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Triple junction orogeny: tectonic evolution of the Pan-African Northern Damara Belt, Namibia

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Trench-trench-trench triple junctions are generally geometrically and kinematically unstable and therefore can result at the latest stages in complicated collisional orogenic belts. In such geodynamic sites, mechanism and timescale of deformations that accommodate convergence and final assembly of the three colliding continental plates are poorly studied.

In western Namibia, Pan-African convergence of three cratonic blocks led to pene-contemporaneous closure of two highly oblique oceanic domains and formation of the triple junction Damara Orogen where the NE-striking Damara Belt abuts to the west against the NNW-striking Kaoko-Gariep Belt. Detailed description of structures and microstructures associated with remote sensing analysis, and dating of individual deformation events by means of K-Ar, Ar-Ar (micas) and U-Pb (zircon) isotopic studies from the Northern Damara Belt provide robust constraints on the tectonic evolution of this palaeo-triple junction orogeny.

There, passive margin sequences of the Neoproterozoic ocean were polydeformed and polymetamorphosed to the biotite zone of the greenschist facies to up to granulite facies and anatexis towards the southern migmatitic core of the Central Damara Belt.

Subtle relict structures and fold pattern analyses reveal the existence of an early D1 N-S shortening event, tentatively dated between ∼635 Ma and ∼580 Ma using published data. D1 structures were almost obliterated by pervasive and major D2 E-W coaxial shortening, related to the closure of the Kaoko-Gariep oceanic domain and subsequent formation of the NNW-striking Kaoko-Gariep Belt to the west of the study area. Early, km-scale D1 E-W trending steep folds were refolded during this D2 event, producing either Type I or Type II fold interference patterns visible from space. The D2 E-W convergence could have lasted until ∼533 Ma based on published and new U-Pb ages. The final D3 NW-SE convergence in the northernmost Damara Belt produced a NE-striking deformation front in weak metasedimentary rocks during SE-directed indentation of a rigid Paleoproterozoic basement. In the central and southern parts of the Northern Damara Belt, D3 is mostly expressed by km-scale local Type I fold interference patterns formed by the refolding of D2 upright synclines as well as bending around a steep axis of the D2 refolded folds and steep S2 multilayer. In the western part however, where the two orthogonal trends of the Damara and Kaoko-Gariep Belts meet, D3 is described in literature as sinistral shearing along reactivated steep S2 planes that is associated with steep-hinge folds with steep NE-striking axial planes. Our new ages indicate that D3 lasted from ∼513 Ma to ∼460 Ma throughout the entire Northern Damara Belt.

These results document for the first time a regional-scale early Pan-African N-S shortening event of uncertain geotectonic significance. They furthermore indicate that two competing orthogonal collisional systems have contributed in resolving instabilities at the triple orogenic junction over a period in the order of ∼100 m.y. and could therefore account for the assembly of the three cratons. The E-W convergence was preponderant in strength and pre-dates the NW-SE one, the latter being associated with localized sinistral shearing along the Kaoko Belt interface in the westernmost Northern Damara Belt.