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The Agulhas-Karoo Geoscience Transect: Tectonic processes along the sheared South African continental margin

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During the Cretaceous break-up of Gondwana, the southern margin of South Africa developed as a consequence of the shear motion between the African and South American plate along the Agulhas-Falkland transform. This resulted in unique formations of the adjacent basins and may have an effect on lithospheric vertical motion processes of the southern African continent. As part of the German - South African “Inkaba ye Africa” project, the marine component of the onshore/offshore Agulhas-Karoo Geoscience Transect was surveyed in order to reveal the deep crustal structure along a corridor stretching from the Agulhas Plateau of the Indian Ocean, across the Agulhas-Falkland Fracture Zone (AFFZ) and across the basins of the continental shelf towards the South African southern coast. The main objectives include questions regarding (1) the continental or oceanic affinity of the Agulhas Plateau, (2) the characteristics of the continent-ocean boundary of the sheared margin, (3) the deep formation of the Outeniqua Basin and other basins, and (4) the evolution and possible neotectonic reactivation of the AFFZ. Along two sub-parallel deep seismic refraction and reflection profiles, we obtained detailed velocity-depth models from ocean-bottom seismometer (OBS). The models show crustal thicknesses from 30 km beneath the inner continental shelf and down to 7 km in the Agulhas Passage. P-wave velocities range from 5.6 to 6.6 km/s for the upper crust and from 6.4 to 7.1 km/s for the middle to lower crust. Uppermost mantle velocities are measured from 7.8 to 8.0 km/s. A continent-ocean transition extends over a width of about 50 km at the location of the Agulhas-Falkland Fracture Zone. Beneath the southern Outeniqua Basin and the Diaz Marginal Ridge, an up to 3 km thick zone of relatively low velocities is discovered in the upper crust, which is interpreted as an older foreland basin filled with pre-breakup metasediments.

Our model suggests that the evolution of the Diaz Marginal Ridge is connected to the later history of this old basin. In the Agulhas Passage, almost no stratified sediment cover exists due to strong erosion by ocean currents. Alternating layers of volcanic flows and sediments with a mean velocity of about 4 km/s can be identified. These volcanic flows seem to have accompanied a possible re-activation of parts of the Agulhas-Falkland Fracture Zone along the sheared margin.