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Origin and evolution of the ~1.9 Ga Richtersveld Magmatic Arc, SW Africa

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ABSTRACT

The results of a study of the Paleoproterozoic Richtersveld Subprovince/Magmatic Arc (RMA) in southern Namibia are integrated with previous work in adjacent NW South Africa to produce a new, unified model for the evolution of the RMA. The RMA was variably affected by the ~1 Ga Namaqua. In the west, low-grade metamorphic rocks (Vioolsdrif Domain) record a limited Namaqua imprint whereas in the east, the equivalent rocks were converted to amphibolite-facies gneisses (Pella Domain). Tectonic slivers of RMA rocks are also found in an imbricate thrust zone that forms the base of the over-riding Namaqua-age Kakamas Domain further east. The volcanic and equivalent plutonic rocks (Orange River Group (ORG) and Vioolsdrif Suite respectively) of the RMA form a coeval calc-alkaline magma series with characteristic island-arc geochemical signatures. The entire magmatic history took place between 1910 and 1865 Ma, contrary to the much longer time-spans previously suggested. A large inclusion of migmatite (Bankwasser Migmatite) gave Archaean detrital zircon ages. It is interpreted as a possible fragment of Archaean Kaapvaal Craton basement that was incorporated into the RMA prior to ~1885 Ma. ~2 Ga detrital zircon ages in the ORG and ~2 Ga magmatic zircon inheritance and xenoliths entrained in the Vioolsdrif Suite reveal a hitherto unrecognised pre-RMA history. Recent work has shown that a pre-RMA arc (Sperrgebiet Arc) had developed to the west at ~2020 Ma in an upfaulted block within the Neoproterozoic Gariep Orogen. Consequently, a two-arc model is proposed for the early evolution of western Namaqualand with the early Sperrgebiet Arc evolving at ~2020 Ma which, possibly by processes of subduction migration, was cannibalised by the RMA at ~1885 Ma. Our data also suggests that certain quartzite sequences, traditionally placed within the ORG, were deposited after cessation of RMA activity and are thus unrelated to it.

1. Introduction

The Mesoproterozoic (~1.1 Ga) Namaqua-Natal Province (NNP) forms a significant segment of the world's "Grenville-aged" orogenic belts. The belt is associated with the formation of the Kalahari Craton (Jacobs et al., 2008), which constituted an important crustal block within the Rodinia supercontinent (Li et al., 2008). The NNP comprises those rocks in southern Namibia and South Africa which were, to a greater or lesser extent, reworked by the late Mesoproterozoic (~1.2–1.0 Ga) tectono-metamorphic event. It forms an arcuate swathe of crust over 1800 km long and up to 400 km wide that stretches from near Lüderitz on the west coast of Namibia to the KwaZulu-Natal coast in SE South Africa (e.g. Hartnady et al., 1985; Thomas et al., 1994; Cornell et al., 2006; Miller, 2008, 2012 and references therein, Fig. 1).

Whereas the eastern, Natal, sector of the NNP comprises juvenile ~1.2 Ga crust generated in island arcs that were accreted to the Archaean Kaapvaal Craton at ~1.1 Ga (Thomas et al., 1994), much of the western Namaqua sector involved crust with a Palaeoproterozoic heritage (e.g. Reid, 1997 and references therein). The unravelling of Palaeoproterozoic versus Mesoproterozoic events in the Namaqua sector of the NNP has proved to be a stubborn problem over the years, hindering our understanding of the extremely complex geological history of this part of the belt. Part of the key to gaining such understanding is to obtain large amounts of

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