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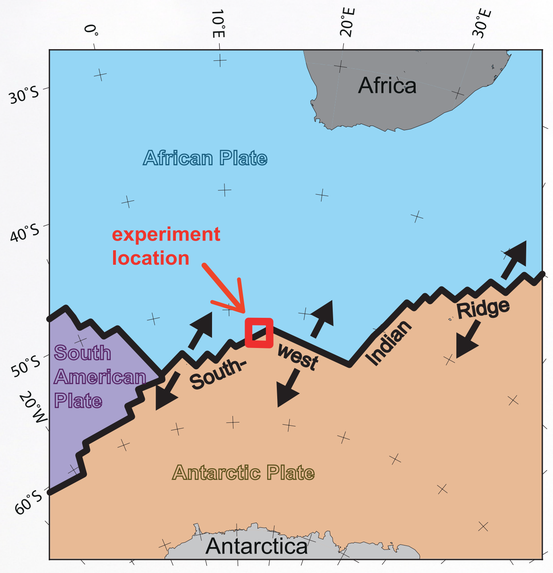
Seismicity of an amagmatic Southwest Indian Ridge segment

First results of a combined long term OBS experiment



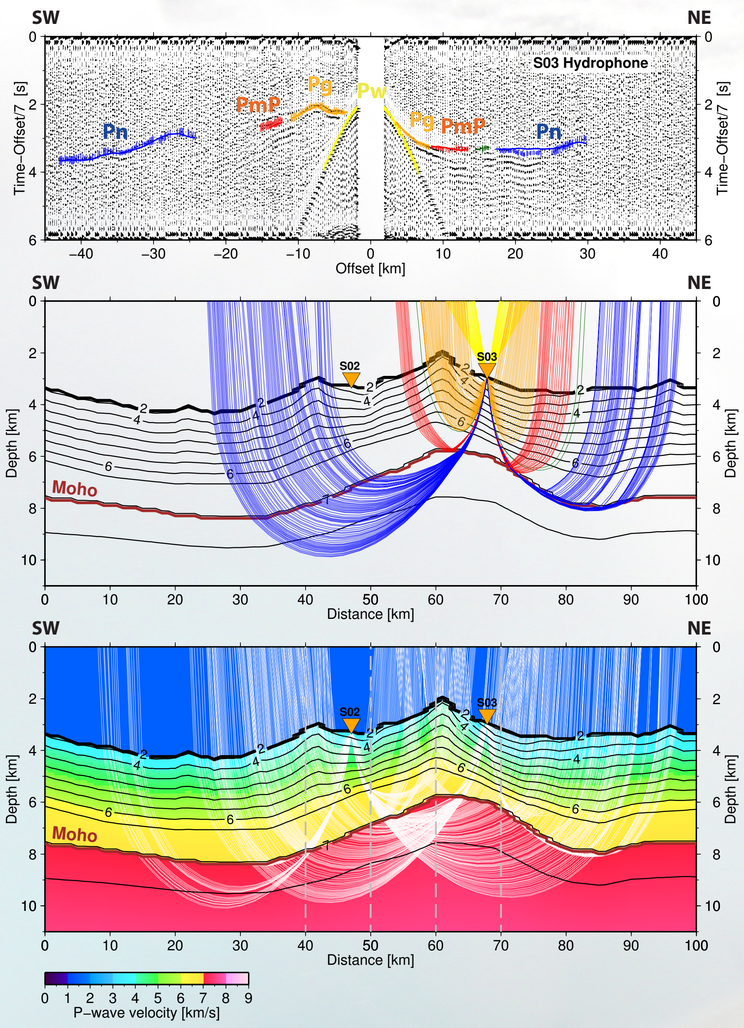
Objectives

For the first time an array of 10 ocean bottom seismometers (OBS) has been installed in late 2012 at an amagmatic segment of the Southwest Indian Ridge (SWIR), in the *furious fifties* latitudes. During the multidisciplinary *RV Polarstern* cruise ANT-29/8[1] in autumn 2013 five short wide-angle seismic profiles were shot across the array and 9 instruments could be recovered afterwards. To date various aspects of the formation of new oceanic crust at the SWIR are only partly understood. Local seismicity at mid ocean ridges settings reflects tectonic, volcanic and hydrothermal activity and will be exploited in this study to shed some light on the processes leading to the amagmatic creation of new oceanic crust at the SWIR.


