The Origin and Emplacement of the West Burma-West Sumatra Ribbon-Continent

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Abstract

The combined West Burma-West Sumatra ribbon-continent has a Cathaysian Early Permian fauna and flora similar to those of South China and Vietnam. Evidence suggests that in the mid- to Late Permian it became separated from the eastern margin of Cathaysia as a thin continental sliver by the formation of a backarc basin and by the Middle Triassic had moved along a transcurrent fault system around Indochina into its present position to the west of Sibumasu. Subsequently, in the Miocene, the two blocks were separated by the formation of the Andaman Sea.

Keywords: Indochina, Sibumasu, Malaya, Sumatra, Thailand

1. Introduction

Western Myanmar, between the strike-slip Sagiang Fault in the east and the frontal thrusts of the Indo-Burman Ranges in the west, was identified by Mitchell (1989) as an allochthonous continental block, now largely overlain by Cenozoic sediments and an active magmatic arc. He named this continental block 'Mount Victoria Land' from an occurrence of metamorphic rocks, taken to represent the outcrop of the continental basement. This block has been termed the 'West Burma Block' by Hutchison (1989).

Following the recognition that Southeast Asia is made up of a series of continental blocks which separated from northern Gondwana during the Late Paleozoic and Mesozoic and were subsequently accreted to the southern margin of Asia, it was suggested in palaeogeographic reconstructions that in the Palaeozoic and early Mesozoic West Burma was originally located to the north of Western Australia (e.g. Audley-Charles, 1988; Metcalfe, 1996), became separated by spreading and the development of oceanic crust in the Late Jurassic, as shown by ocean floor magnetic anomalies in the Argo Abyssal Plain ('Argoland') and by the Late Cretaceous had been accreted to the western margin of Southeast Asia in its present position.

Barber and Crow (in press) from a detailed study of the geology and plate tectonic history of Sumatra, Indonesia, have proposed that a direct correlation can be made between the tectonic units which make up southern Southeast Asia in the Malay Peninsula and Sumatra and those which make up Indochina, Thailand and Myanmar-including the West Burma Block-in the northern part of Southeast Asia.

2. Tectonic units in southern Southeast Asia

The eastern part of the Malay Peninsula (East Malaya Block) contains a tropical Cathaysian Permian fauna and flora and is regarded as part of the Indochina Block. The Indochina Block is considered to have separated from eastern Gondwana in the Devonian and by Permian times had drifted northwards into equatorial latitudes (Metcalfe, 1996). East Malaya is separated from the western part of the peninsula by the Bentong- Raub Line, regarded as a suture marking the subduction of Palaeotethys and the collision of the Indochina Block with the Sibumasu Block in the latest Permian or early Triassic (Metcalfe, 2000). The Sibumasu Block, which also includes the eastern part of Sumatra, is characterised by Late Carboniferous-Permian diamictites, interpreted as glacigenic deposits formed during Late Paleozoic glaciation when Sibumasu was still attached to Gondwana.

The West Sumatra Block, like East Malaya is characterised by Permian volcanics and volcaniclastics and has a Cathaysian flora and fauna. It is separated from the Sibumasu Block by a major shear zone, the Medial Sumatra Tectonic Zone (MSTZ) (Barber and Crow, 2003; Barber et al., 2005). The MSTZ is interpreted as a major transcurrent fault zone along which the West Sumatra Block was emplaced against Sibumasu by strike-slip

movements. An overlapping Triassic sequence, extending across East Malaya, Sibumasu, the MSTZ and West Sumatra, together with stitching granitoid plutons of Triassic, Jurassic and Cretaceous age, indicate that in the southern part of Southeast Asia the collision of Sibumasu with West Malaya and the strike-slip emplacement of the West Sumatra Block against the eastern margin of Sibumasu had both been completed by Triassic times.

3. Tectonic units in northern Southeast Asia

Tectonic units recognised in southern Southeast Asia can be traced northwards into northern Southeast Asia (Fig. 1). In the east the Indochina Block is the northern extension of the East Malaya Block, with a Permian Cathaysian flora and fauna. Northern Thailand, in which at least two collisional sutures have been recognised, is more complex than the area to the south. Ueno and Hisada (2001) have suggested that the Nan-Uttaradit Suture on the western margin of the Indochina Block represents the collapse of a back arc basin and Sone and Metcalfe (2008) have proposed that it is the site of the collision of a Permian continental magmatic arc, the Sukhothai Terrane, with the western margin of the Indochina Block.

