A new seismic stratigraphy for the Agulhas Plateau resembles major paleo-oceanographic changes in the Indian-Atlantic Ocean gateway since the late Miocene

J. GRUETZNER[1], F. J. JIMENEZ ESPEJO[2], N. LATHIKA[3], GABRIELE UENZELMANN-NEBEN[1]

[1]Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany
[2]Institute of Biogeosciences, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Japan
[3]Ice Core Laboratory, National Centre for Antarctic and Ocean Research (NCAOR), Vasco-da-Gama, Goa, India

The exchange of shallow and deep water masses between the Indian Ocean and the Atlantic constitutes an integral inter-ocean link in the global thermohaline circulation. In the gateway south of South Africa long-term changes in deep water flow during the Cenozoic have been initially studied using seismic reflection profiles. But the seismic stratigraphy was poorly constrained and not further resolved within the time period from the late Miocene to present. In particular, there were limited Pliocene records that could be used to investigate the influence of climatic (e.g. Antarctic ice volume) and tectonic (e.g. closure of the Central American seaway) on the deep-water variability. In 2016 the International Ocean Discovery Program (IODP) Expedition 361 ("SAFARI") recovered complete high-resolution Plio-/Pleistocene sediment sections at six drilling locations on the southeast African margin and in the Indian-Atlantic ocean gateway (Gruetzner et al., 2017). Here, we present results from Site U1475 (Agulhas Plateau), a location proximal to the entrance of North Atlantic Deep Water (NADW) to the Southern Ocean and South Indian Ocean (Hall et al., 2017). The site is located over a sediment drift in 2669 m water depth and comprises a complete carbonate rich (74 – 85%) stratigraphic section of the last ~7 Ma. We edited high-resolution data sets of density, velocity and natural gamma radiation measured at Site U1475 and corrected them to in-situ conditions. Cross correlations show that acoustic impedance contrasts and thus the formation of seismic reflectors are mainly due to density changes that are caused by climate-induced variations in biogenic vs. terrigenous sediment input. The calculated synthetic seismograms show an excellent correlation of drilling results with the site survey seismic field record, provide an accurate traveltime to depth conversion, and allow preliminary age assignments (± 0.3 Ma) based on the shipboard bio- and magnetostratigraphy. The most prominent reflectors are associated with compositional changes related to late Pleistocene glacial/interglacial variability, the middle Pleistocene transition, and the onset of the northern hemisphere glaciation. Furthermore, a peculiar early Pliocene interval (~ 5.3 – 4.0 Ma) bounded by two reflectors is characterized by 3-fold elevated sedimentation rates (> 10 cm/ka) and the occurrence of sediment waves. We argue that this enhanced sediment transport to the Agulhas Plateau was caused by a reorganization of the bottom current circulation pattern due to maximized inflow of NADW. Rhythmic bedding within the Pliocene sediment wave sequence likely reflects the 100-kyr orbital cycle. On the other hand, colour reflectance and natural gamma radiation show highest variability in the precession band. The very regular response of the core logging data to orbital forcing suggests that the shipboard age model can be significantly improved by cyclostratigraphy.

References:

Gruetzner, J., Just, J., Koutsodendris, A., Tangunan, D., Hall, I.R., Hemming, S.R., LeVay, L.J., and the Expedition 361 Scientists, 2017. IODP Expedition 361 – Southern African Climates and Agulhas LGM Density Profile, Gemeinsames Kolloquium - DFG-Schwerpunktprogramme ICDP (International Continental Scientific Drilling Program) und IODP (International Ocean Discovery Program), Braunschweig.

Hall, I.R., Hemming, S.R., LeVay, L.J., Barker, S., Berke, M.A., Brentegani, L., Caley, T., Cartagena-Sierra, A., Charles, C.D., Coenen, J.J., Crespin, J.G., Franzese, A.M., Gruetzner, J., Han, X., Hines, S.K.V., Jimenez Espejo, F.J., Just, J., Koutsodendris, A., Kubota, K., Lathika, N., Norris, R.D., Periera dos Santos, T., Robinson, R., Rolinson, J.M., Simon, M.H., Tangunan, D., van der Lubbe, J.J.L., Yamane, M., Zhang, H., 2017b. Site U1475, in: Hall, I.R., Hemming, S.R., LeVay, L.J., and the Expedition 361 Scientists (Ed.), South African Climates (Agulhas LGM Density Profile), Proceedings of the International Ocean Discovery Program, 361. International Ocean Discovery Program, College Station, TX.