Search for the Permian-Triassic boundary in central Peninsular Malaysia: Preliminary report

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The Permian–Triassic boundary (PTB), despite decades of searching, has not been located precisely to date in Malaysia. We are currently focusing our search for the PTB in central Peninsular Malaysia as part of our contribution to the geological heritage scheme launched by the National University of Malaysia (Universiti Kebangsaan Malaysia) and as a contribution to the new IGCP 572 Project "Restoration of marine ecosystems following the Permian–Triassic mass extinction: Lessons for the present".

In central Peninsular Malaysia, there are several limestone karst hills which have yielded data indicating the possible presence of the PTB. Among them, Gua Bama has now emerged as the most prospective site, as it displays strata ranging from Upper Permian to Triassic. Its lithofacies is a thickly to massively bedded succession of limestones, with occasional tuffaceous layers.

Upper Permian colaniellid foraminifers are known from the base of Gua Bama (Lim and Abdullah, 1994). The Triassic nautiloid *Sibyllonautilus bamaensis* was recently reported from the top of the hill, confirming the presence of the Triassic (Sone *et al*., 2004). Thus, the Gua Bama limestone hill must include the Permian–Triassic transition. The nautiloid-bearing deposit includes abundant sponges and algae, which are extremely rare in the Early Triassic in general, and therefore we consider the uppermost part of the Gua Bama strata to be most likely Middle Triassic in age.

In addition to foraminifera, conodonts, brachiopods, and corals have recently been discovered from the basal part of Gua Bama. The conodonts include *Hindeodus typicalis* (Sweet), which is known to straddle the PTB, ranging from the upper Changhsingian through to the lower Induan (Lower Triassic) (e.g. Jiang *et al*., 2007; Yin *et al*., 2001) and gondolellids that indicate a probable Changhsingian age. The brachiopods include *Dongpanoproductus*, known elsewhere only from the upper Changhsingian of South China (He *et al*., 2005). We therefore interpret the lowest part of Gua Bama to most likely be of late Changhsingian age. This implies that the PTB is located some short distance above the conodont-brachiopod horizons. We are currently carrying out additional bed-by-bed systematic sampling and anticipate locating the PTB at Gua Bama in the near future.

At the base of Gua Bama, passage beds from the underlying shale (which extends down to the so-called Lyttoniid Shales of Muir-Wood, 1948) to the Gua Bama limestone are exposed (Leman, 1995; Sone *et al*., 2004). The shales often yield abundant brachiopods, which may include more than one fauna and were collectively interpreted to possibly range from Roadian to Wuchiapingian in age (Campi *et al*., 2002). However, our new biostratigraphic data from the lower part of Gua Bama implies that some brachiopod-bearing shales nearby Gua Bama may be as young as Changhsingian in age.

In addition, another limestone hill, Gua Sei located about 3 km east of Gua Bama, yields the conodonts *Isarcicella isarcica* and *Hindeodus parvus*, indicative of a basal Triassic age (Metcalfe, 1995). So far, it is uncertain whether the PTB is also present in Gua Sei. However, Paleozoic productoid brachiopods previously reported from Gua Sei imply the presence of the PTB. Our recent field survey in Gua Sei confirms that there are some

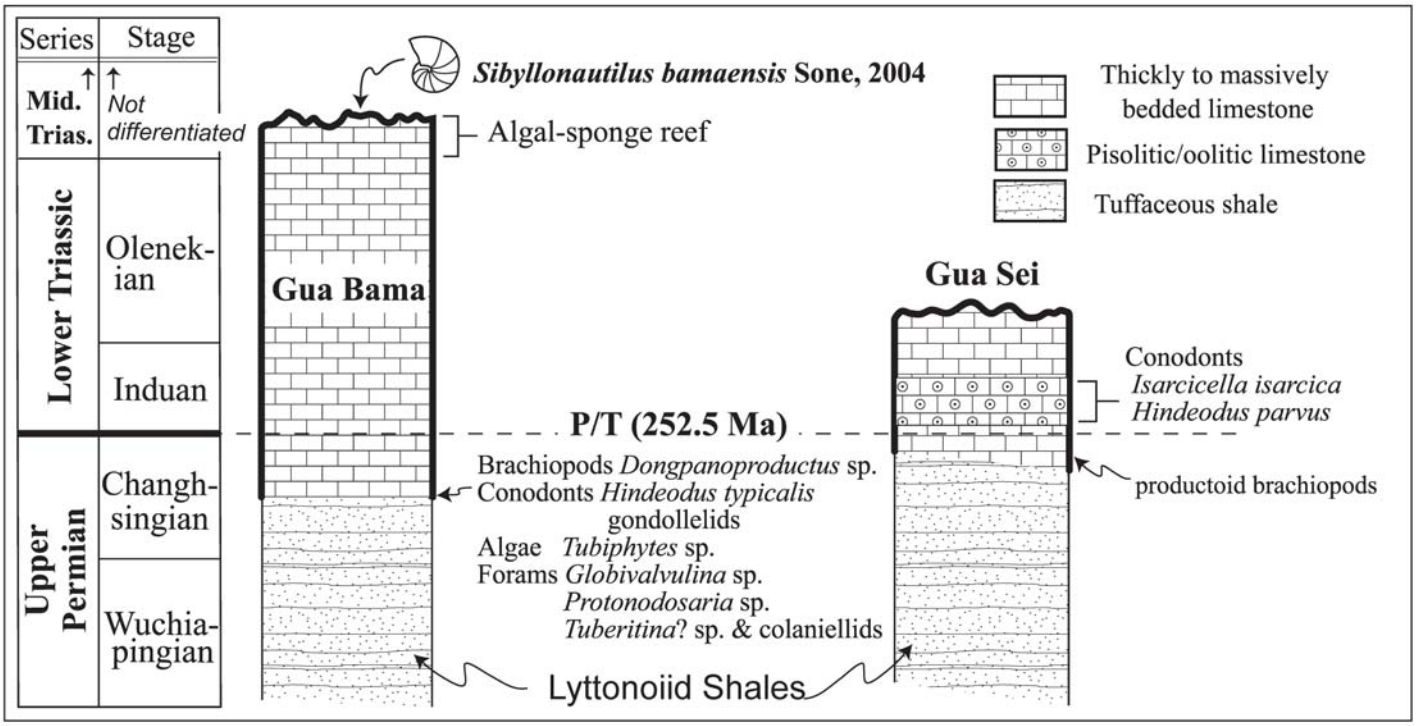

Fig. 1. Correlation chart between Gua Bama and Gua Sei (modified from Sone *et al*., 2004). PTB isotopic age from Mundil *et al*. (2004).

strata continuing below the conodont horizons, which may extend down into the Permian.

Furthermore, approximately 25–30 km east of Gua Bama and Gua Sei, there is another limestone unit called the Kenong limestone, which consists of some six major hills. As a whole, it also demonstrates a stratigraphic range from Wuchiapingian to Anisian (Middle Triassic) (Fontaine *et al*., 1994), yet the exact locality for the PTB is not known. All Gua Bama, Gua Sei, and Kenong limestones constitute parts of the same carbonate platform of the Late Permian–Triassic, which developed over a shallow-water basin of the East Malaya Terrane with Cathaysian affinity.

We are currently seeking co-researchers to undertake radio-isotopic dating (zircon U-Pb) of tuff layers close to the PTB and stable carbon and other isotopic analyses of carbonates for episodic environmental change across the PTB. We would appreciate hearing from any potential collaborators.

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Submission Deadline for Issue 51 is Wednesday, December 31, 2008