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Early opening of Australia and Antarctica - revisited

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The initial fit and early opening of Australia (AUS) and Antarctica (ANT) remain debated issues. Magnetic anomalies prior to Chron 31n old (68.7 Ma)in both basins are poorly defined and can be interpreted either as seafloor spreading anomalies formed at ultra slow spreading rate or as extended continental crust intruded by dykes. Moreover, difficulties remain with both end-member models: whereas Tikku et al. (JGR, 1999) predict a significant overlap between Antarctica and the South Tasman Rise, Whittaker et al. (Science, 2007) do not account for the observations in the Kerguelen-Broken Ridge area. The initial AUS-ANT motion differs significantly, from N-S (Tikku et al., 1999) to NW-SE (Whittaker et al., 2007). Both models are built on the same magnetic anomaly picks but differ in the match of conjugate fracture zones used in the statistical great circle segment fit method of Kirkwood et al. (Geophys. J. Int., 1999). In this study, we are trying to use different approaches to analyze the plate tectonic evolution of Australia and Antarctica in order to better constrain the initial continental fit and the motion between the two plates.

First, we attempt to determine finite rotation parameters by using the same magnetic anomaly picks as previous worker but adopting the Bullard contour fit method to reconstruct conjugate isochrons, because this method better accommodates the limited available constraints on the fracture zones in both basins. Poorly defined fracture zones do constrain too strongly the resulting rotation parameters in the Kirkwood et al. (1999) statistical reconstruction methods. We do not set any a priori assumption on the location and match of the fracture zones. A set of finite rotation parameters from Chrons 20n old (43.8 Ma) to 34n young (83 Ma) is obtained by reciprocative rotation of conjugate plates, a method that reduces the uncertainty error in the fit calculation. The resulting rotation parameters are intermediate between those of Whittaker et al. (2007) and Tikku et al. (1999).

Second, we try to better constrain the problem by using a plate circuit system involving the Indian plate (IND). The IND-ANT rotation parameters are available from reconstructions of the Central Indian and Crozet basins, on each side of the Southeast Indian Ridge, since Chron 34 (Yatheesh et al., AGU FM, 2009; Cande et al., JGR, 2010). The AUS-IND rotation parameters have been obtained from the Wharton Basin fossil ridge, which displays Chron 20n young to 34n young (42.5-83 Ma). However, conjugate pairs of anomalies only exist from Chrons 20ny to 26no (42.5-57.8 Ma) on both flanks of the fossil axis, making impossible to quantitatively combine the three plate motions before Chrons 26no (Jacob et al., EGU, 2009). To overcome this difficulty, we combine the finite rotation parameters of IND-ANT and ANT-AUS (for the various models) to obtain parameters for the IND-AUS motion to be compared to the available anomalies (which, despite the lack of conjugate, gives an estimate of the spreading rate assuming symmetrical spreading) and fracture zone (which relate to the spreading direction). The outcome of this combination does not fit well the Wharton Basin observations but instead shows a significant discrepancy in reconstructing the younger chrons of the basin. An additional complexity lies in the presence of the younger diffuse plate boundaries, active since less than 20 Ma between the Indian Australian and Capricorn plates, in the Wharton Basin. Indeed the Wharton basin has undergone strong lithospheric deformation long after spreading ceased. These deformations may account for the misfit in the three plate circuit.