Keynote Paper 2

The gravity field of Borneo and its region

JOHN MILSOM
Department of Geological Sciences, University College London

Gravity mapping of Borneo is still incomplete The largest single onshore data set was obtained in western and central Kalimantan by the Indonesian Geological Research and Development Centre in conjunction with the Australian Bureau of Mineral Resources. Much additional work has been done in eastern Kalimantan by various oil companies but the results are either unpublished or available only in the form of very small scale maps. A rather similar situation exists in Sarawak, but Sabah has now been covered at a regional reconnaissance level. Shipborne surveys provide considerable detail in some offshore areas but are lacking or confidential in many others.

Free-air gravity maps derived from measurements by radar satellites of sea surface elevations represent a major new resource. Although such maps have existed for more than a decade, it is only in the last 12 months, during which geodetic missions by the European ERS-1 satellite were completed and the results of earlier geodetic missions by the American Geosat were released, that cross-track separations have become commensurate with along-track resolutions. Satellite-derived maps now provide resolution of anomalies with wavelengths of as little as 10 km, and good agreement with data from shipborne surveys. By placing Borneo in its regional context, they provide important new constraints on the evolution of the island.

The Java Sea forms part of the continental Sunda Shelf. Subdued patterns of bathymetry and gravity anomaly link Java to Borneo along slightly arcuate NE-SW trends which may mark belts of strain and accretion along the Sundaland margin. Levels of free-air and Bouguer anomaly are generally positive, averaging about +35 mGal in very shallow water. Sedimentary basins do not give rise to obvious gravitational lows but basement ridges are marked by narrow elongated highs.

The South China Sea is recognised as a major area of crustal extension which can be divided into three distinct provinces. In the south and close to the shorelines of Southeast Asia, the underlying crust has been moderately and variably extended with the development of deep rift basins. In the north and west, extension has continued to the point at which actual oceanic crust has been generated, isolating fragments of the former margin of southern China at the eastern margin of the sea. Between these two provinces lies a region, bounded by a distinctive arcuate belt of strong free-air anomaly, in which continental crust has been very drastically stretched and attenuated. Patterns of gravity anomaly suggest that isostatic equilibrium has been maintained, so that very thick accumulations of sediment produce only very subdued free-air lows.

The gravitational patterns around Palawan and the Sulu and Celebes Seas are complex, reflecting the rapid changes in water depth and crustal composition and a history of volcanism, extension, collision and accretion. A particularly interesting feature is the gravity high which is more or less co-extensive with Darvel Bay, in eastern Sabah. The bay is noted as the site of an ophiolitic mass which is principally exposed on small islands within it. The precise correlation between the gravity high and the morphological depression points to subsidence directly due to loading by the dense oceanic rocks.

Free-air gravity anomalies in the central Makassar Strait are generally close to zero but increase towards both coasts. The increase is particularly notable towards the west, where absolute values rise to almost +100 mGal in the Mahakan Delta region, despite the presence of very thick sediments in the Tertiary Kutai Basin. These high values indicate that the sediments were deposited on crust which is thinning appreciably towards the east, and point to an extensional origin for both the basin and the Makassar Strait.

Isostatic effects thus dominate the gravity field in the Borneo region, with the crust showing ability to support loads for short periods only and even then only in relatively small areas such as Darvel Bay. Attempts to estimate total sediment thicknesses from gravity measurements are thus doomed to failure. The uses of gravity data in this area lie principally in defining small features within basins and in indicating variations in crustal thickness and tectonic setting which have implications for basin development and thermal history.