

# The Indian-Atlantic Ocean gateway during the Pliocene: current dynamics and changing sediment provenance

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The Pliocene epoch represents a discrete interval which reversed a long-term trend of late Neogene cooling and is also the most recent geological interval in which global temperatures were several degrees warmer than today. It is therefore often considered as the best analogue for a future anthropogenic greenhouse world. However, there is growing evidence that the Pliocene was not a stable period but can rather be subdivided in several distinct climate phases. Our understanding of Pliocene climate variability in the Southern Hemisphere, and especially in the Atlantic-Indian ocean gateway, is limited by scarce marine records and poor age control on existing terrestrial climate archives. At five from six drilling locations of IODP Exp. 361 (Jan. – March 2016) high resolution complete Plio-/Pleistocene sections have been recovered (see IODP Expedition 361 – Southern African Climates and Agulhas LGM Density Profile by Gruetzner et al., this Volume).

Our new research proposal focuses on three of these sites forming a latitudinal transect in the Atlantic-/Indian Ocean gateway and combines chemical, physical property and seismic methods. Primary site for our investigations is Site U1475 with the focus on the interplay between northern and southern sourced deep water masses at the Agulhas Plateau. This will be augmented by investigations at Sites U1479 (Cape Basin) and U1474 (Natal Valley), both located in the pathway of modern NADW. Our research is driven by three main working hypotheses:

## Seismic stratigraphies for the last 6 Ma and sediment drift growth in the Atlantic-Indian gateway are mainly controlled by bottom water flow changes

Using the new sediment archives and physical property records from IODP Exp. 361 (Hall et al., 2016) we aim to construct detailed seismic stratigraphies for the Agulhas Plateau, the Natal valley and the Cape basin for the last 6 Ma. At all Exp. 361 sites *P*-wave velocity and density records are of sufficient quality to enable detailed correlations of drilling results and site survey data through the calculation of synthetic seismograms. Our working hypothesis implies that seismic reflection patterns and sediment accumulation during the Pliocene are closely linked to deep water circulation changes associated with climate Pliocene phases. Furthermore four distinct high latitude Pliocene glaciation events have been identified. We speculate that these phases and events have led to deep water circulation changes in Agulhas region, have altered the sediment physical properties and thus may be recognized as reflectors in the seismic profiles. How did the sediment input of terrigenous vs. biogenic sediment components in the gateway change during these events? Are these changes driven by dilution, dissolution, or productivity? We strive to answer these questions by interpreting the physical and chemical (XRF) core scanning records.

## Trajectories and intensities of deep water masses in the Agulhas region during the Pliocene were influenced by Antarctic ice volume rather than by the closure of the Central American Seaway.

The Exp. 361 drill sites offer the possibility to inter-correlate different flow speed proxies and to derive a detailed picture of flow changes during the Pliocene. By comparing core-measurements of sortable silt (SS), physical properties and XRF-core scanning data with seismic features we will tie the major flow speed changes to our seismic grid covering the Agulhas Plateau such that changing current intensities and pathways can be mapped together. Here we hypothesize that these changes are mainly driven by climate (Antarctic ice volume). What were the main changes associated with the Pliocene instability of Antarctic ice sheets and was the production of Antarctic Bottom Water (AABW) reduced or enhanced during these intervals? How have the sedimentation patterns changed under the growing influence of North Atlantic Deep Water (NADW)? Was there also a potential influence of tectonic processes on the flow changes in the Agulhas region? Especially the closure of the Central American Seaway CAS between ~14 and ~2.7 Ma is thought to have had a profound impact on climate.

## The Pliocene variability in sediment provenance on millennial timescales is subdued when compared to the Pleistocene.

Understanding the mechanisms and causes of abrupt climate change is one of the major challenges in global climate change research today and there is growing evidence that millennial scale climate variability was enhanced during times when a critical threshold in continental ice volume was surpassed. Dramatic millennial scale climate shifts are well documented for the “glacial world” of the late Pleistocene but are examined to a much lesser extent for earlier time periods. We suggest testing the potential threshold behaviour for the Atlantic-Indian gateway by comparing short term fluctuations in sediment composition and siliciclastic provenance in the Agulhas region before and after the onset of the Northern Hemisphere glaciation (NHG) at ~2.7 Ma. Time series of sediment provenance dated by “orbital tuning” will be analysed in the time and frequency domain to investigate at what times during the interval 2 – 6 Ma millennial scale climate variability was enhanced or subdued.

### References:

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