Global wrench tectonics and its consequences for the tectonic evolution of the NW Borneo continental margin

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Based on Storetvedt's new theory of Global Wrench Tectonics a reinterpretation of the structural history of the NW Borneo continental margin is proposed. The new evolutionary scheme has significant consequences for the tectonic development of Borneo and adjoining regions, including questions of formation of the NW Sabah Trough, clastic source areas, folding and thrusting, ophiolite occurrences, heat flow history, Tertiary uplift, and hydrocarbon potential.

According to variations in structure and depositional history the NW Sabah continental margin can be sub-divided into 6 units (Hazebroek and Tan, 1993) which in seaward direction are: 1, the mostly onshore Rajang Group Fold-Thrust Belt, forming a 1,000 km long and arcuate tectonic belt in NW Borneo; 2, Inboard Belt, a deep basin with more than 12 km of Neogene-Recent siliciclastic sediments with main deformation in late Miocene/early Pliocene; 3, Outboard Belt, a structurally complex NE-SW trending late Miocene-Pliocene basin with a western thrust front; 4, Baram Delta, depocenter with thrust front to the west (adjacent to the NW Sabah Trough); 5, NW Sabah Trough, a down-faulted, relatively narrow, part of the NW Sabah Platform reaching water depths of up to 2,800 m; and 6, NW Sabah Platform, the southern portion of the attenuated continental crust underlying the South China Sea basin. The offshore Luconia Province on the Sarawak shelf is characterised by numerous carbonate buildups upon a stable horst and graben basement. West of the Lupar Line lies the crystalline Sunda Shield.

To explain this tectono-stratigraphic sequence subduction of hypothesised South China Sea oceanic crust beneath NW Sabah (Haile, 1973; Hamilton, 1979) and diachronous collision of the NW Sabah Platform (Hazebroek and Tan, 1993) have been invoked, but we regard such plate tectonic thinking both unnecessary and untenable. Based on the new geological/geophysical framework of SE Asia (Storetvedt, this volume) we propose instead the following three-step development model for the NW Borneo continental margin:

1. Normal continental crust is thought to have originally occupied the present marginal seas of SE Asia, and extensive Alpine age sub-crustal 'chemical' thinning is held responsible for the variably attenuated crust presently observed in the region of the South China Sea. Worldwide

gravitational loss of lower crustal material to the mantle can be associated with the observed acceleration in Earth's rate of rotation at around the K/T boundary, causing westward rotations/wrenching of the two palaeo-hemispheres, i.e. clockwise rotations in the north and anticlockwise rotations in the south. At that time the palaeoequator crossed the present equator at around 90 E, running in an ESE direction. Therefore, SE Asia was located in the Northern Hemisphere which due to inertia forces underwent a clockwise torsion. The overall NE-SW trending tectonic grain of the South China Sea was most likely impressed at that time (late Cretaceous-early Tertiary), and incipient sedimentary basins started to develop.

2. A 35 degree spatial reorientation of the globe in late Eocene-early Oligocene time (35–38 Ma), relative to the astronomical rotation axis, shifted the equatorial bulge to near its present position. This dynamical reorganization of the Earth reactivated the NE-SW fracture system along which crustal thinning processes and associated basin subsidence became enhanced. A new wave of mantle upwelling and associated crustal attenuation commenced in the Lower-Middle Miocene, further speeding up the deepening process and accumulation rates of the NW Sabah depocentres.
3. The original azimuthal orientation of Australia was different from that of today in that Southern Australia (the Australian Bight) was facing the Indian Ocean. But at around Middle-Upper Miocene time changes in global dynamics brought about a 70 degree anticlockwise rotation of Australia and surrounding insular regions (New Guinea, New Caledonia, Timor, etc.), docking against eastern Borneo. This tectonic juxtaposition not only created the Earth's most significant biogeographical boundary, the Wallace Line, but it also produced a tectonic revolution in major parts of SE Asia. The imbricate structure of the Rajang Group, with its ophiolite occurrences and major wrench deformation, the transpressive tightening of the Inboard and Outboard belts, and the outer Thrust Zone with its downfaulted part of the NW Sabah Platform can all be intimately related to the anticlockwise rotation of Australia and environs in Miocene-Pleistocene time. The tectonic development of NW Borneo can therefore be ultimately related to 'lithospheric' inertia effects triggered by changes in planetary rotation.