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A late Neoproterozoic ridge-trench encounter: evidence from the Khomas accretionary complex, Damara Belt, Central Namibia

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Ridge subduction is an inevitable consequence of plate tectonics. Although documented in recent circum-pacific examples, it is only rarely recognized in the geological record, with most well documented examples limited to Meso-and Cenozoic convergent margins. Here, we present evidence for ridge subduction from the late-Neoproterozoic/early-Phanerozoic Damara Belt in central Namibia that records the convergence and eventual collision of the Kalahari and Congo Cratons between ca. 580-530 Ma. The Damara Belt shows a remarkable preservation of its original architecture. This includes a very wide medium-P, medium T accretionary prism situated on the Kalahari plate in the south (the Southern Zone or Khomas accretionary complex), juxtaposed against the high-T, low P central magmatic axis of the Central Zone situated along the leading edge of the overriding Congo Craton in the north. There is general consensus that the Damara Belt developed during convergence between the Kalahari and Congo Cratons, but there are a number of features that have always been noted to be anomalous, namely the lack of any clear subduction signature in the voluminous granite plutonism throughout the Central Zone and the unusually high-T, low-P metamorphic conditions that characterize large parts of the overriding plate.

The Khomas accretionary complex exposes a thick (> 10 km), imbricated and multiply folded, amphibolite-facies (P ca. 8 kbar, T ca. 500°C) metaturbiditic sequence representing mainly trench sediments. Imbricated into this thick succession is a 350 km long and up to 3 km wide zone of metamafic volcanic and intrusive rocks, referred to as the Matchless Amphibolite Belt, and regarded as the uppermost section of the Khomas ophiolitic sequence (Kukla and Stanistreet, 1991).

For the most part, rocks of the Matchless Amphibolite Belt are structurally imbricated with metaturbidites, mainly interlayered quartz-plagioclase schists and micaschists. In low-strain domains, however, primary stratigraphic relationships between fine-grained, massive metabasalts and trench sediments are preserved in the form of low-angle cross-cutting, intrusive contacts of basalt layers with the enveloping trench sediments. Along the intrusive contacts, delicate interfingering of amphibolite and sediments is commonly preserved at cm-scale. An aureole along the sediment-basalt interface is further evidence of the primary intrusive relationships. We interpret these structures to indicate the interaction of the ridge being brought into trench.

Ridge subduction could explain a number of features recorded on the upper plate (the Central Zone, Congo Craton) that have, hitherto, been regarded as being problematic. This includes (1) the lack of any significant calc-alkaline plutonic rocks in the voluminous granite suite of the Central Zone, but rather the presence of I- and particularly S-type granites, indicating the extensive melting of pre-existing crust. (2) the presence of syn-collisional (ca. 540-520Ma) syenites and alkaline rocks (e.g. Jung et al., 2004, 2005) that form a volumetrically minor, but petrologically significant component of the plutonic suite; (3) the presence of unusually high geothermal gradients (50-80°C/km) recorded in the high-T, low-P Central Zone; (4) the occurrence of large-scale, Au-mineralizing hydrothermal systems in the arc/back-arc region of the belt at ca. 530 Ma. We suggest that all of these features are consistent with their origin during slab-window magmatism and associated mafic underplating that must be expected during ridge subduction. In summary, combined evidence from lower and upper plate rocks of the late Neoproterozoic Damara Belt may possibly indicate the oldest example of ridge subduction reported in the literature.

Jung et al. (2004), Contrib. Mineral. Petrol. 148, 104-121.
Jung et al (2005), Journ. of Geol. 113, 651-672.
Kukla and Stanistreet (1991), Geology 19, 473-476.