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Chronology of the oldest supracrustal sequences in the Palaeoarchaean Barberton Greenstone Belt, South Africa and Swaziland

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ABSTRACT

Zircon age data for felsic metavolcanic rocks of the Sandspruit and Theespruit formations, the two oldest supracrustal components in the Palaeoarchaean Barberton Greenstone Belt, show that these two successions are time-equivalent and constitute one single volcanic event at ca. 3530 Ma. The Sandspruit felsic rocks are ubiquitously metasomatized, intensely deformed and intruded by, and tectonically interlayered with, ca. 3450 Ma granitoid sills that are probably part of the Theespruit Pluton. One metasomatized Sandspruit sample contains abundant metamorphic zircons with a weighted mean $^{207}Pb/^{206}Pb$ age of 3220.1 ± 1.6 Ma, reflecting a widespread metamorphic event in parts of the eastern Kaapvaal craton in South Africa and Swaziland.

Several samples of felsic metavolcanic rocks of the Theespruit formation confirm a previously established magmatic emplacement age of ca. 3530 Ma, but slightly older rocks up to 3552 Ma were found in the easternmost exposure of the Theespruit sequence near the South African/Swaziland border and may represent a lower lithostratigraphic level than exposed farther west.

Hf-in-zircon isotopic data for most felsic metavolcanic rocks confirm earlier results suggesting that these rocks predominantly originated from melting of a felsic continental basement, possibly related to the oldest, ca. 3660–3550 Ma components of the Ancient Gneiss Complex in Swaziland. However, several Sandspruit samples also suggest that a juvenile source was involved in their generation, perhaps a mafic underplate. We see no evidence in the geochemistry and isotopic signatures of felsic volcanic rocks of the Sandspruit and Theespruit formations for partial melting of a metabasaltic protolith and for Palaeoarchean oceanic crust that formed in connection with subduction. We rather favor a plateau-type setting on older continental crust.

1. Introduction

The oldest supracrustal units of the Palaeoarchaean Barberton Greenstone Belt in southern Africa are known as the Sandspruit and Theespruit formations (Viljoen and Viljoen, 1969a,b) and exclusively occur in the southern part of the Barberton Mountain Land, east of the town of Badplaas (Fig. 1). Mapped in detail by Anhaeusser (1980) and Anhaeuser and Robb (1980), these rock predominantly consist of strongly deformed mafic–ultramafic metavolcanic rocks. However, pillows and variolitic textures are well preserved in komatiitic and basaltic flows in low strain zones (Van Kranendonk et al., 2009). At most localities these rocks occur as rafts and xenoliths in the surrounding tonalitic–trondhjemitic gneisses of the Badplaas, Stolzburg and Theespruit Plutons (Viljoen and Viljoen, 1969; Anhaeusser, 2010; Van Kranendonk et al., 2014) and are metamorphosed up to upper amphibolite-facies as shown by the occurrence of garnet-amphibolites (Dziggel et al., 2005; Moyen et al., 2006). A recent review was provided by Anhaeusser (2014).

Viljoen and Viljoen (1969a) defined the Sandspruit Fm. as the lowermost unit of the Onverwacht Group and considered it to be

