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The Rio Grande Rise - a detached microcontinent or a large igneous province?

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Introduction

The Rio Grande Rise (RGR) in the SW Atlantic is a massive Plateau, rising to about 2 km below sea level (Fig. 1). It consists of an eastern (ERGR) and western (WRGR) part. Both formed together with the Walvis Ridge while the Tristan-Gough plume hotspot was located on or close to the Mid-Atlantic spreading ridge (Fig. 2).

The RGR was formerly thought to be entirely volcanic in origin. However, rock samples of continental character, like high-grade sili-Ca-rich metamorphic rocks, granites, and quartz sand, were recently recovered from the walls of the Cruzeiro do Sul Lineament (CdSL) (Fig. 3). Therefore, there is an ongoing debate whether the RGR might contain a sliver of continental crust, which was captured at the time of continental breakup, or if it is an oceanic Large Igneous Province (LIP).

In spring 2019, the RGR was examined by a scientific cruise to acquire solid information on the crustal structure and evolution of the RGR by geophysical and petrological data. We will present first results based on a wide-angle seismic profile AWI-20190200, crossing the WRGR in a NNE-SSW direction (Fig. 3 & 4).

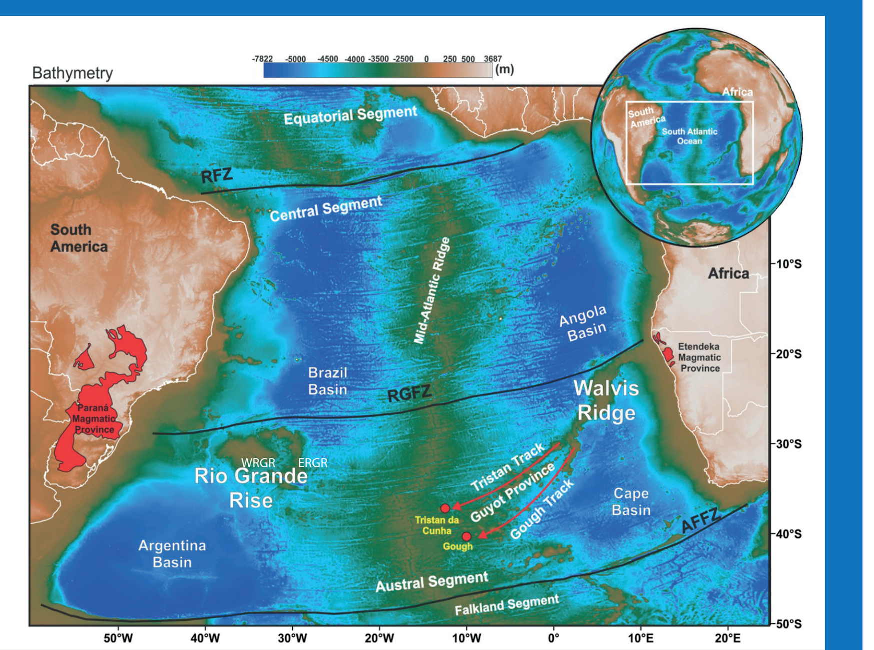

Fig. 1: Overview, modified after Graça et al. (2019)

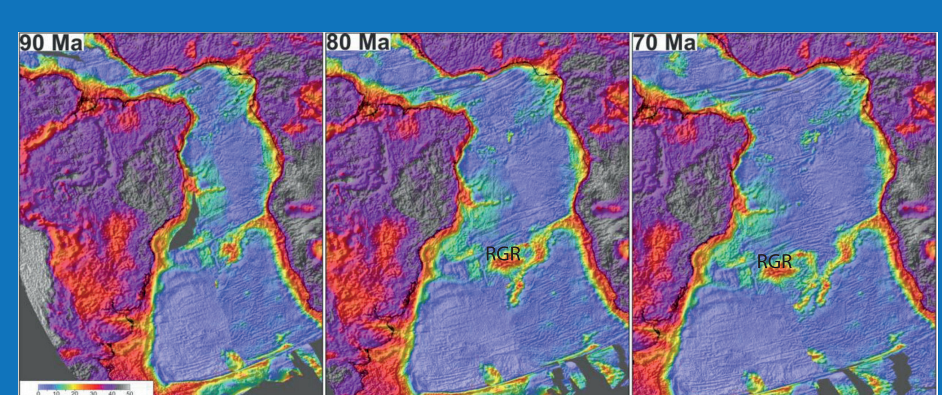

Fig. 2: Evolution of the Rio Grande Rise and Walvis Ridge between 70 - 40 Ma, taken from Graça et al. (2019)