gales are very frequent in the furious fifties

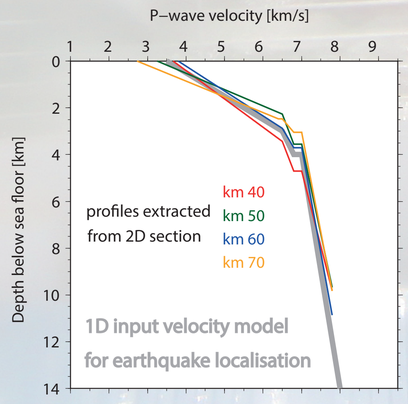

OBS deployment

Wide-angle seismic experiment

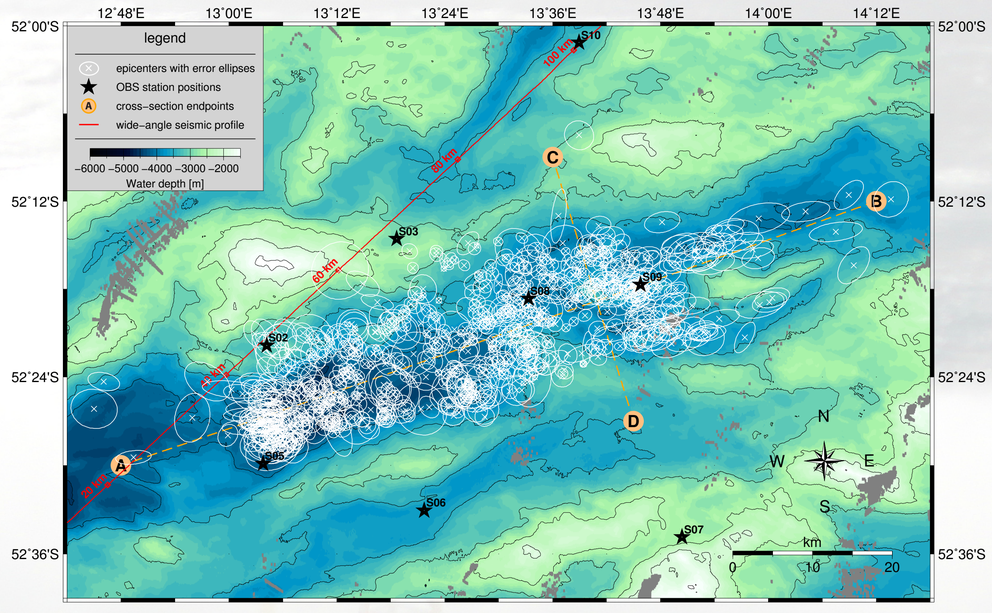


For the wide-angle seismic survey a cluster of four G-gun type air-guns was used as seismic sources and an average shot point spacing of 150m was achieved. Results of forward modeling and inversion of refracted crustal (Pg) and mantle (Pn) phases and Moho reflected (PmP) phases provide a 2D image of crustal and upper mantle P-wave velocities. High amplitude crustal refractions indicate steep velocity gradients near the sea floor and decreased velocity gradients in the lower crust. Moho reflections indicate a crustal thickness in the range of 3.0-4.5 km along the modeled profile section. Mantle refractions are observed up to 45 km offset, providing a good constraint on upper mantle P-wave velocities.

Four vertical velocity profiles were extracted from the modeled profile section for the region of highest ray coverage (see grey dashed lines in figure above and graphic to the right). A 1D input velocity model for the earthquake localisation was constructed, based on P-wave velocities and average seismic layer thicknesses of the four profiles.

