GEOPHYSICS PAPER 3

ROTATION OF BORNEO REVISITED – NEW INFERENCES FROM GRAVITY DATA AND PLATE RECONSTRUCTIONS

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Borneo has commonly been considered to have undergone two stages of major anti-clockwise rigid-block plate rotation - 50° between 80 and 30 Ma and 40° between 30 and 10 Ma (e.g. Fuller et al., (1999) and Hall (2002), based on interpretations of palaeomagnetic data from Kalimantan and Sarawak). These interpretations have recently been challenged (Cullen, 2010). Considerations based on gravity data and plate modelling add further concerns.

Cullen (2010) pointed out that the earlier authors had rejected those palaeomagnetic data that did not match their model, using the argument of young re-magnetisation. If those data are taken into account, the 30-10 Ma anti-clockwise rotation must have been restricted to smaller tectonic blocks, with no rigid-plate rotation of Borneo as a whole. It should also be noted that the palaeomagnetic data from

Borneo provide similar results to those for the Malay Peninsula, Sulawesi, the Celebes Sea and parts of the Philippines; this suggests that any rotation should be applied to a block much larger in extent than just Borneo (Fuller et al., 1999).

This suggestion that Sundaland remained a continuous continental shelf - albeit with the formation of deep sedimentary basins due to extension and subsidence processes (Hall, 2002) - is further supported by the lack of evidence for the strike-slip faulting in the Java Sea area that would be required in order to accommodate large amounts of rotation of Kalimantan with respect to a more stationary Java. Large gravity lineaments running east-west through Kalimantan and into the Sea of Kalimantan as well as distinct ENE-WSW gravity anomalies continuing across the Java Sea and into Sumatra are both seen as evidence of crustal continuity. To test the rigid-plate model, the gravity map of the area was reconstructed to 30 Ma according to the rotations of Hall (2002).

The rotation produced a clear misfit along the western coast of Borneo, with the large gravity lineaments that run E-W through central Borneo obliquely overlapping the distinct gravity anomalies trending ENE-WSW in the East Java Sea. The rotation further resulted in significant shortening west of Borneo and substantial extension to the east of the island. However, the Thai and Malay basins preclude compression as late as the Neogene. The implied stretching for the eastern coast of Borneo is far too high compared to our calculations from 2D gravity models and furthermore, sedimentary basins of that area (e.g. Kutai Basin) recorded a phase of inversion in the Early and Middle Miocene. We are therefore in agreement with Cullen (2010) that there is no support for a major (40°) anti-clockwise rotation of Borneo in the period 30-10 Ma.

Based on our results, we propose an alternative plate model that predicts 12-13° of clockwise rotation for Kalimantan and Sarawak relative to South China since 30 Ma. Northern Sabah is separated in our model from Sarawak and Kalimantan by a plate boundary which implies a common tectonic history for northern Sabah and southern Palawan (cf. Cullen, 2010). This history must have been different from the evolution of the remaining part of Borneo up to the Middle Miocene docking of the Palawan Block to the northern margin of Borneo and the Cagayan Ridge.

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