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A decade of aerogeophysical exploration provides new perspectives on crustal architecture and tectonic evolution in Antarctica

Fausto Ferraccioli
British Antarctic Survey, Geological Sciences, Cambridge, United Kingdom (ffe@bas.ac.uk)

Antarctica stands out as the least understood continent on Earth, despite being a keystone within the Gondwana and Rodinia supercontinents. Here I review several major results from a decade of intense aerogeophysical exploration that significantly advance our knowledge of Antarctica by unveiling crustal architecture and tectonic evolution, in particular in the interior of the continent. In western Dronning Maud, high-resolution aerogeophysical data have enabled analyses of the subglacial Jutulstraumen rift that heralded Gondwana break up, and also identified remnants of a Grenvillian-age (ca 1.1. Ga) igneous province and magmatic arc along its flanks. Further in the interior of East Antarctica, a mosaic of largely unknown Precambrian provinces has recently been recognised from aeromagnetic and satellite magnetic patterns, coupled with new models of crustal thickness and lithospheric strength (Ferraccioli et al., 2011, Nature). A major suture is marked by a 20 km step in Moho depth and a major change in crustal density and effective elastic thickness and separates the Archean Ruker Province from an inferred Meso-Paleoproterozoic Gamburtsev Province. Geophysical interpretations favour the hypothesis for Grenville-age accretion and collision of these provinces linked to Rodinia assembly and/or older Paleoproteroic events related to Nuna/Columbia assembly. Rather that new lithosphere formation in late Pan-African times, this interpretation favours the hypothesis for reactivation of the proposed suture in a more intraplate setting. Independently of the hotly debated timing of the assembly of interior East Antarctica, 3D models of effective elastic thickness indicate that the inherited mosaic of Precambrian provinces clearly influenced the location of the newly identified East Antarctic Rift System, which extends for 3,500 km from India to the Recovery Highlands. Continental rifting has been modelled as a key tectonic trigger for uplift of the Gamburtsev Subglacial Mountains (Ferraccioli et al., 2011, Nature). However, while Permian rifting is well-established in both India and East Antarctica, the extent and kinematics of Cretaceous rifting remains to be further understood. A new aeromagnetic and airborne and satellite gravity data compilation is now providing tantalising glimpses into the Wilkes Subglacial Basin region and its Precambrian basement provinces that were formerly adjacent to Australia. An over 1,900 km long fault system is traced along the margin of the Archean-Proterozoic Mawson continent and is interpreted as delineating part of a Neoproterozoic rift system, which heralded Rodinia break-up and that was imposed upon a major transcontinental suture zone of inferred Paleoproterozoic age (Ferraccioli et al., 2013, in prep. Nature). New aeromagnetic compilations are also revealing Phanerozoic crustal growth processes along the paleo-Pacific active margin of Gondwana, by unravelling the architecture of Cambro-Ordovician terranes affected by the Ross Orogen, and imaging several distinct magmatic arc provinces that may have docked against the margin of Gondwana in the mid-Cretaceous. Aeromagnetic and gravity imaging is also providing new views of the Cretaceous to Cenozoic age West Antarctic Rift System (Bingham et al., 2012 Nature) and on the inland extent of the Jurassic Weddell Sea Rift system (Jordan et al., 2012, Tectonophysics) that are both largely buried beneath the West Antarctic Ice Sheet.