Poster 3

Gravity anomalies, isostasy, and the tectonic evolution of the Malay and Penyu Basins

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The structure and stratigraphic architecture of the Malay and Penyu Basins, in particular the recognition of synrift and postrift phases of subsidence, indicate that the basins were formed by lithospheric extension. The subsidence history derived from backstripped biostratigraphic data is typical of extensional basins; rapid initial subsidence during the first 10 Ma or so, followed by slower subsidence due to cooling of the lithosphere. Stretching (ß) factors estimated using 1D-backstripping and subsidence modelling techniques range from 1.2 on the flanks to about 4 at the centre of the Malay Basin. These ß values predict present heat flows that are comparable to those derived from drill stem tests and production tests and, thus, provide support for the lithospheric stretching model.

Free-air gravity data for the eastern offshore Peninsular Malaysia show two main regions of negative anomalies in the order of -20 mGal that are related to the formation of the underlying Malay and Penyu Basins. Gravity anomalies are a sensitive indicator of the density contrasts in the upper lithosphere that may arise from lithospheric extension. Hence, an understanding of the mechanisms of extension, subsidence, and isostatic compensation and their influence on gravity anomalies can provide us with clues to the origin of these basins.

Several profiles of gravity anomalies and sediment thickness across the basins were modelled using an iterative forward-modelling technique that combines 2D (flexural) backstripping and gravity modelling to investigate the relationship between crustal stretching/thinning and gravity anomalies. If Airy isostasy is assumed, the -20 mGal free-air gravity anomaly over the Malay Basin is not compatible with the observed 14 km of sediment fill. This great sediment thickness implies a large amount of crustal thinning and tectonic subsidence that should have resulted in a positive rather than negative anomaly. The modelling results suggest that Airy isostatic compensation alone could not have generated the nearly up to 5 km of total tectonic subsidence in the basins. Even poorer results are obtained if the lithosphere is assumed to have a finite flexural rigidity. Hence, processes other than lithospheric stretching may have contributed to the total tectonically induced subsidence.

The Moho depth beneath the basins as constrained by the free-air gravity data is deeper than the backstrip Moho depth predicted using Airy isostasy, by about 25%. This implies that the basins are undercompensated isostatically. The discrepancy between the calculated and backstrip Moho is attributed to uncompensated tectonic subsidence that may have resulted from thin-skinned extension, i.e. crustal extension that did not involve the mantle lithosphere. The Malay and Penyu Basins are therefore interpreted as hybrid basins formed by a combination of whole-lithosphere stretching and thin-skinned crustal extension.