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Southeast Asia as a part of an early Palaeozoic Australian Gondwanaland

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Abstract: Provenance studies on the Palaeozoic rocks from Thailand and Malaysia (parts of the Sibumasu Block or Shan–Thai Block) suggest proximity to a Precambrian craton. Biogeographic and taxonomic studies on Upper Cambrian through Ordovician trilobite and mollusc faunas suggest that this craton is northern Australia and an Ordovician placement next to Australia is probable.

Constraints on the rift-drift sequence are provided by the probable glacial sediments of Upper Carboniferous age in Thailand and Malaysia and by the limited number of unconformities recorded in the sedimentary basins of northern Australia. An Early Carboniferous break-up is most likely, putting Sibumasu in moderate, but frigid, latitudes by the Late Carboniferous and in the subtropics by the Early Permian.

Collision with the Indochina Block took place in the Triassic.

INTRODUCTION

Southeast Asia is a part of the Asian composite continent (Argand, 1924; Kropotkin, 1972; Dickinson, 1973; Burrett, 1973 and 1974).

Most recent authors divided mainland Southeast Asia into three major blocks: West Burma; the Sibumasu Block (or Shan–Thai Block or West Malaysian Block) and the Indochina Block, and have the Indochina Block colliding with the South China Block in the Triassic (Burrett, 1974; Bunopas, 1982; Gatinsky *et al.*, 1978; Hutchison, 1975; Mitchell, 1984; Ridd, 1980; Stauffer, 1974). The sutured boundary between the Sibumasu Block (Metcalfe's 1984 acronym for Siam, Burma, Malaysia and Sumatra) and the Indochina Block is taken as the Pha Som-Sra Kaeo ophiolite belt in Thailand (Bunopas, 1982) and the Bentong–Raub line in Malaysia (Hutchison, 1975). Mainly due to poor outcrop, the ultramafics and mafics of this line have been very poorly studied but it is regarded as the remnants of a former ocean by Bunopas (1982) and Hutchison (1975). Sibumasu and Indochina probably collided in the Triassic (Bunopas, 1982) though an earlier date is suggested by Helmcke (1984).

PALAEOPOSITION

There are few constraints on the placement of the Sibumasu and Indochina Blocks prior to the Triassic. Palaeomagnetic data are sparse. Lower Palaeozoic data (Haile, 1980) come from the Setul Limestone of Malaysia, which on the basis of conodont

geothermometry, has been heated to 300°C and experience of the Ordovician limestones of Tasmania suggests that quite low temperatures (= 100°C) are sufficient to reset the palaeomagnetism (Sharples and Klootwiyk, 1981).

A study of the boulders in the Carboniferous Phuket Group of peninsular Thailand suggests derivation from a cratonic source (Stauffer and Snelling, 1977) and detrital diamonds suggested to Burton (1970) that the source was the Precambrian kimberlites of India. Abundant, bright blue detrital quartz found in the Ordovician Setul Limestone of the Langkawi Islands (Wyatt, 1983) suggests derivation from a polymetamorphic, probably granulite source (A.B. Thompson *pers. comm.)*.

Opinions have differed as to which craton the Sibumasu Block should be anchored during the Lower Palaeozoic. Burton (1970) suggested India but the complete lack of Lower Palaeozoic in peninsular India (but which are widespread in Malaysia) makes this improbable. Similarly, Stauffer's placement next to North Africa is unlikely as there is nothing in common between the tropical Ordovician Limestone of Sibumasu (Wongwanich *et al.*, 1973; Wongwanich and Burrett, 1983, Wyatt, 1983) and the glacial condition of North East Africa.

An Early Palaeozoic placement against northwest Australia has been suggested by many (e.g. Bunopas, 1982; McTavish and Legg, 1976; Webby, 1978) but until recently there has been no evidence to support this (Griffiths and Burrett, 1973). Our research on the Lower Palaeozoic of Thailand, Malaysia and Australia strongly supports juxtaposition of the Sibumasu and Australian Blocks (Stait and Burrett, 1983; 1984 a; 1984 b). The Lower Palaeozoic of Thailand and Malaysia consists of an Upper Cambrian—Lower siliciclastic sequence conformably overlain by an Ibexian through Whiterockian (Tremadoc through Llandeilo) carbonate sequence. This is disconformably overlain by an Upper Ordovician to Silurian sequence of graptolitic shales. In northern Thailand there is weak evidence for 'Caradoc' age carbonates and in Burma there is certainly sedimentation during this time. A lack of fossiliferous sediments of 'Caradoc' age is also apparent over the whole of northern Australia, though sediments of this age are well developed in southeast Australia.

The strongest evidence for continuity of the Sibumasu and Australian Blocks comes from biogeography. Nautiloids are common in the Ordovician carbonates of Thailand, Malaysia and Australia. Contrary to popular belief, based on comparison with the modern day *Nautilus*, most fossil forms are unlikely, because of their heavy cameral and siphonal deposits, to have drifted far *post mortem*. Thus the very close similarity of the nautiloid faunas of Sibumasu and Australia suggest close proximity during the Early and Middle Ordovician. Nautiloid genera endemic to Sibumasu, Tibet and Australia include *Georgina* and discosorid *gen. nov.* (Stait and Burrett, 1983; 1984 b). The Simpson Index of comparison between Sibumasu and Australian nautiloids is 0.92. Other elements of the Sibumasu Block Ordovician fauna are close, including the otherwise Gondwana snail *Peelerophon oehlerti* (Jell *et al., in press*), the characteristic snail *Teiichispira*, the poly-placophoran *Chelodes whitehousei* (Stait and Burrett, 1984a) the rostroconch *Euchasma* and stromatoporoids (Webby *et al.,in press*). Other very close similarities are between the Upper Cambrian saukiid faunas of Thailand and Australia (Shergold *et al.*. in prep.).