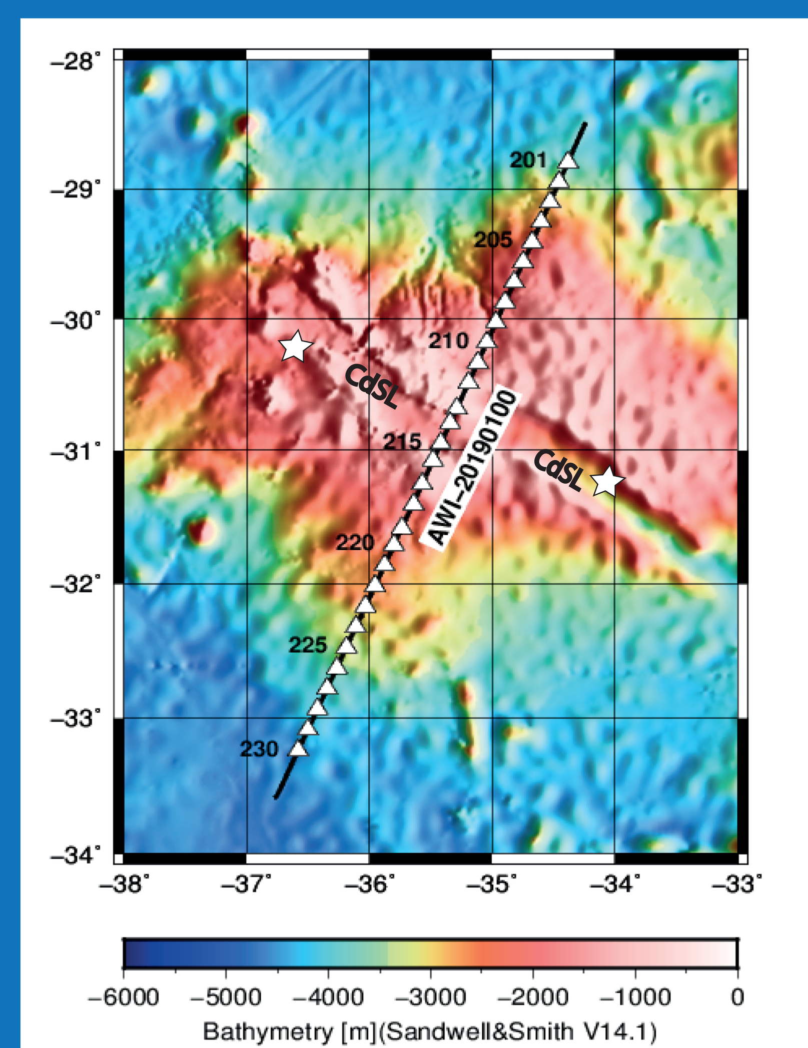

Fig. 3: Location of refraction seismic profile AWI-20190200 across the Western Rio Grande Rise
The deployment positions of the ocean bottom seismometers (OBS) are marked with white triangles. Every 5th OBS is annotated. The refraction seismic profile is shown as a black line. Black stars mark the position of dredged rocks of continental character (Santos et al., 2019). CdSL=Cruzeiro do Sul Lineament

Research Questions

- What is the crustal structure of the Western Rio Grande Rise?
- Are there indications for a microcontinent within the plateau?
- How does the crust compare to the conjugate Walvis Ridge?

