T23E-0416

Contact
tabea.altenbernd@awi.de

The nature and origin of the 85°E Ridge at 2°N. A hotspot track?

Tabea Altenbernd*, Wilfried Jokat*, Wolfram H. Geissler*
*Alfred-Wegener-Institute for Polar- and Marine Research (AWI), Germany

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

INTRODUCTION

Investigating the 85°E Ridge in the Bay of Bengal is difficult, because the ridge is completely covered by sediments and not characterized by an elevated basement (Fig. 1). Therefore, the extent and position of the ridge is not apparent in the bathymetry. Seismic data revealed that the northern 85°E Ridge has a complex and variable topography and consists of magmatic material deposited on oceanic crust. Most authors favor a hotspot related formation of the ridge.
One of the main characteristics of the 85°E Ridge is a pronounced gravity low (Fig. 1). This gravity low extends approximately from north to south, changes its direction at 6°N to SW and terminates in the Afanasi Nikitin Seamount Chain (ANS). If the gravity low between 6°N and the ANS depicts the prolongation of the 85°E ridge, its change in direction has to be explained by a bended hotspot track or plate kinematic changes.

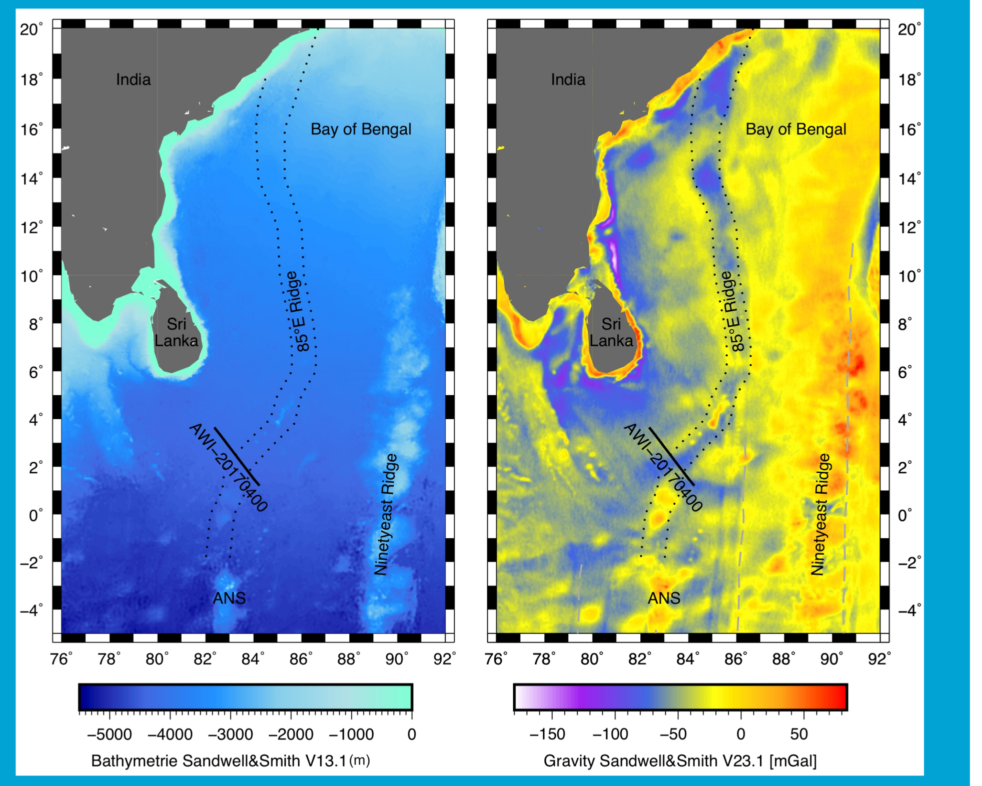


Fig.1 Bathymetrie and gravity map of the Research Area in the Indian Ocean.
The proposed extent of the 85°E Ridge is marked by a gravity low. The reflection, refraction and gravity profile AWI-20170400 crosses the proposed ridge at 2°N.