The Sukhothai Terrane is limited to the west by the Chiang Rai-Chiang Mai Line, termed the 'Cryptic Suture' by Barr and Macdonald (1991), which separates it from the Inthanon Zone. The Inthanon Zone includes imbricated serpentinite, oceanic basalts, radiolarian cherts and massive limestones from Devonian to Triassic age (Sashida et al., 1993), interpreted as ocean floor material and oceanic seamounts with carbonate caps. The faunas indicate Tethyan and Cathaysian affinities. The Inthanon Zone is interpreted by Sone and Metcalfe (2008) as accreted material from the floor of Palaeotethys, marking the collision zone between the Indochina-Sukhothai Block and Sibumasu, corresponding to the Bentong-Raub Line of peninsula Malaysia in southern Southeast Asia. The western margin of the Sukhothai Terrane has been defined as the Mae Sariang 'Suture', with serpentinites, imbricated sandstones, limestones and bedded cherts with Middle Triassic radiolaria, indicating that in the northern part of Southeast Asia the final destruction of Palaeotethys with the collision between Sibumasu and the Indochina Block, occurred in the Late Triassic (Kamata et al., 2002), rather than in late Permian to Early Triassic as in the area to the south.

The Mae Sariang Suture lies very near to the boundary between Thailand and Myanmar. The Shan Plateau in eastern Myanmar is composed of a Proterozoic, Lower Palaeozoic to Early Permian succession, with Late Carboniferous to Early Permian diamictites and with eastern Sumatra and southern Thailand is considered to belong to the Sibumasu Block. In Myanmar the Sibumasu Block is bounded on its western side by the Mogok Metamorphic Belt, composed of low to high grade metamorphic rocks, including marbles, augen gneisses, schists and mylonites (Mitchell et al., 2007). The augen gneisses have yielded Middle Jurassic isotopic ages and are considered to be granitic intrusions into an active shear zone. The zone is also intruded by undeformed granitoids of Cretaceous and younger ages.

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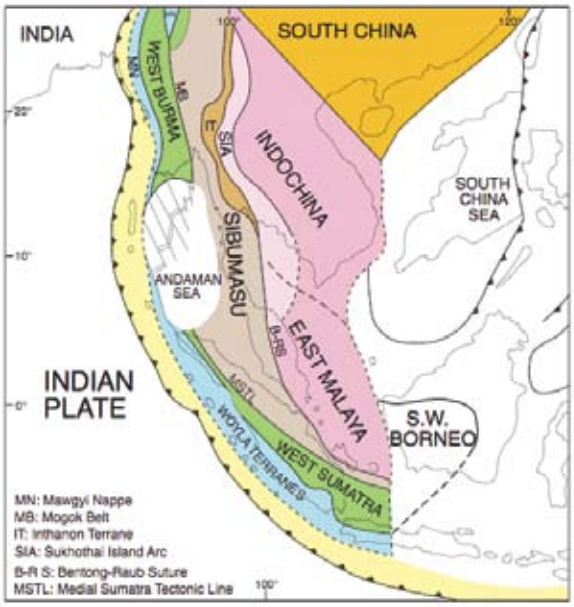

Figure 1 *Tectonic units of Southeast Asia, based on original map by Metcalfe (2005) with modifications after Sone & Metcalfe (2008) and & Crow (in press).*

Barber & Crow (in press) have suggested that the Mogok Metamorphic Belt is the northward continuation of the Medial Tectonic Zone of Sumatra and represents a major transcurrent fault zone of largely Triassic age.

3. Relationships between Sumatra and Myanmar

In Sumatra the Medial Tectonic Zone separates the Gondwanan Sibumasu Block from the Cathaysian West Sumatra Block. In Myanmar the Mogok Belt separates

the Sibumasu Block from the West Burma Block. It is reasonable to suggest that before the opening of the Andaman Sea in the Miocene (Curray, 2005) the West Burma Block was continuous with the West Sumatra Block (Fig. 1). Indeed Permian fusulinids of Cathaysian type have been described by Oo et al. (2002) from Karmine in the northern part of the West Burma Block.

In Sumatra the West Sumatra Block is overlain by the Woyla Nappe composed of a Jurassic-Cretaceous intra-oceanic island arc, with fringing reefs and an associated subduction complex. A similar Jurassic-Cretaceous island arc system, the Mawgyi Nappe has been described by Mitchell (1993) overthrust onto the western margin of West Burma (Fig. 1). Again this overthrust arc must have been continuous from west Sumatra to western Myanmar before the opening of the Andaman Sea.

