Paper 13

Did the Northwest Borneo Trough terminate at the West Baram Line — what do the Miocene adakites/diorites indicate?

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It is widely accepted that the Northwest Borneo Trough represents a now extinct plate margin and that it was an active trench during spreading of the South China Sea marginal basin, from anomaly 11 (31 Ma, Oligocene) to anomaly 5c (16 Ma, Middle Miocene). The Mount Kinabalu pluton cooled through the temperature range 500° to 300°C during the interval 13.7 to 10.0 Ma and, as a result of uplift tectonics, is related to activity at the Northwest Borneo Trough. Its actual emplacement age (> 13.7, Middle Miocene) cannot be determined because it was a slow-cooling pluton. In no way does it represent a volcanic arc, which lies farther to the southeast–the Cagayan Ridge through Sandakan (Hutchison *et al.*, 2000). All tectonic models show the Trough terminating at the West Baram Line, with total silence about what might have happened westwards of this Line.

The models of Sarawak have ignored the existence of the Miocene Sintang Suite sub-volcanic arc, which extends through Kuching and Bau south-south-easterly along the length of the Ketungau Basin in Kalimantan. This arc indicates that the Northwest Borneo active trench continued westward and did not terminate at the West Baram Line. The Cretaceous to Palaeocene igneous rocks can be paired with an equivalent age accretionary prism to form an appropriate arc-trench system, as shown in tectonic cartoons by Moss (1998). The Sintang Suite volcanic-plutonic arc has no outcropping similar age accretionary prism material. The latter, therefore must lie beneath the South China Sea.

What then is the West Baram Line? If it had been a transform fault, it could have displaced the active trench left-laterally. There are several major faults of similar orientation cutting Mount Kinabalu and the Crocker Range, which can be attributed to spreading in the South China Sea Basin. The offset trench to the west of the West Baram Line has neither been identified nor discussed.

In general, the subducting oceanic lithosphere slab does not melt, but dehydrates, contributing fluids into and enhancing melting conditions in the overlying mantle wedge. The Lower Miocene diorites of the Sintang Suite are typical of subduction-related arc magmatism derived from melting of the mantle wedge. They have yielded whole-rock Lower Miocene K:Ar dates within the range 21.9 to 23.7 Ma (Prouteau *et al.*, 2001).

Melting of the subducting slab, of Mid Ocean Ridge Basalt composition (MORB), has been shown to result in trondhjemite-tonalite-dacite (TTD), produced by high pressure under a high geothermal gradient. Such magmas are characteristic of the Archaean greenstone belts, when the Earth was hotter. They have become rare since then. Cenozoic TTD rocks do occur and are known as ADAKITE. The adakitic dacites and microtonalites of the Sintang Suite have yielded whole-rock K:Ar Upper Miocene dates within the range 6.4 to 14.6 Ma (Prouteau *et al.*, 2001).

Oceanic crust (MORB) younger than 25 Ma has a heat flow in the range 2.8–8.0 HFU, whereas older crust has a relatively constant 1.0–2.5 HFU. The popular concept is that in orogenic terrains, where young, hot oceanic crust subducts, the slab itself has the ability to melt, producing Cenozoic adakite magma under garnet amphibolite to eclogite metamorphic conditions (Drummond *et al.*, 1996). Experimental study of adakites from the 1991 Mount Pinatubo dacite have led Prouteau *et al.* (2001) to a modified theory that Sintang Suite adakites originated from partial melting of MORB basalts from a fragment of oceanic lithosphere that continued to reside within the upper mantle following some previous subduction event (the diorite-producing Lower Miocene subduction).

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The different hypotheses have no effect on the general conclusion that Lower to Middle Miocene subduction resulted in the Sintang Suite. Sintang Suite rocks form stocks and dykes and have hypabyssal to volcanic petrography. They caused metamorphism of the Eocene coals of the Silantek Formation. No volcanic morphology has been discovered, so it must be concluded that the sub-volcanic intrusions had their overlying volcanic edifices eroded. Archaean TTD granitoids of greenstone belts have an extremely strong genetic relationship to gold mineralization. Likewise the Middle Miocene adakites are responsible for the gold (with antimony and mercury) deposits of Bau.

The location of the trench of the arc-trench system has been neglected by geologists seeking to understand the tectonic evolution of Sarawak and Borneo. Several obvious arcuate lineaments, extending seawards from known on land geology, may be discerned on SEASAT images, but no obvious trench-like feature can be seen.

Where, then, could the cryptic suture reside? With the same trend as the Northwest Borneo Trough, it could continue southwestwards within the Balingian Province, between South Acis and Temana, landward of which position many anticlines have up thrust the basement and Cycles I through V are generally absent. The cryptic suture would have been uplifted within a collision zone as the Central Luconia micro continent converged on mainland Borneo.

The trend of the possible suture swings from the Balingian Sub-Basin to a NNW direction, and is lost in the complexity of the major West Balingian Line. The fundamental geology of Southwest Luconia has not been sufficiently documented to enable a discussion of where the cryptic suture could reside but it is not in the half-graben province of what Petronas and Shell (wrongly) named the offshore Tatau Province.