P-wave velocity model

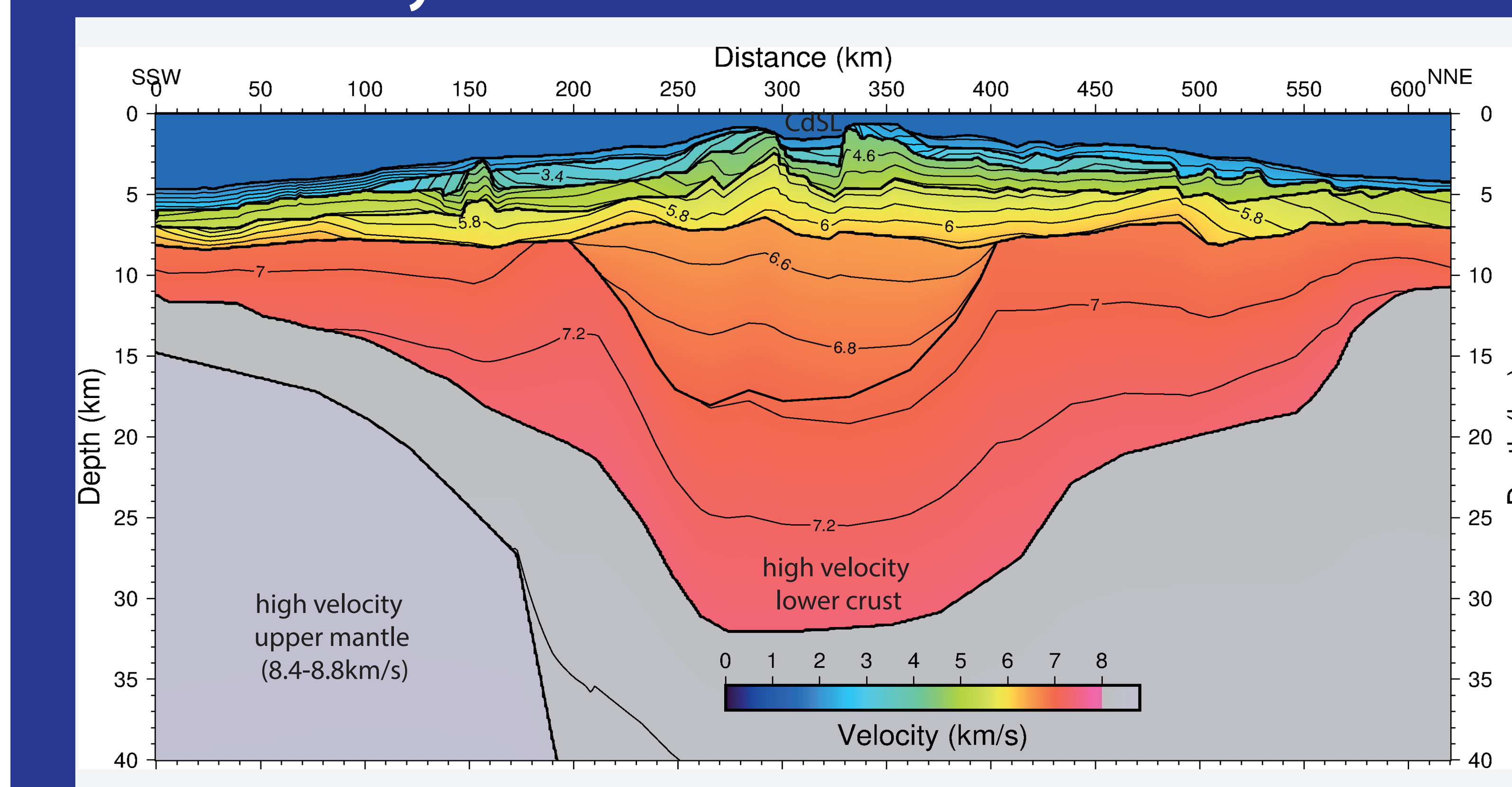

Fig. 4: P-wave velocity model AWI-20190200, derived by forward modelling
Thick black lines mark the boundaries of the velocity layer. The ray coverage is shown in Fig. 5