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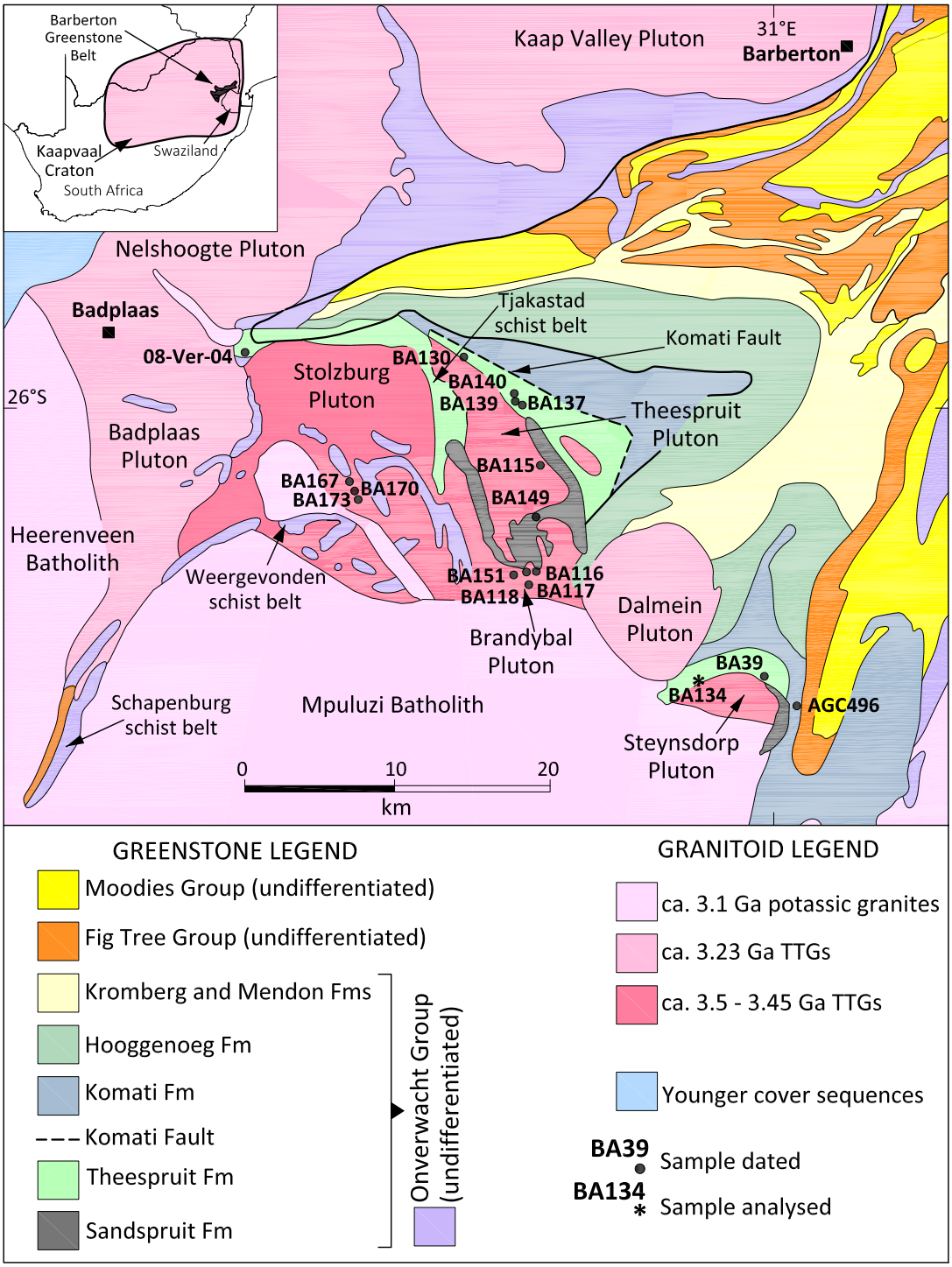

Fig. 1. Geological sketch map of the southern Barberton granitoid-greenstone terrane showing major rock units and sample locations.

largely composed of mafic (basaltic) and predominantly ultramafic (komatiitic) material with only minor felsic components. In contrast, the Theespruit Fm., considered by Viljoen and Viljoen (1969b) to overlie the Sandspruit Fm., was found to contain felsic volcanic rocks, as well as talc–chlorite and carbonated schists, and from mafic–ultramafic horizons. The chemical characteristics of the mafic–ultramafic components of the two formations were also used by Viljoen and Viljoen (1969b) to discriminate between the two, and they considered the Sandspruit Fm. rocks to be more primitive than those of the Theespruit Fm. From a limited geochemical database, they distinguished two komatiite-bearing units on the basis of higher Si, Ca, Fe and alkali elements and lower Mg for the Sandspruit Fm. relative to those of the Theespruit Fm. However, field relationships are ambiguous or inconclusive, as the rocks of both sequences appear to merge lithostratigraphi cally/tectonically with each other, and no direct contact relations between the two formations were found. Viljoen and Viljoen (1969b) claimed that the Sandspruit ultramafic rocks were not as