The pre-drift situation of the Sibumasu Block is indefinite. Placement against the Tasman orogenic belt of eastern Australia is very unlikely and a placement against western or north-western Australia is plausible. The placement of Bunopas (1982) (Fig. 1) seems most likely to us though a more northerly position, outboard of Timor, as suggested by Audley-Charles (1983) and McTavish and Legg (1976) remains possible.

Recent studies on the Carboniferous Phuket Group of Thailand and similar strata in Malaysia have interpreted these pebbly mudstones as glacial or glacio-marine (Stauffer and Lee, 1984; Tantiwat *et al.*, 1983).

If these interpretations are correct, then it seems likely that either the Sibumasu Block (a) remained attached to Australia until the Late Carboniferous or (b) rifted off earlier but remained at high—moderate southerly palaeolatitudes and close to the frigid Gondwana supercontinent.

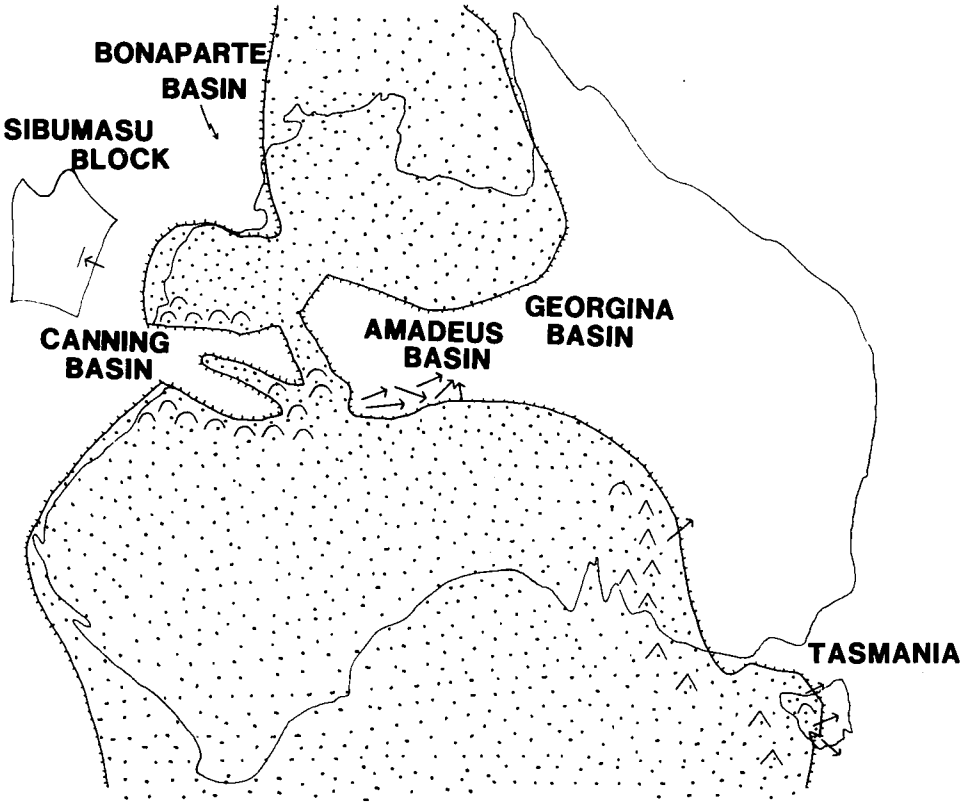

Fig. 1. Palaeogeographic reconstruction for Australia for the Lower Arenig based on many sources. Arrows indicate palaeocurrents. Inverted 'U's are hills and inverted 'V's are mountains. Placement of Sibumasu Block (= Shan–Thai Block) after Bunopas (1982).

RIFTING

Although the western and north-western margins of the Australia Block have been repeatedly rifted and the direct evidence of rifting in the form of rift volcanoes may be hidden in the basement of the small suspect terrains in Indonesia, it should still be possible to distinguish times of rifting. For the Canning Basin of Western Australia, the major times of non-deposition, uplift, warping or unconformity are Middle—Late Ordovician, Middle Devonian, Early Carboniferous, Early Permian, Late Permian to Early Triassic and Late Jurassic (Towner and Gibson, 1983). As we know that the major blocks of Asia fused during or prior to the Triassic (Burret 1974) and as it seems likely on biogeographic and palaeoclimatic considerations that the Sibumasu Block was in the tropics by the Late Permian, then the Middle Devonian or Early Carboniferous seem the most likely times for rifting. Of these the latter represents a major unconformity. Given an average rate of ocean-floor spreading, this allows the Sibumasu Block to be at temperate palaeolatitudes in the Late Carboniferous and in the sub-tropics by the Early Permian. Collision with the Indochina Block took place in the Triassic. Although there is considerable support for this model, critical and essential tests would include detailed comparisons of faunas and sediments from the Devonian and Carboniferous and reliable palaeomagnetic data from crucial sequences of well dated igneous (rather than sedimentary or metamorphosed) rocks.

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