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Crustal root related to magmatic underplating beneath the Transantarctic Mountains: new evidence from gravity data

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The Transantarctic Mountains (TAM) are traditionally regarded as the flank of the West Antarctic Rift System (WARS). However, significant controversy still surrounds TAM uplift mechanisms. Detachment faulting linked to Cretaceous distributed extension, Cenozoic flexure of East Antarctic cratonic lithosphere, erosional denudation and plateau collapse are amongst the several competing models proposed to account for mountain uplift. The TAM reach elevations of 4,500 m, are > 3,000 km long, and are over 400 Km wide. Compared to other rift flanks the range is therefore significantly higher, longer and wider. Unravelling the processes, which are responsible for these unique characteristics, requires an improved knowledge of its deeper crustal architecture and uplift mechanisms. Limited wide-angle and passive seismic data have provided some insight into the boundary between East and West Antarctica, but uplift mechanisms for the TAM remain poorly constrained by seismic data alone. Here we present new models for the crustal structure and uplift mechanisms for the TAM, based on a compilation of new aerogravity and previous land gravity data over the Prince Albert Block (PAB) and marine gravity data over the adjacent Ross Sea Rift (RSR). The recent aerogravity data were acquired as part of a joint Italian-UK survey aimed at exploring the TAM and its ice covered hinterland where the Wilkes Subglacial Basin (WSB) lies. New Free-air and Bouguer anomaly maps for the region provide the basis for crustal modelling. To reduce inherent ambiguities associated with gravity modelling, we also incorporated independent wide-angle and passive seismic constraints onshore and existing seismic reflection interpretations within the RSR. Our preferred model indicates that the crust beneath the PAB is 40$\pm$2 km thick, while the crust under the WSB is 33$\pm$3 km thick. A 5 Km-thick root is therefore imaged under the PAB, in good agreement with previous gravity interpretations further south over the TAM. We propose that a significant component of the root (ca. 3 km) is due to magmatic underplating, while the remaining 2 km may be a “residual root” due to early Paleozoic (Ross-age) orogenic events. The age of the inferred underplating process is unconstrained. However, aeromagnetic data delineate large volumes of Jurassic tholeiites emplaced in a linear rift zone over the TAM and the WSB that may speculatively be associated with magmatic underplating. If this inference is correct, then magmatic underplating may have helped form a proto-TAM prior to the main stages of continental rifting in the WARS during the Cretaceous and Cenozoic. Flexural modelling show that magmatic underplating could cause up to 1/3 of TAM uplift. The remainder is modelled as a function of mechanical unloading along the TAM rift flank, erosion, and thermal buoyancy due to warmer and lower-density upper mantle underlying the WARS.