornhoek plutons are relatively HREE-undepleted with significant Eu anomalies. Nd isotope analyses show that the 3.4 Ga TTGs have positive εNd values (0 to +3.7), indicative of depleted-mantle sources, similar to the oldest greenstone belt formations (the Onverwacht). In contrast, the 3.2 Ga TTGs have negative εNd, suggesting crustal or enriched-mantle input into the magmas.

The GMS rocks, on the other hand, are medium- and high-K metaluminous I-type rocks. They display two dominant REE patterns. Medium-K GMS rocks (the Dalmein and portions of Heerenveen) are LREE-enriched, HREE-depleted and have no Eu-

anomalies, whereas, the high-K GMSs (Heerenveen, Mpuluzi and Boesmanskop) are relatively HREE-enriched with negative Eu anomalies. Positive and negative εNd values (-4.4 to +4.8) for the Boesmanskop Syenite suggests depleted-mantle and crustal signatures.

The εNd and REE patterns, in particular, provide insights into the compositions of potential source rocks and restites for the TTG and GMS suites. Since HREEs and Eu are readily accommodated in garnet and plagioclase, respectively, their depletion suggests the presence of these minerals in the restite. For the TTG suite, we therefore suggest a garnet-rich amphibolitic or eclogitic depleted-mantle source at a depth $>$ 40 km. This has been confirmed by experimental work constraining the stability of garnet in the trondhjemite compositions, and at magmatic temperatures, to a pressure of 15.24 $\pm$ 0.5 kbar corresponding to a depth of 54.9 $\pm$ 1.8 km. In contrast, the GMS suite most probably had a plagioclase-rich, garnet-poor source that may be a mixture of depleted-mantle and crustal materials.

Tectonically, the Barberton area is dominated by two episodes of terrane accretion at $\sim$3.5 and 3.2 Ga, the ages of TTG magmatism. This compressional tectonic regime, coupled with the results of experimental work on the partial melting of greenstone type material leads us to suggest basaltic amphibolites of the greenstone sequences as likely source materials for the TTGs. The likely source rocks for the GMS suite, however, are not so easily constrained. The chemistry and εNd values of the Boesmanskop syenite suggest a hybrid mantle-crustal source. This type of hybrid source might also explain the features of the monzogranitic batholiths. Close associations between syenite and monzogranites are common, particularly in post-orogenic extensional/transtensional settings. Although extensional activity has not been documented in Barberton, $\sim$3.1 Ga strike-slip activity has. A post orogenic thinning of the crust might explain the production of large voluminous monzogranite batholiths and the passive nature of their intrusion dynamics.