



Long-term landscape evolution of the South Atlantic passive continental margin along the Kaoko- and Damara Belts, NW-Namibia

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The Kaoko Belt in northwestern Namibia originates in the collision of the Rio de la Plata and Kongo Craton during the Pan-African Orogeny in the Neoproterozoic (1) and represents the northern arm of the Damara Orogen. NW-Namibia's continental crust mainly consists of the NE-SW striking intracontinental branch of the Pan-African Damara mobile belt, which separates the Congo from the Kalahari craton. The Damara Orogen is divided into several tectonostratigraphic zones that are bounded by steeply dipping, ductile shear zones. These regional lineaments can be traced at least 150 km offshore (2). The lithostratigraphic units consist of Proterozoic and Cambrian metamorphosed rocks (534 (7) Ma – 481 (25) Ma (3) as well as Mesozoic sedimentary and igneous rocks. From Permo-Carboniferous to Mid Jurassic northern Namibia was affected by deep erosion of the Damara Orogen, Permo-Triassic collisional processes along the southern margin of Gondwana and eastern margin of Africa (4), and the deposition of the Nama Group sediments and the Karoo megasequence (5). Between the Otjihorongo and the Omaruru Lineament-Waterberg Thrust early Mesozoic tectonic activity is recorded by coarse clastic sediments deposited within NE trending half-graben structures. The Early Jurassic Karoo flood basalt lavas erupted rapidly at 183 ± 1 Ma (6). The Early Cretaceous Paraná-Etendeka flood basalts (132 ± 1 Ma) and mafic dike swarms mark the rift stage of the opening of the South Atlantic (7). Early Cretaceous alkaline intrusions (137-124 Ma) occur preferentially along Mesozoic half-graben structures and are called the Damaraland Igneous Province (8). Late Cretaceous alkaline intrusions and kimberlite pipes occur in northern Namibia. Post Early Paleocene siliciclastic sedimentation in Namibia was largely restricted to a 150 km wide zone (9) and is represented by the Tsondab Sandstone Formation (~ 300 m thickness). The oldest part has an age of early Paleocene and the upper part span from middle Miocene (~ 13 Ma) to Pliocene (~ 2 Ma) (10). Cenozoic alkaline intrusions and kimberlite pipes are also known from the region.

The so-called "Great Escarpment" that reach elevation of up to 2350 m characterizes strongly the morphology of the passive continental margin in Namibia (11,12). In contrast to Brazil, the escarpment is more than 150 km inland of Namibia. Interesting enough the Brandenburg intrusive complex of ~ 130 Ma age clearly indicates the post-intrusion denudation of more than 4,000m (13). The Great Escarpment can be traced from central Angola to the eastern edge of South Africa. A considerable variation along its distribution reflects variations in tectonic history, in lithologies, and in the drainage system. In Namibia, the retreating model has dominated the genetic discussion (14,15,16). However, surface process modeling has suggested other possibilities¹¹. In addition, apatite fission-track research, terrigenous cosmogenic nuclides (TCN) have been used on specific landscape elements to determine denudation rates. In the central Namib Desert, denudation rates calculated from ^{10}Be and ^{26}Al are in the range of ± 5 m Ma^{-1} and might be representative for the last 103 - 106 a (17). The persistence of arid climatic conditions throughout the Cenozoic might even lead to such low denudation rates for the past 10-12 Ma. A low retreat rate of ~ 10 m Ma^{-1} representative for the last 1 Ma was determined for the Great Escarpment in central and southern Namibia. Considering all currently, available thermochronological data for the Namibian margin (18,19,20), the validity of the scarp retreat model is highly problematic.

Apatite fission-track ages revealed so far range between 390.9 ± 17.9 Ma and 80.8 ± 6.0 Ma. The large spread in ages is partly related to significant changes of ages at the NW-SE trending Purros Lineament and at the Sesfontein thrust. In general, the AFT-ages are older northeast of the Purros Lineament. Furthermore, all basalt samples of Etendeka age display the same AFT-age range within error, between 103.5 ± 4.9 and 108.0 ± 5.6 Ma. The oldest ages are revealed from metamorphic rocks of the Damara Group as well as sandstones and glacial deposits of the Permo-Carboniferous Karoo series.

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