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Antarctic lithospheric provinces imaged with satellite gravity gradient and airborne gravity data

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The Antarctic lithosphere forms the cradle on which the Antarctic ice sheets flow. To determine how the Solid Earth influences Antarctic ice sheets it is therefore imperative to gain further knowledge on: subglacial topography; geothermal heat flux; crustal and lithospheric thickness and effective elastic thickness; mantle viscosity and its controls on Glacio-Isostatic-Adjustment (GIA) and; at shallower crustal level the distribution of sedimentary basins and crystalline basement provinces. An improved knowledge of the Antarctic lithosphere is also crucial in order to determine the role of Antarctica in the supercontinental cycle, from Gondwana to its predecessors, Rodinia and Nuna/Columbia.

Here we analyse GOCE satellite gravity gradient datasets in combination with the latest compilation of Antarctic airborne gravity and the most recent datasets collected over South Pole, as part of the PolarGAP project, to aid imaging of several different Antarctic lithospheric provinces. We show that satellite gravity clearly images the contrast between the thinner crust and lithosphere underlying the West Antarctic Rift System (WARS) and the Weddell Sea Rift System (WSRS) and the thicker lithosphere of East Antarctica. Distributed lithospheric and crustal extension is imaged from satellite gravity over the Ross Sea Embayment and the less well-known Ross Ice Shelf and the Amundsen Sea Embayment sectors of the West Antarctic Ice Sheet. However, the rift system appears to be too narrow to be as well-resolved from satellite gravity observations towards the southern edge of the Antarctic Peninsula, in the Bellingshousen sector.

In East Antarctica, satellite and airborne gravity data shed new light into the Archean to Mesoproterozoic Terre Adelie Craton, and highlight the contrast wrt to the crust and lithosphere beneath the Wilkes and the Sabrina subglacial basins. Thick crust is imaged beneath the Transantarctic Mountains, the Terre Adelie Craton, the Gamburtsev Subglacial Mountains and Eastern Dronning Maud Land, in particular beneath the recently proposed Tonian Oceanic Arc Superterrane (TAOST). One of the most prominent lithospheric-scale features revealed from satellite gravity gradient imaging is the Trans East Antarctic Shear Zone that appears to separate the Gamburtsev Province from TOAST, and forms the southern boundary of the Recovery Province. We suggest that it represents a major Pan-African age suture and/or shear zone related to Gondwana assembly.

Finally, we show that new airborne gravity data collected as part of PolarGAP fill the data void in GOCE and help reveal the form, extent and tectonic origin of the Pensacola-Pole Subglacial Basin, stretching from the WSRS to South Pole.