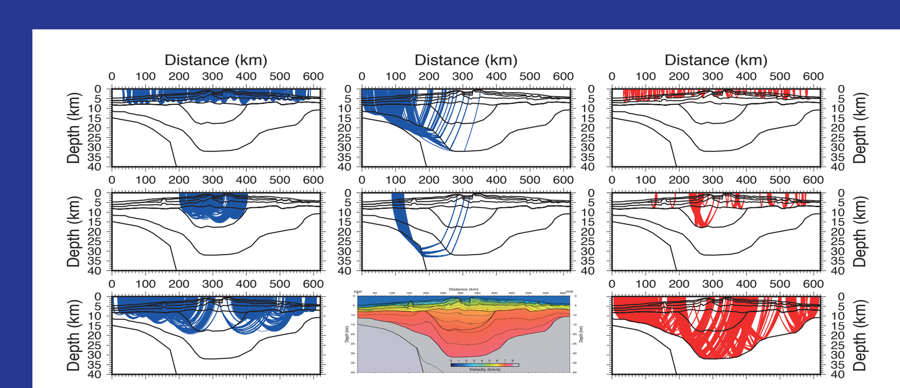

Fig. 5: Ray coverage of AWI-20190200
Refracted rays are marked in blue, reflected rays are red. Black lines mark the layer boundaries of the velocity layers

Preliminary Results

- Crust of Western Rio Grande Rise up to 30 km thick, containing a high velocity lower crust
- High upper mantle velocities (8.4-8.8 km/s) below the SW part of the Western Rio Grande Rise
- **Crustal structure typical for Oceanic Plateaus (LIP) & submarine ridges**
- **Crust below Western Rio Grande Rise comparable to crust of Walvis Ridge**
- **No indications for a detached microcontinent**

Comparison of crust beneath WRGR with other crustal models

Oceanic Plateaus (LIP) and submarine ridges

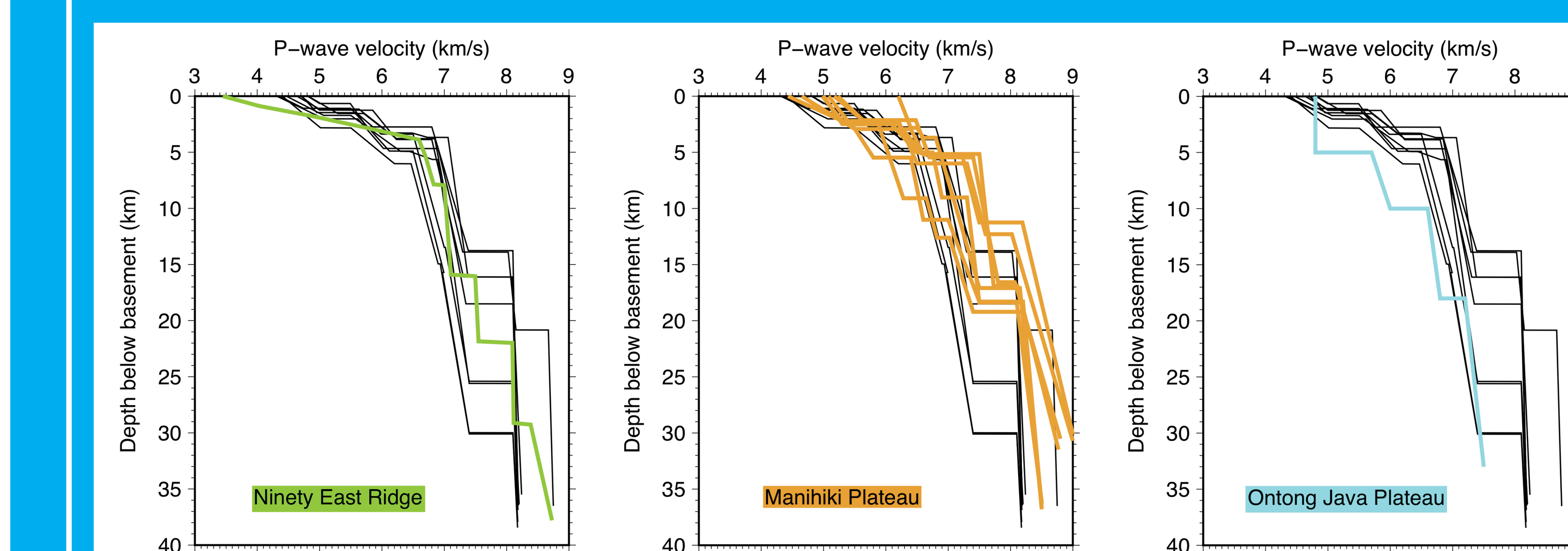

Fig. 6: Comparison of velocity-depth profiles along AWI-20190200 (black) with crust beneath the Ninety East Ridge (Grevemeyer et al., 2001), Manihiki Plateau (Hochmuth et al., 2014), and Ontong Java Plateau (Miura et al., 2004)

