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Soft sediment deformation associated with the passage of North Atlantic Deep water through the deep Ariel Graben, Mozambique Ridge southwest Indian Ocean.

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Interactions between bottom water currents and seafloor sediments are well known. Bottom current generated bedforms are varied both morphologicaly and sedimentologicaly. Sediment transport and deposition, associated with bottom water circulation, plays a significant role is sculpting seafloor morphology in all ocean basins. Indeed, bedforms have been used to great effect to define the presence, direction and strength of bottom water circulation globally. Here we present new multibeam swath bathymetry and high frequency seismic data from the Natal Valley and Mozambique Ridge, southwest Indian Ocean. These data show a deep (-3200 m) channel-like feature (Ariel Graben, situated at 28° 30”S on the Mozambique Ridge) connecting the northern Natal Valley to the Mozambique Basin. A distinct W – E change in seafloor morphology and seismic character is noted moving from the Natal Valley through the Ariel Graben. The northern flank of the graben exhibits smooth plastered drifts which give way to undulating seafloor in the east. The plastered drifts are characterised by distinct bottom echoes, with several discontinuous sub-bottom reflections. In contrast, the undulating seafloor is characterised by distinct hyperbolic echoes, with occasional indistinct sub-bottom reflectors. The W – E orientated undulations are straight crested, parallel / sub-parallel to the local isobaths. Wavelength is variable, ranging from 600 m to 1200 m. Cross-sectional symmetry of these features varies from symmetrical to asymmetrical, with board crests and narrow troughs. When asymmetrical, the lower (south-facing) limb is the longer (511.76 m average) than the upper (north-facing) limb (323.53 m average). The lower limbs are also steeper than the upper limbs; calculated averages being 3.80° and 1.55°, respectively. Overall, the slope on which the undulations are found, is south-facing with a gradient of 1.54°, however, the area affected by undulations is slightly steeper (average slope of 1.75°). Beyond -3000 m, the lower limit of the undulations, the gradient increases to 4.71°. The total slope average in this eastern region is 0.54° steeper than in the west area. The channel floor, no longer flat, is ca. 440 m wide at -3160 m depth. The Ariel Graben represents a deep saddle across the Mozambique Ridge at 28°30”S. This saddle provides a northern-most passage for the transport of NADW from the northern Natal Valley to the Mozambique Ridge. Evidence of this transport is manifest as crudely developed plastered drifts in the west and a soft sediment deformation field in the east of the study area. Here, current flow stripping, due to increased curvature of the saddle axis, results in deposition of suspended load in accordance with reduced current velocity. The steepened northern graben flank in this area provides limited accommodation space which promotes high sedimentation. Deposited sediments overcome the necessary shear stresses, resulting in soft sediment deformation in the form of down-slope growth faulting and generation of undulating sea-floor morphology.