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Crustal structure across the Filchner Ronne Shelf, Antarctica

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One large gap in understanding the tectonic evolution of Antarctica beside the few rock outcrops on the continent is the missing information on crustal thickness along its margins but also in its interior. E.g., the few marine deep seismic lines are located mainly along the Antarctic Peninsula/Pacific margin, but for most of the East Antarctic margins such information is not available. In this contribution we concentrate on one of the most remote areas in Antarctica, the Filchner Ronne Shelf (FRS). The area is underlain by approximately 12 km of sediments, but its crustal fabric is questionable. Thus, some existing deep seismic sounding data were modeled and reinterpreted. Especially, data gathered in 1995 have been analyzed, and a more detailed 2D P-wave velocity model has been calculated.
For the profiles in total 12 RefTek stations each with nine geophone chains were placed on the ice shelf and 3175 airgun shots along a 480 km transect were fired by two 32 l BOLT-Airguns each 60 s. Signals were recorded up to distances of 180 km. Due to the ice coverage it was not possible to acquire the data without gaps or along straight lines, which caused some difficulties in the modeling process. Furthermore, in the new model all data from older experiments of the AWI and Soviet Antarctic expeditions acquired with dynamite sources were incorporated.
The model shows a sedimentary basin with a thickness up to 12 km and a large velocity inversion in a deeper sediment unit. The crustal thickness varies from 40 km beneath the Antarctic Peninsula, and 14 km of basement in the center part of the profile. Towards Berkner Island the crust thickens again, but the top of the basement is still 11 km deep. The lower crustal velocities range between 6.8 and 7.2 km/s. We interpret the crustal structure as clear evidence for the presence of a failed rift. The initial stretching of the continental crust documented by the high lower crustal velocity might have already starting during Jurassic times and terminated most likely with the opening of the Weddell Sea more in the north. Yet, it is not clear if in the central part of FRS already thick oceanic crust is found, or if the data still represent highly extended and intruded continental crust. Here, our P-wave model differs from previously published models. Based on the seismic velocities a density model was derived and fitted to the existing ship- and airborne gravity data. Finally, the seismic and gravity data were combined with aeromagnetic data.