Research Questions

- **What causes the gravity low between the northern 85°E Ridge and Afanasi Nikitik Seamount Chain (ANS)?**
- **Does the gravity low mark the prolongation of the northern 85°E Ridge?**
- **Does the crustal structure beneath the gravity low give us any information about its formation?**
- **Do we find indications for a hotspot-relatated formation?**

SEISMIC REFLECTION DATA

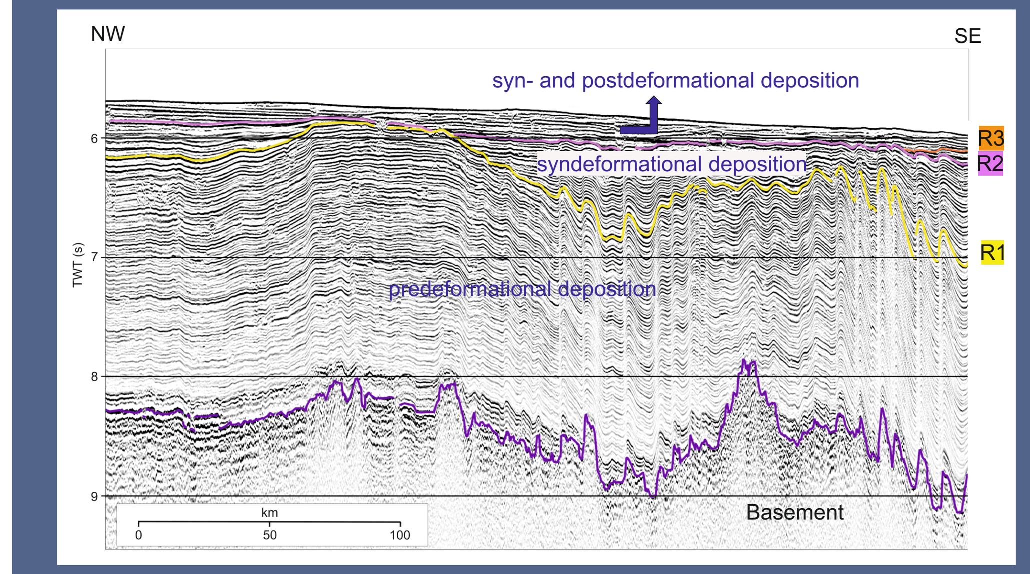


Fig.2 Stacked and migrated profile AWI-20170400
R1, R2 and R3 mark major unconformities.The sedimentary cover can be divided into three depositional types. The crust and nearly the entire sedimentary cover was deformed by long-wavelength deformation.

Results

- Deformation of lithosphere caused by faulting and folding
- Deformation increased towards the south
- Reactivation of normal faults as reverse faults
- Long-wavelength folding occurred after majority of the sediments (below R1) had already been deposited

Theories for the origin of the gravity low	Possibility based on our results
1)The gravity low comprises the continuation of the 85°E Ridge	X
2) An up to 6km deep Moho depressions developed due to the accumulation of volcanic material on at least 35 Myr old lithosphere	X
3) Low density of the ridge material is responsible for the formation of the gravity low	X
4) Compression let to sagging of the oceanic crust and the formation of the gravity low	✓

CONCLUSIONS

- **No prolongation of 85°E Ridge between northern 85°E Ridge and ANS**
- **No signs for hotspot-related formation of the gravity low**
- **Pronounced gravity low formed during deformation related to plate tectonic reorientation, causing long-wave compression of lithosphere and sagging of crust**
- **The gravity low probably evolved during the Pliocene**

