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A volcanic plateau origin of the Barberton granitoid-greenstone terrain

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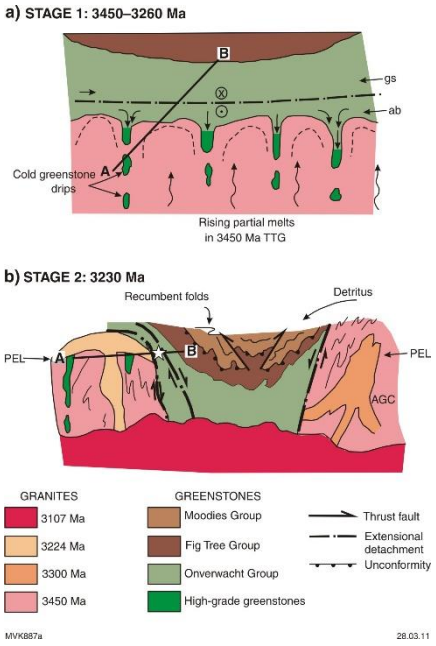
The Barberton granitoid-greenstone terrain (BGGT) is a key area for the study of Archean tectonic processes. Well known to consist of an upward-younging stratigraphic succession within the Barberton Greenstone Belt, these rocks are, for the most part, extremely well preserved despite having been deformed into a series of open to isoclinal, upright to recumbent folds, and transected by numerous faults. Only the lower, more highly metamorphosed parts of the belt are very strongly deformed where they have been intruded by a series of metamorphosed plutonic suites emplaced broadly at 3510 Ma, 3440 Ma, and 3220 Ma, the latter during regional metamorphism. Folding style and complexity increase towards the base of the belt and include steeply plunging structures that contrast markedly with the generally shallow plunges of fold structures within the belt.

The complexity of structures and southeasterly dip of inclined folds and faults through the central part of the belt, in combination with TTG-like geochemistry of pre- and syn-metamorphic plutonic rocks, have led many to regard BGGT formation as due to convergent plate margin processes. However, this ignores several critical features that are incompatible with such a model. These are the fact that the axial traces of large-scale folds converge inwards towards the core of the belt. Major shear zones are known to be extensional, not thrusts as originally suggested by convergent margin proponents. The dome-and-keel geometry in the southern part of the belt, where lineations plunge steeply and are radially distributed around 3440 Ma plutonic rocks with little-deformed cores and strongly sheared margins, indicates the tectonic process known as partial convective overturn (PCO), driven by mid-crustal softening of granitoid lithology and consequent sinking of dense greenstones (Fig. 1). Purported evidence for early Archean thrusting and mid-Archean subduction has now been refuted [1,2].



Indeed, it is uniquely this process of PCO that can explain the structural complexity of the BGGT and rationalise the now widespread evidence of crustal contamination of even the oldest greenstone components (Sandspruit and Theespruit formations[1,2]). PCO occurs in terrains formed as volcanic plateaus over hot, upwelling mantle that caused eruption of thick komatiite-basalt-dacite successions, extensive downward crustal thickening through underplating, contemporaneous formation of a thick, depleted subcontinental lithospheric mantle keel, and internal differentiation to generate voluminous TTG derived from a combination of melting of older TTG components and addition of juvenile material [2,3].

Figure 1: Schematic model for Barberton greenstone belt evolution. A) Stage 1: initiation of greenstone sinking commenced at 3.26 Ga with cool greenstone drips into partially molten, ca. 3.45 Ga TTG, and development of the Fig Tree basin. B) Stage 2: wholescale greenstone sinking at 3.23 Ga was accommodated by extensional shear zones (heavy dash-dot lines), uplift of flanking polyphase, granitic middle crust (pink areas), and deposition of Moodies Group sediments during compression within the core of the greenstone belt.[1]

[1] Van Kranendonk MJ (2011) *J Afr Earth Sci* 60: 346–352. [2] Van Kranendonk MJ et al. (2009) *Chem. Geol.* 261: 114-138. [3]Van Kranendonk MJ et al. (2015) In: *Continent Formation Through Time*. *Geol. Soc. Lond, Spec Publ* 389: 83-112.