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# A Portrait of the Volcanic Rifted Margin of Namibia: Igneous Underplating, Regional Dike Swarms and Intrusive Ring Complexes

R.B. TRUMBULL, K. BAUER, T. VIETOR
GeoForschungsZentrum Potsdam, Telegrafenberg, 14473 Potsdam, Germany

The Early Cretaceous volcanic rifted margin of NW Namibia represents a possible endmember case of passive margin development dominated by magmatism. This contribution summarizes results of geophysical experiments and geologic-petrologic studies of igneous complexes with an aim to understand the scale and the origin of magmatism that accompanied continental breakup in this setting.

Seismic transects across the Namibian margin at about 200 km south of the Walvis Ridge revealed a broad and thick (up to 200 km wide and 20 km thick) prism of high-velocity material (Vp = 7.1 - 7.6 km/s) at the continent-ocean boundary (COB) that we interpret as thick basaltic crust. Petrophysical models estimate that this material has 14-18 wt.% MgO, consistent with formation from an upwelling mantle plume. Perhaps the most important feature of these transects is the abrupt transition from thick basaltic crust to continental crust with a normal velocity structure. There is no wide zone of extended, transitional crust at the COB. This kind of abrupt COB has been found on margins of the North Atlantic as well and may be typical for magmatically-dominated systems.

The onshore record of breakup-related magmatism in Namibia includes three main components: 1) volcanic plateaus with a bimodal association of tholeiitic basalts and rhyo-dacite lavas or pyroclastic flows, 2) swarms of mostly basaltic dikes that are chemically equivalent to the volcanic units and may represent their feeder conduits, and 3) a series of intrusive ring complexes that includes both mantle-derived alkaline rocks (carbonatites, syenites, basanite-phonolites) and crustal-derived anorogenic granites. Radiometric dates from rocks of all three associations overlap in the range of 135-130 Ma and slightly pre-date the oldest seafloor-spreading anomaly M4.

The influence of the Tristan mantle plume on magmatism and continental breakup near the Walvis Ridge has long been postulated but in fact the geochemical composition of the huge volumes of flood basalts and tholeiitic feeder dikes is inconsistent with a plume origin and these magmas are thought instead to have formed within the mantle lithosphere. On the other hand, isotopic evidence for a plume source of the mafic alkaline ring complexes in Namibia is widespread. Combined with estimated depths of magma generation from geochemical models, this indicates the presence of a plume in ca. 100-150 km depth at 132 Ma, shortly before continental separation.

The distribution and geometry of dike swarms and ring complexes in Namibia have been studied using high-resolution aeromagnetic data supplemented by LANDSAT TM images. Most intrusions follow NE-trending structures of the late Precambrian Damara fold belt; coast-parallel dikes are subordinate. Most dikes are nearly vertical and fill purely dilational fissures. Normal fautling did not accompany extension across the dike swarms, and this implies a high magma flux relative to the rate of extension. The large-scale intrusion of the crust by mafic magma is shown not only by the density of dike swarms mapped at surface but also by geophysical data from the ring complexes. A seismic, gravity and magnetic profile across the Messum and Cape Cross complexes show that the crustal column beneath them is heavily intruded (30-60% gabbroic material) all the way from surface to the Moho.