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Inland termination of the Weddell Sea Rift against a major Jurassic strike-slip fault zone between East and West Antarctica

Tom Jordan (1), Fausto Ferraccioli (1), Phil Leat (1), Neil Ross (2), Rob Bingham (3), David Rippin (4), Anne LeBrocq (5), Hugh Corr (1), and Martin Siegert (6)

(1) British Antarctic Survey, Geological Sciences, Cambridge, United Kingdom (tomj@bas.ac.uk), (2) Newcastle University, (3) University of Aberdeen, (4) University of York, (5) University of Exeter, (6) University of Bristol

The Weddell Sea Embayment (WSE) lies in a key position to study the nature of the tectonic boundary between East and West Antarctica and the development of continental rifting processes and magmatism during the early stages of Gondwana break-up. Evidence for continental rifting within the WSE derives from previous reconnaissance geophysical investigations offshore and geological studies of the associated Jurassic magmatism onshore. Seismic data reveal high stretching factors beneath the Weddell Sea Rift (WSR) between 1.5 and 3.0, and gravity data suggest a crustal thickness of ca 27 km and an effective elastic thickness of $\sim$35 km for the rifted region. Geochemical interpretations indicate that a Middle Jurassic LIP, including extensive mafic tholeiites and some Jurassic granitic intrusions may be related to a superplume that impinged beneath the WSE. Here we present results from a recent aerogeophysical investigation that sheds new light into the previously largely unknown inland extent of the WSR beneath the West Antarctic Ice Sheet. This includes new insights into its magmatic patterns, as well as the nature of its tectonic boundaries with the adjacent Ellsworth-Whitmore block (EWM) and the margin of East Antarctica. Aeromagnetic images were interpreted to reveal pre-rift rocks, including Proterozoic basement, Middle Cambrian rift-related volcanics and metasediments and rift-related Jurassic granitoids. Magnetic depth-to-source estimates were calculated and help constrain two joint magnetic and gravity forward models for the study region. These models were used to assess crustal thickness variations, the extent of Proterozoic basement, and the thickness of Jurassic intrusions and inferred post-Jurassic sedimentary infill. The Jurassic granitoids were modelled as 5-8 km thick. These intrusions include roughly circular plutons, emplaced at the transition between the thicker crust of the EWM block and the thinner crust of the WSR, and more elongated bodies emplaced within the newly identified Pagano Shear Zone, a major tectonic boundary between East and West Antarctica. We put forward two alternative kinematic tectonic models by analysing a compilation of our new data with previous magnetic and gravity datasets. In the simple shear model, $\sim$E–W oriented Jurassic extension within the WSR was accommodated by left-lateral strike–slip motion on the Pagano Shear Zone. This would have facilitated eastward motion of the EWM block relative to East Antarctica, effectively transferring the block to West Antarctica. In a pure shear model, the left-lateral Pagano Shear Zone we identified and the dextral and normal fault systems, previously interpreted from aeromagnetic data further east at the the margins of the Dufek Intrusion, would represent conjugate fault systems. In the latter scenario, a more complex and potentially more distributed strike-slip boundary between the WSE and a mosaic of distinct East and West Antarctic crustal blocks may be possible. This tectonic model would resemble some geodynamic models for the opposite side of Antarctica, in the Ross Sea Embayment and Transantarctic Mountains, where more recent (Cenozoic) intraplate strike-slip fault systems have been proposed.