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Crustal structure of the Amundsen Sea Embayment, West Antarctica: Implications for its tectonic evolution from a geophysical dataset.

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The Amundsen Sea Embayment of West Antarctica is a centrepiece in understanding the history of the New Zealand – Antarctica breakup. This region plays a key role in plate kinematic reconstruction of the southern Pacific from the collision of the Hikurangi Plateau with the Gondwana subduction margin to the evolution of the West Antarctic Rift System. During two RV Polarstern cruises in 2006 and 2010, a large geophysical dataset was collected consisting of seismic refraction and reflection profiles, shipborne gravity and helicopter magnetic measurements. The data provide constraints on the crustal architecture, the structural evolution and the tectonic block formation during and after the Cretaceous continental breakup. We present two continental rise-to-shelf P-wave velocity models which were derived from forward travel-time modelling of ocean bottom hydrophone recordings which provide an insight into the crustal and upper mantle architecture beneath the Amundsen Sea Embayment for the first time. The sedimentary sequences and the basement were constrained by seismic reflection data. A 2-D density-depth model supports and complements the P-wave modelling. Observed P-wave velocities show 10 to 14 km thick crust of the continental rise and up to 28 km thick crust beneath the middle and inner shelf. The crust of the continental rise is characterized by a small gradient in thickness. Including horst and graben structures this can be associated with wide-mode rifting. A high velocity zone with velocities ranging between 7.1 and 7.6 km/s indicate magmatic underplating of variable thickness along the entire transect. We classify this margin as one of volcanic type rather than magma poor because of the high-velocity zone and seaward dipping reflectors observed from the seismic reflection data. We discuss the possibility of a serpentinized upper mantle caused by seawater penetration at the Marie Byrd Seamounts. The crustal structure, distinct zones in potential field anomalies indicate several phases of fully developed and failed rift systems and a possible branch of the West Antarctic Rift System in the Amundsen Sea Embayment.