✓ crust comparable to LIP & submarine ridges ✓

Walvis Ridge

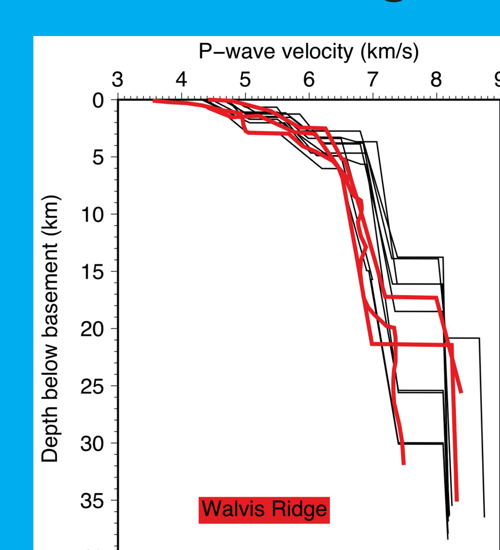

Fig. 7: Comparison of velocity-depth profiles along AWI-20190200 (black) with crust beneath the Walvis Ridge (Fromm et al. 2015 & 2017)

✓ crust comparable to Walvis Ridge ✓

Continental crust and continental fragments

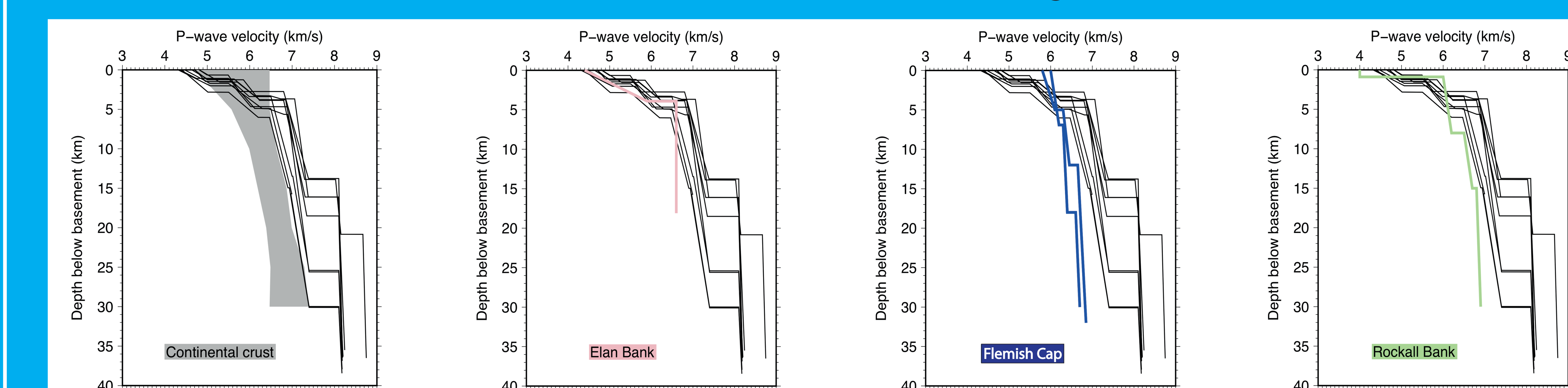

Fig. 8: Comparison of velocity-depth profiles along AWI-20190200 (black) with average continental crust (Christensen & Mooney, 1995), Elan Bank (Borissova et al., 2003), Flemish Cap (Funck, 2003; Gerlings et al., 2011), and Rockall Bank (Vogt et al ,1998).

X no indications for a microcontinent X

Acknowledgements
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