SEISMIC REFRACTION DATA

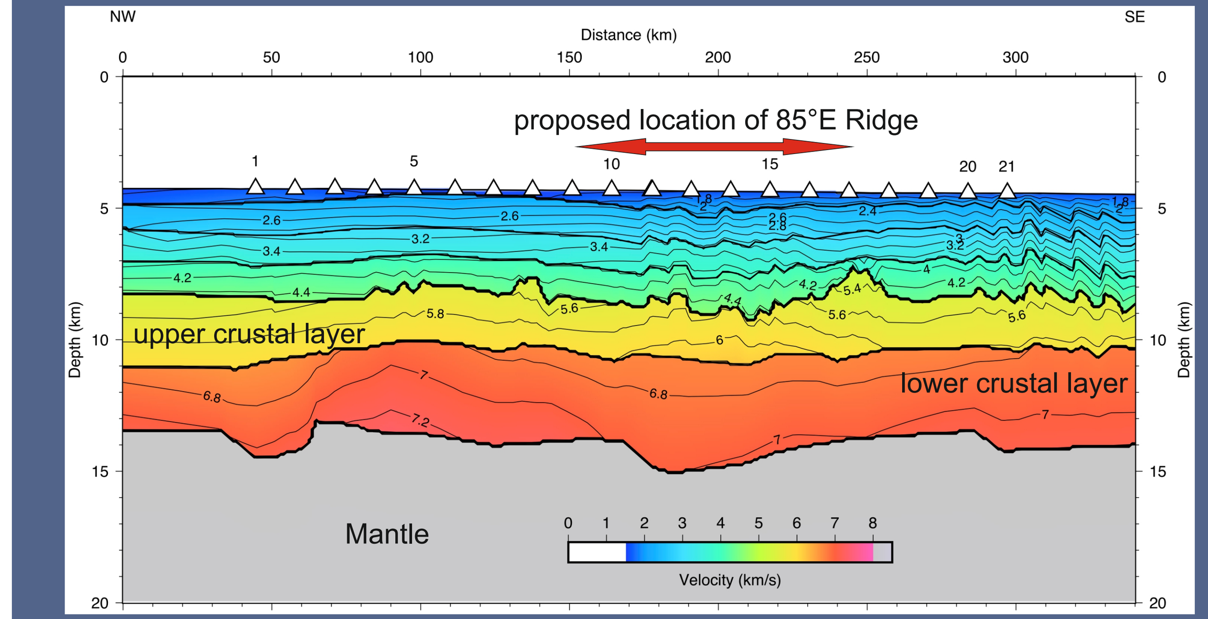


Fig.3 P-wave velocity model of the 340km long profile AWI-20170400
The model was derived by forward modelling with the software rayinvr. Triangles mark the position of 21 Ocean Bottom Seismometers (OBS) deployed every 13km along the profile. For location of OBS see Fig. 1. The ray coverage of the model is shown in Fig. 5.

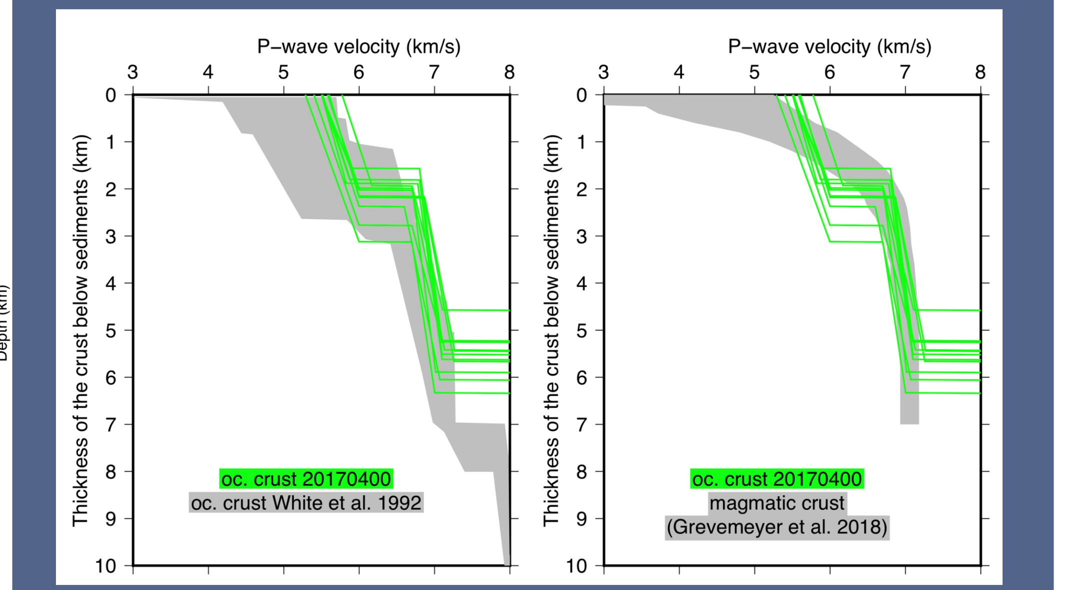


Fig.4 Comparison of velocity-depth profiles
The velocity-depths profiles were taken every 50km along AWI-20170400 (green). They are compared with velocity-depth profiles typical for oceanic crust (grey shaded area).