4. Conclusions

With the recognition that West Sumatra has a Cathaysian fusulinid fauna Barber et al. (2005) present a series of palaeogeographic cartoons showing the West Sumatra Block attached to the southern margin of Cathaysia in Early Permian times. Later in the Permian it is shown displaced along a major transcurrent fault outboard of the Sibumasu Block, which by this time had collided with the margin of the Indochina Block, reaching its present position with respect to East Sumatra by the Early Triassic. West Burma with a similar Cathaysian fusulinid fauna must be incorporated in this scenario. These two blocks, allowing for the displacement of 450km in the Andaman Sea, comprise a ribbon-continent over 2000km long. The close relationships between the Early Permian fusulinid faunas and those of Vietnam and South China suggest that the ribbon-continent lay originally on the eastern side of the Indochina Block, facing the Palaeo-Pacific Ocean. The model proposed by Ferrari et al. (2008) in which subduction of the Palaeo-Pacific beneath Indochina generated a back arc basin which separated off continental fragments, including the ribbon-continent, which were then displaced westwards around Indochina by transcurrent fault movement, accounts for the present distribution of the tectonic blocks.

Structural events in Thailand which have been attributed to the collision of West Burma in the Cretaceous are more probably due to the overthrusting of the Mawgyi Nappe and there is no evidence to support the suggestion that West Burma originated off northwest Australia in the Argo Abyssal Plain. The missing Argoland is most probably Southwest Borneo.

References

Audley-Charles, M.G. 1988. Evolution of the southern margin of Tethys (North Australian Region) from Early Permian to Late Cretaceous. In: Audley-Charles, M.G., Hallam, A. (eds) *Gondwana and Tethys.* Geological Society Special Publication 37, 79-100.

Barber, A.J., Crow M.J. 2003. Evaluation of plate tectonic models for the development of Sumatra. *Gondwana Research*, 20, 1-28.

Barber, A.J., Crow, M.J. The structure of Sumatra and its implications for the tectonic assembly of Southeast Asia and the destruction of Palaeotethys. *Island Arc* (in press).

Barber, A.J., Crow, M.J., Milsom, J.S. (eds) 2005. *Sumatra: Geology, Resources and Tectonics.* Geological Society Memoir, 31, 290p.

Barr, S.M., Macdonald, A.S. 1991. Toward a Late Paleozoic–Early Mesozoic tectonic model for Thailand. *Journal of Thai Geosciences*, 1, 11-22.

Curray, J.R. 2005. Tectonics and history of the Andaman Sea region. *Journal of Asian Earth Sciences*, 25, 187-232.

Ferrari, O.M., Hochard, C., Stampfli, G.M. 2008. An alternative plate tectonic model for the Palaeozoic-Early Mesozoic Palaeotethyan evolution of Southeast Asia (Northern Thailand-Burma). *Tectonophysics*, 451, 346-365.

Hutchison, C.S., 1989. *Geological Evolution of South-east Asia.* Oxford University Press.

Kamata, Y., Sashida, K., Ueno, K., Hisada, K., Nakornsri, N. Charasiri, P. 2002. Triassic radiolarian faunas from the Mae Sariang area, northern Thailand and their palaeogeographic significance. *Journal of Asian Earth Sciences*, 20, 491-506.

Metcalfe, I. 1996. Pre-Cretaceous evolution of SE Asia terranes. In: Hall, R., Blundell, D.J. (eds). *Tectonic Evolution of Southeast Asia*. Geological Society, London, Special Publication, 106, 97-122.

Metcalfe, I. 2000. The Bentong-Raub Suture Zone. *Journal of Asian Earth Sciences*, 18, 691-712.

Mitchell, A.G.H. 1989. The Shan Plateau and Western Burma: Mesozoic-Cenozoic plate boundaries and correlation with Tibet. In: Sengör, A.m.C. (ed.) *Tectonic Evolution of the Tethyan Region*. Kluwer Academic Publishers, 567-583.

Mitchell, A.G.H. 1993.Cretaceous-Cenozoic tectonic events in the western Myanmar (Burma)-Assam region. *Journal of the Geological Society, London*, 150, 1089-1102.

Mitchell, A.G.H., Myint Thien Htay, Kyaw Min Htun, Myint Naing Win, Thura Oo, Tin Hlaing 2007. Rock relationships in the Mogok Metamorphic belt, Tatkon to Mandalay, central Myanmar. *Journal of Asian Earth Sciences*, 29, 891-910,

Oo, Thura, Tin Hlaing, Nyuny Htay 2002. Permian of Myanmar. *Journal of Asian Earth Sciences*, 20, 683-689.

Sashida, K., Igo, H., Hisada, K-I.., Ueno, K., Nakornsri, N., Ampornmaha, A. 1993. Occurrence of Paleozoic and Early Mesozoic Radiolario in Thailand (preliminary report). *Journal of Asian Earth Sciences*, 8, 97-108.

Sone, M, Metcalfe, I., 2008. Parallel Tethyan sutures in mainland Southeast Asia: New insights for Palaeotethys closure and implications for the Indosinian orogeny. *C. R. Geoscience*, 340, 166-179.

Ueno, Y., Hisada, K. 1999. Closure of Paleo-Tethys caused by the collision of Indochina and Sibumasu. *Chikyu Monthly*, 21, 832-839 (in Japanese).