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Structural, geochronological and P-T constraints on subduction-accretion processes in a Pan-African accretionary wedge – The Deep Level Southern Zone of the Damara Belt in Namibia

Shawn Kitt[a,*], Alexander Kisters[a], Ian Buick[a], Jan Kramers[b]

[a] Department of Earth Science, Stellenbosch University, Stellenbosch, South Africa
[b] Department of Geology, University of Johannesburg, Johannesburg, South Africa

ABSTRACT

The Southern Zone (SZ) accretionary prism of the Damara Belt in Namibia records the burial, offscraping and accretion of marine and original trench sediments during the Pan-African (~590–500 Ma) convergence of the Congo and Kalahari cratons. Although the structure and metamorphic conditions of the prism sediments have been documented, the processes that led to the imbrication of 100 km^2 slivers of Mesoproterozoic basement gneisses with the overlying prism metasedimentary rocks are poorly understood. This study combines structural data with P-T estimates and in-situ LA-ICP-MS U-Pb xenotime dating and Ar-Ar age determinations of mineral separates, to give insight into the dynamics of subduction and exhumation in the deeply eroded, tectonically interleaved Deep Level Southern Zone (DLSZ). Peak metamorphic assemblages in garnet-bearing amphibole gneiss from the Ekuja basement dome record P-T conditions of 8.5–9.1 kbar and 635–655 °C, suggesting burial to ca. 35 km. Garnet zoning patterns and breakdown textures show that peak metamorphism was followed by a clockwise retrograde P-T-t evolution. Exhumation of the Ekuja Dome is supported by structural observations and the retrogression of amphibole-plagioclase assemblages to biotite and epidote in the Omitiomire Shear Zone (OSZ). $^{40}Ar/^{39}Ar$ dating of biotite from the OSZ constrain the timing of exhumation of the Ekuja Dome to between 526.4 ± 3.5 and 521.9 ± 3.6 Ma. Peak metamorphic assemblages in garnet-kyanite schists from the overlying prism metasedimentary rocks at Hochberg record P-T conditions of 7.0–9.3 kbar and 640–675 °C, suggesting burial to 27–35 km. U-Pb dating of xenotime constrains the timing of peak metamorphism in the overlying metasedimentary rocks to ca. 515 Ma, ca. 10 myr after the onset of exhumation of the Ekuja Dome. This indicates that the Ekuja Dome was already on its exhumation path from larger depths while the overlying Hochberg metasedimentary unit was still undergoing burial, and reflects the dynamics of burial and exhumation along intraprism thrusts at the interface between the downgoing plate and the overlying prism sediments in accretionary complexes. The structural, metamorphic and geochronological similarities between the Southern Zone of the Damara Belt and the Lufilian Arc point to a contiguous convergent margin along the leading edge of the Congo Craton that was active to at least ca. 515 Ma.

1. Introduction

Accretionary prisms form an integral part of most subduction zones, recording the offscraping and accretion of material from the downgoing plate to the base of the overriding plate (Karig, 1983; Cloos and Shreve, 1988; Moore, 1989; von Huene and Scholl, 1991). Lateral growth and thickening of the prism occur through a combination of frontal accretion of material at the toe and underplating to the base of the prism, mainly via arc-ward dipping thrust systems (Platt, 1986; Cloos and Shreve, 1988). Parts of the accreted material may eventually be subducted, but most will be offscraped along or close to the leading edge of the overriding plate. In the latter case, continued subduction and sediment accretion leads to the uplift and eventual exhumation of previously buried sediments at the backstop of the prism, where the offscraped sediments are forced upwards (Platt, 1986, 1993). The complex internal dynamics of accretionary wedges are mainly documented from active or recent subduction zones (Glodny et al., 2005; Agard et al., 2009; Angiboust et al., 2013, 2016; Plunder et al., 2015) and much of our understanding of the mechanisms, flow trajectories and rates of material transfer comes from analogue and numerical models of accretionary systems (Cloos, 1982; Gutscher et al., 1998; Yamada et al., 2006; Graveleau et al., 2012). The dynamics of ancient, Paleozoic and

* Corresponding author at: Dept. of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland, 7602 Stellenbosch, South Africa.
E-mail address: shawnkitt@gmail.com (S. Kitt).

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