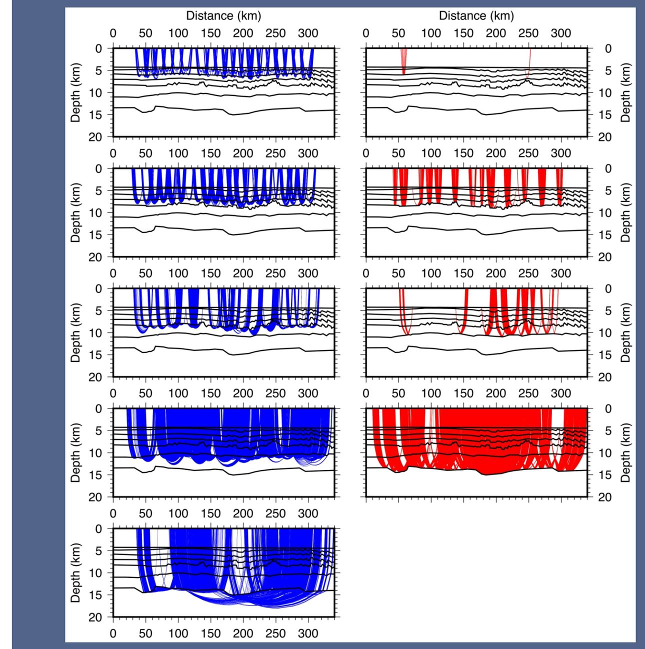


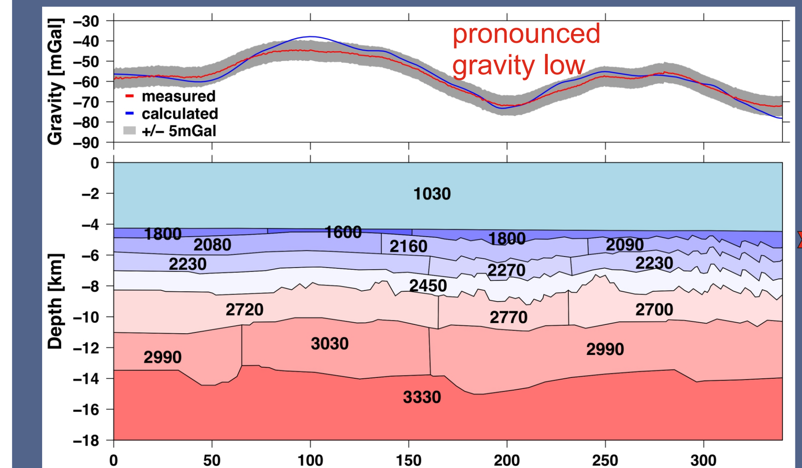
Fig.5 Ray coverage of P-wave velocity profile AWI-20170400
Refrated waves are marked in blue, reflected waves are red.

Findings crustal structure

- 4.5 to 6.5 km thick crust. The velocity-depth profiles are typical for oceanic crust (Fig. 4)
- No significant deposition of magmatic material on top of oceanic crust, except a 1km high magmatic structure between km 230-255
- Area of gravity low is best described as crustal depression
- No significant crustal thickening in area of gravity low
- No signs for underplating of high velocity material in area of gravity low

Crustal structure does not support a hotspot-related origin of the gravity low
No ridge structure!

