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Continental growth and convergence-related arc plutonism in the Mesoarchaean: Evidence from the Barberton granitoid-greenstone terrain, South Africa

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ABSTRACT

U–Pb zircon ages from trondhjemitic gneisses of the Badplaas domain, located in the southwestern parts of the Mesoarchaean Barberton granitoid-greenstone terrain of South Africa, document a hitherto largely unrecognized plutonic event. The geochronological results indicate the addition of juvenile, felsic crust over a period of 60 Myr between ca. 3290 and 3230 Ma and prior to the main collisional event in the granitoid-greenstone terrain at 3230 Ma. The timing and duration of plutonism, together with the structural and compositional heterogeneity of the Badplaas domain suggest that the Badplaas domain represents part of a convergence-related magmatic arc. On a regional scale, the spatial and temporal relationships between plutonism, metamorphism and deformation are interpreted to preserve an almost complete inventory of a Mesoarchean arc-trench system. This includes (1) the 3290–3230 Ma convergence-related magmatic arc, (2) a largely coeval deposition of the back-arc type volcano-sedimentary 3260–3225 Ma Fig Tree Group of the Barberton greenstone belt, (3) relics of the underplated crust preserved in high-P, low-T rocks to the immediate east of the magmatic arc, juxtaposed against (4) high-T medium-P rocks of the overlying plate along the major crustal structure of the Inyoni shear zone. These findings corroborate the notion that thermal and rheological conditions on the early Earth supported, at least locally, crustal growth and the extraction of buoyant felsic crust along convergence-related magmatic arcs.

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1. Introduction

Like many Archaean granitoid-greenstone provinces, the Barberton TTG-greenstone terrain is made up of a sequence of supracrustal rocks, preserved in the Barberton greenstone belt, surrounded by an extensive TTG terrain. Facies variations, structure, petrography and distinct age structures in the supracustals point to the presence of at least two distinct terranes underlying the greenstone belt (De Wit et al., 1992; Lowe, 1994; Kröner et al., 1996). Most studies explain the juxtaposition of these terranes through uniformitarian processes and as a result of the accretion of two oceanic plateaus along a convergent plate boundary. The timing of the collisional phase can be constrained to ca. 3230 Ma (the D2 deformational event, after De Ronde and de Wit, 1994; Kamo and Davis, 1994; De Ronde and Kamo, 2000). The D2 deformation in the belt coincides with a high-P low-T metamorphic event recorded in rocks of the southern TTG terrain, which is interpreted to represent the burial of this southern terrain following convergence and collision in an arc-trench setting (e.g. Dziggel et al., 2005; Moyen et al., 2006). Geochronological studies have delineated three main phases of relatively short-lived TTG plutonism. Early TTG suites intruded at 3500 and 3450 Ma in the southern parts of the TTG-greenstone terrain and are largely coeval with the deposition of the lower parts of the greenstone sequence. This was followed by ca. 3230–3220 Ma-old plutons along the NW flank and in the south of the greenstone belt, the latter coinciding with or slightly postdating the main D2 deformation phase. A later suite of 3140–3100 Ma granites intruded the granitoid-greenstone terrain as areally extensive, tabular batholiths, postdating the main accretionary event in the belt (e.g. Anhaeusser and Robb, 1983; Kamo and Davis, 1994; Westraat et al., 2005; Schoene and Bowring, 2007). Field relationships and age constraints point to the syn- to late-collisional emplacement of the TTGs (e.g. De Ronde and Kamo, 2000). TTG plutonism that could be related to subduction and convergence prior to the main collision has, in contrast, not been demonstrated for any of the TTG terrains surrounding the greenstone belt. Sporadic pre-D2 ages of between 3300 and 3260 Ma are only recorded from isolated outcrops or xenoliths of migmatitic gneisses along the northern margin of the belt (Tegtmeyer and Kröner, 1987; Kamo and Davis, 1994; Schoene et al., 2008).

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