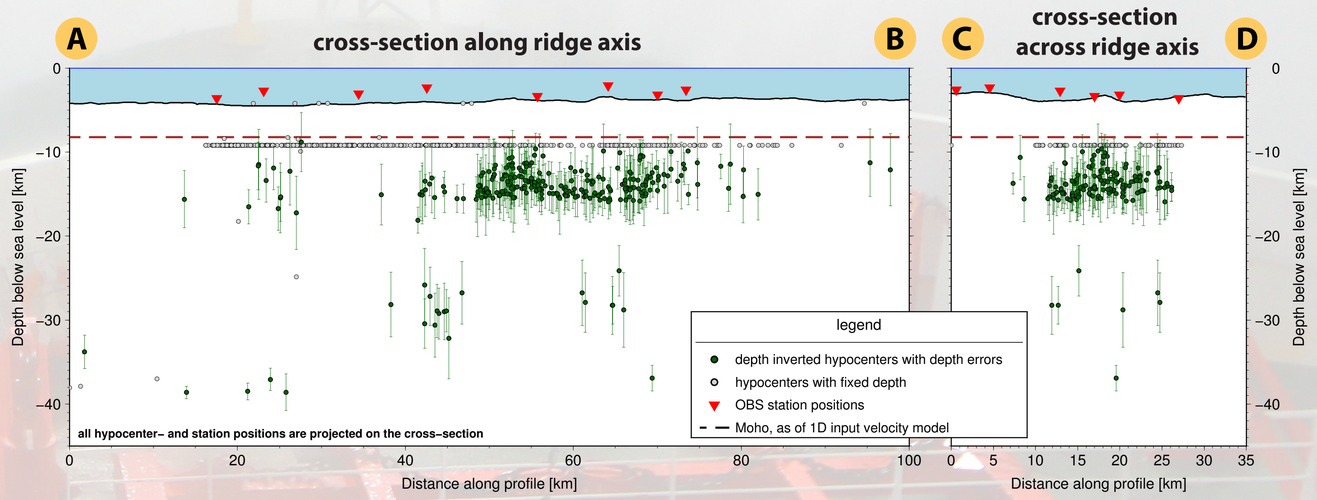


Preliminary earthquake epi- and hypocenters



The continuous dataset of 11 month recording was scanned with a STA/LTA trigger, returning a total of 2697 detections. For 1449 of these events P- and S-phase onsets could be picked manually at 3 or more stations. The HYPOSAT[2] algorithm, used for the localisation was able to relocate 1404 events of the given dataset.

Preliminary results indicate that the local seismicity is strongly constrained to the rift valley while only odd events are found beyond the axial valley flanks.



The hypocenter depth inversion returned a stable solution for 314 events. Hypocenter depths were projected on cross-sections along and across the ridge axis. The majority of depth inverted hypocenters form a cluster situated in the center of the rift valley in the range of 50 - 75 km along cross-section AB. The cluster ranges at depths of 6 - 12 km below the sea floor. Scattered events are found at greater depth. However, explanation and interpretation of hypocenters deeper than 15 km below the sea floor at mid ocean ridge settings is somewhat intricate from a physical point of view, due to the rheological properties of the mantle. Possibly, deep hypocenters here are a result of falsely identified S-phases.

Next steps

+ detailed quality control of localisation results, in particular for deep hypocenter events
+ estimation of body wave magnitudes
+ establishing an event catalogue suitable to serve as basis for a local tomography study
+ set up a benchmark test and model parameters for a combined local earthquake and active source tomography study
+ run the tomography model and do an integrated interpretation of all results

References

(1) Schlindwein, V. (Ed.) (2014), The expedition of the Research Vessel „Polarstern" to the Antarctic in 2013 (ANT-XXVIII/8), 111 pp., Alfred-Wegener-Institut, Bremerhaven.

(2) Schweitzer, J. (2001), HYPOSAT - An enhanced routine to locate seismic events, Pure Appl. Geophys., 158, 277-289

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