Paper 12

Sundaland half-grabens of Sarawak — implications

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By end Cretaceous-Palaeocene, Sundaland was a large continental peninsular landmass, which extended from Sumatra, Vietnam, China and the Malay Peninsula as far southward as Java and eastward to Bali and western Sulawesi. It was on this continent that rifting, in the form of half-grabens, progressively developed from the Late Eocene through the Oligocene. These were the important non-marine beginnings of oilfields widely scattered from the Pearl River, Gulf of Thailand and Malay Basin in the north, to the Tanjung of the Meratus and Kangean of the Java Sea in the south.

Sarawak west of the fundamentally important **West Balingian Line** (Fig. 1) was an integral part of this landmass; a fact not sufficiently recognized. The regional significance of this line has been obscured by the over emphasis placed upon the Lupar Line. The region west of the West Balingian Line has inexplicably been named the "Tatau Province" by Petronas. It has no connection with Tatau and should have been named the Mukah Province.

The Penian, Sirik and Patok highs of this province represent an integral part of the Late Cretaceous–Palaeocene Sundaland land surface not inundated by the sea until the Middle Miocene. The cycle terminology of Shell, developed for the Baram Delta, has no relevance for

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this province, and the stratigraphy cannot be compared across the West Balingian Line: the Balingian Province to its east is a distinct geological terrane of contrasting stratigraphy and tectonic style.

The master faults of the Mukah Province trend NW–SE to WNW–ESE, downthrown to the west and south. These faults developed throughout Sundaland. The Late Eocene to pre-Middle Miocene half-graben fill is non-marine and may be as thick as 5 km. General marine inundation occurred only after Middle Miocene sagging.

Similar half grabens also simultaneously developed upon the uplifted Rajang Group of the Sibu Zone. This was possible because the Late Eocene Sarawak Orogeny uplifted the Rajang Group in a collision zone to become an integral part of the Sundaland landmass. Although the half grabens upon the offshore Sibu Zone (Rajang Group) generally contain less than 1 km of sedimentary fill, the Soikang Basin near Natuna is more comparable to the deeper basins of the Mukah Province. Coal-bearing basins occur upon the uplifted Rajang Group, for example at Merit-Pilah. Their stratigraphy is conventionally assigned to the Oligocene-Lower Miocene Nyalau Formation, but unless palaeontologically proven, they are more likely to be Upper Eocene and to correlate with the Silantek Formation.

The Ketungau Basin of Kalimantan is not unique. The Lupar Fault is its master fault (Fig. 2) identical to the Sirik and S.W. Luconia faults of the Mukah Province and the unnamed faults of the Sibu Zone. To the west of the Lupar Fault is a half graben, which contains the Late Eocene– ?Oligocene non-marine Silantek and Plateau Sandstone formations. The Lupar Fault occurred close to a line of ophiolite within the Rajang Group, causing its prominence in regional syntheses. But we do not know what zone of weakness controlled the geographical position of the other master faults lying beneath the South China Sea. The Ketungau Basin (Mandai and Melawi of contiguous Kalimantan) developed on a region of interior Borneo that, as shown by the Silantek Formation, was uplifted by Early Miocene and never completely inundated by the sea.

It is commonly held that a region such as Sundaland needed to have been reduced to low elevation or peneplained before the extensive development of Late Eocene extension and rifting. A much better terminology for the half-grabens is intermontane basins. They are flat subsiding plains surrounded by mountains, as in northern Thailand. It is preferable to envision the topography of the Basin and Range province of western North America, where basins close to mountains may even subside beneath sea level. The nearby ranges provided the erosional provenance for the sediments that progressively filled the active half-grabens. Long-range transport is a bad concept. Basin formation is a late-stage consequence of orogeny; the mountains are reduced by localized subsidence resulting in steep slopes causing accelerated erosion, a process now already initiated in the Tibetan plateau.

There is no longer a problem of the detrital diamonds (and gold) in western Sarawak and Kalimantan. It is usually stated that major rivers transported them far from China. This is unnecessary and likely to be wrong. The Late Eocene (and ?Oligocene) quartz-rich Plateau Sandstone (and Kayan Sandstone) were provenanced from the **nearby** mountains of Sundaland, such as the Penian, Sirik or Patok highs, that have since been denuded to fill the adjacent grabens.

The Rajang Group is more elegantly regarded as a thick sequence of Late Cretaceous to Lower Eocene turbidite, which filled in a deep marine Sundaland marginal basin. The term 'Proto-South China Sea' gives a false impression when referring to ophiolites of Sarawak (Lupar Line) and Sabah. Ophiolites are nowhere known to represent oceanic lithosphere, but only of uplifted fore- or back-arc basins (which include marginal basins), and those of Sabah have island-arc geochemical signatures. The provenance of the turbidite was from the nearby Sundaland continental landmass (some of which now exists buried under the Mukah Province).

The deeper parts of intermontane basins invariably become filled by turbidite. Marginal basins have an ephemeral existence, and their rocks are eventually squeezed between the bounding continents and sutured into the regional landmass. Although the Mekong River may have partly supplied sediment to the Rajang group, we must remember that the land across which the river system flowed is to be found buried beneath the Mukah province. It is simplistic to deduce that only the Central Luconia Province caused the elimination of the Rajang Basin. Before the Oligocene opening of the extant South China Sea marginal basin, there was no sea here whatsoever and continental Sundaland extended southwards all the way to Sarawak (interrupted only by a Rajang Group marginal basin). Evolutionary tectonic models generally have the weakness of being based upon present-day geography.