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New U–Pb and $^{40}Ar/^{39}Ar$ ages from the northern margin of the Barberton greenstone belt, South Africa: Implications for the formation of Mesoarchaean gold deposits

Annika Dziggel[a,*], Marc Poujol[b], Alexander Otto[a], Alexander F.M. Kisters[c], Mario Trieloff[d], Winfried H. Schwarz[d], F. Michael Meyer[a]

[a] Institute of Mineralogy and Economic Geology, RWTH Aachen University, Wuellnerstraße 2, 52062 Aachen, Germany
[b] Géosciences Rennes UMR CNRS 6118, Université Rennes 1, 35042 Rennes Cedex, France
[c] Department of Geology, University of Stellenbosch, Private Bag X1, Matieland, 7602 Stellenbosch, South Africa
[d] Institut für Geowissenschaften, Im Neuenheimer Feld 236, 66120 Heidelberg, Germany

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ABSTRACT

Gold mineralization in the Mesoarchaean New Consort gold mine in the Barberton greenstone belt, South Africa, is situated in the immediate hanging wall of an exhumed, composite granitoid gneiss dome known as the Stentor Pluton. The granitoid-greenstone contact is characterized by a contact-parallel high-strain zone that separates the mid-crustal gneisses from the greenschist facies greenstone belt. In contrast to the lower greenschist facies deposits in the central parts of the greenstone belt, the mineralized shear zones at New Consort are hosted by distinctly higher grade metamorphic rocks, ranging from upper greenschist to upper amphibolite facies conditions. A distinct change of ore and alteration assemblages with increasing metamorphic grade points to a temporal and spatial relationship between gold mineralization and the juxtaposition of the Stentor gneiss dome against the overlying greenstone belt. Examination of the structural and petrologic evolution of the mineralized high-strain zone, combined with new U–Pb and Ar–Ar data and previously published ages, indicates a multistage tectono-metamorphic evolution. Early high-T, medium-P metamorphism (ca. 600–700 °C and 5 ± 1 kbar) in the structurally deeper parts of the mine is interpreted to be related to an early period of orogen-parallel (NE–SW) extension and associated detachment shearing during the main (D_2) accretionary event in the centre of the greenstone belt, between ca. 3260 and 3225 Ma. Recent work has shown that these early high-T fabrics were reactivated at ca. 3105 Ma during the subsequent D_3 tectonism and associated emplacement of large potassic granite batholiths. The gold mineralization was coeval with NE–SW extensional exhumation and solid-state doming of the Stentor gneiss dome during the subsequent D_4 deformation. This late-stage deformation and the gold mineralization postdate the emplacement of the D_3-related potassic granites by more than 50 million years, as indicated by (1) a U–Pb age of 3046 ± 27 Ma for a retrograde titanite generation in a D_2-related amphibolite (sample 113), and (2) a 3027 ± 7.5 Ma age for hydrothermal titanite from the so-called footwall lens mineralization, which temperature has been estimated at 590 ± 40 °C. This high-T event is also recorded by a "corrected" 3040 ± 4 Ma hornblende Ar–Ar age from the same sample, suggesting that cooling of the Stentor gneiss dome shortly followed the exhumation. A considerably younger Ar–Ar age (2966 ± 4 Ma) has been obtained for an amphibolite from the contact-parallel high-strain zone, pointing to non-uniform cooling following the mineralization. The gold mineralization was largely contemporaneous with the emplacement of NNW trending, syn-kinematic granitic pegmatites and strain localization along the pegmatite swarm at ca. 3030–3040 Ma. The mineralization is also considerably younger than the gold mineralization in the greenschist facies gold deposits in the Barberton greenstone belt, which has previously been dated at ca. 3080 Ma. In conjunction with previously published ages, the data indicate the Au mineralization in the Barberton greenstone belt to have occurred during, at least, two mineralization episodes at ca. 3080 and 3040 Ma. The main phase of Au mineralization was introduced during the end of an either protracted or episodic structural and thermal evolution of the granitoid-greenstone terrain that may have lasted some 200 Ma.

* Corresponding author. Tel.: +49 241 8095773.
E-mail address: adziggel@iml.rwth-aachen.de (A. Dziggel).

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