GRAVITY DATA

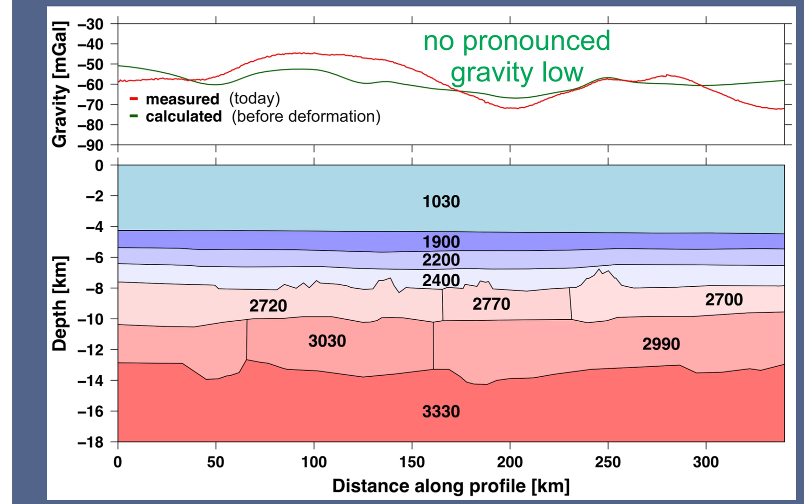


Today

> Calculated anomaly in good agreement with the observed gravity data

Sediments removed in Fig. 6b

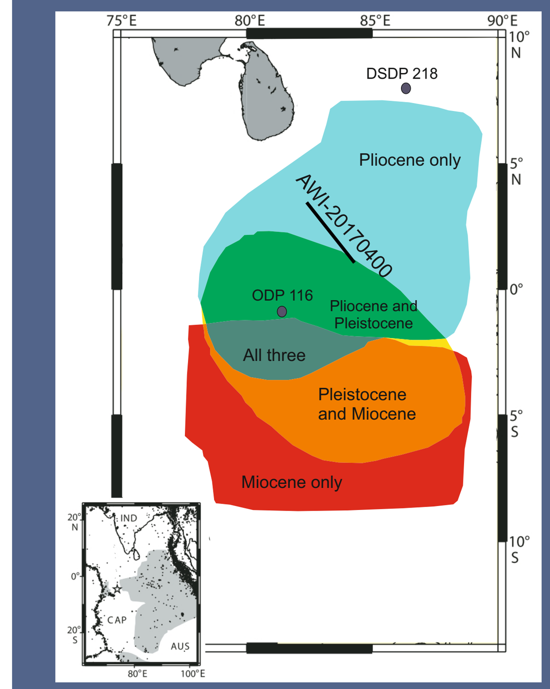
Fig. 6a Density model for AWI/20170400
The upper panel shows the observed and calculated free-air anomalies.The lower panel shows the density model, dervived from the P-wave velocity model (Fig. 3). Density units in the lower panel are given in kg/m3.



Before the deformation

> No pronounced gravity low!
> Gravity low is mainly caused by deformation of lithosphere

Fig. 6b Density model showing the crustal structure before the deformation started
For this model, the pre- and postdepositional sediments above unconformity R1 were removed (Fig. 2). The thickness of the layers was retained. Densities of the sedimantary column were slightly adjusted, while crustal densities were kept constant.



Onset of deformation and formation of gravity low

> Unfortunately, no line ties to well data available
> If R1 (Fig. 2) developed during Pliocene (Fig. 7), the pronounced gravity low is fairly young.

Fig. 7 Multiphase folding in the Indian Ocean
Figure was changed after Krishna et al. 2001 and Krishna et al. 2009. It shows the onset of long-wavelength folding in different areas of the Indian Ocean. Major longwave folding occured during 8-7.5 Ma, 5-4 Ma and 0.8 Ma.

Acknowledgements
We thank captain and crew of RV Sonne for their excellent work during the cruise. We also thank the AWI DEPAS-Pool for providing the OBS. We thank the DFG for funding.

References
Grevemeyer, I., Ranero, C. R. and Ivandic, M. (2018) 'Structure of oceanic crust and serpentinization at subduction trenches', Geosphere, 14(2), pp. 395–418. doi: 10.1130/GES01537.1.
Krishna, K. S., Bull, J. M. and Scrutton, R. A. (2001) 'Evidence for multiphase folding of the central Indian Ocean lithosphere', Geology, 29(8), p. 715. doi: 10.1130/0091-7613(2001)029<0715:EFMFOT>2.0.CO;2.
Krishna, K. S., Bull, J. M. and Scrutton, R. A. (2009) 'Early (pre-8 Ma) fault activity and temporal strain accumulation in the central India Ocean', Geology, 37(3), pp. 227–230. doi: 10.1130/G25265A.1.
White, R. S., McKenzie, D. and O'Nions, R. K. (1992) 'Oceanic crustal thickness from seismic measurements and rare earth element inversions', Journal of Geophysical Research, 97(B13), p. 19683. doi: 10.1029/92JB01749.