



Search for the Permian–Triassic boundary in Peninsular Malaysia: Candidates for the national geological heritage

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The Permian–Triassic boundary (PTB) is defined by the first appearance of the conodont species *Hindeodus parvus* (Kozur and Pjatakova). It is now indicated to be 252.5 Ma by zircon U–Pb radio-isotopic dating (Mundil *et al.*, 2004).

Despite decades of searching (e.g. Metcalfe, 1984), the PTB has not been located precisely to date in Malaysia. In central Peninsular Malaysia, there are several limestone sections, which have yielded biostratigraphic data indicating the plausible presence of the PTB. Two of them, Gua Bama and Gua Sei near Kuala Lipis, Pahang, have now emerged as the most promising sites, as they both display carbonate strata ranging from uppermost Permian to Triassic (Figure 1).

The Triassic nautiloid *Sibyllonautilus bamaensis* Sone was recently reported from the top of Gua Bama, confirming the presence of the Triassic in Gua Bama (Sone *et al.*, 2004). Thus, it is likely that the Gua Bama sequence includes the PTB transition. The nautiloid-bearing deposit includes abundant algae, which in general are extremely rare in the Early Triassic; hence, it is interpreted that the uppermost part of the Gua Bama strata extends to the post-Early Triassic, most likely Middle Triassic (Sone *et al.*, 2008).

From the base of Gua Bama, Late Permian colaniellid foraminifers have been reported (Lim and Abdullah, 1994), and conodonts and brachiopods have recently been discovered. The conodonts include *Hindeodus*, *Iranognathus* and *Clarkina* that indicate a late Changhsingian age. The brachiopods were found in the siliciclastic strata 2 m below the conodont beds; that is, transitional strata from the underlying clastic sequence to the limestones. They include the rare genus *Dongpanoproductus*, known elsewhere only from the late Changhsingian of South China (He *et al.*, 2005). Thus, the lowest part of Gua Bama is most likely of late Changhsingian age, implying that the PTB is located some short distance above the conodont horizons.

Gua Sei is located about 3 km east of Gua Bama, and yields the conodonts *Isarcicella isarcica* and *Hindeodus parvus*, indicative of a basal Triassic age (Metcalfe, 1995). Our recent investigations confirmed extended strata of more than 30 m below the conodont horizons in Gua Sei (Sone *et al.*, 2008), and the Late Permian foraminifer *Colaniella* has been discovered, confirming the Permian in Gua Sei. Thus, the PTB must be located within this interval of 30 m. It is anticipated that the PTB at either or both Gua Bama and Gua Sei can be precisely located in the near future.

In addition, below the Gua Bama and Gua Sei carbonates, the so-called Lyttoniid Shales of Muir-Wood (1948) are known to extend. These shales often yield abundant brachiopods of warm-water Tethyan characters, and the ages were previously interpreted rather broadly as Roadian to Wuchiapingian (Campi *et al.*, 2002). The present study, nevertheless, reveals that some brachiopod-bearing shales around Gua Bama and Gua Sei may be as young as Changhsingian.

The two localities now stand as candidates for the geological heritage of Malaysia, targeting the famous Meishan Section (Global Stratotype Section and Point for the PTB, see Yin *et al.*, 2001) of the Changhsing Geopark in China.

Keywords: Permian, Triassic, boundary, stratigraphy, Malaysia

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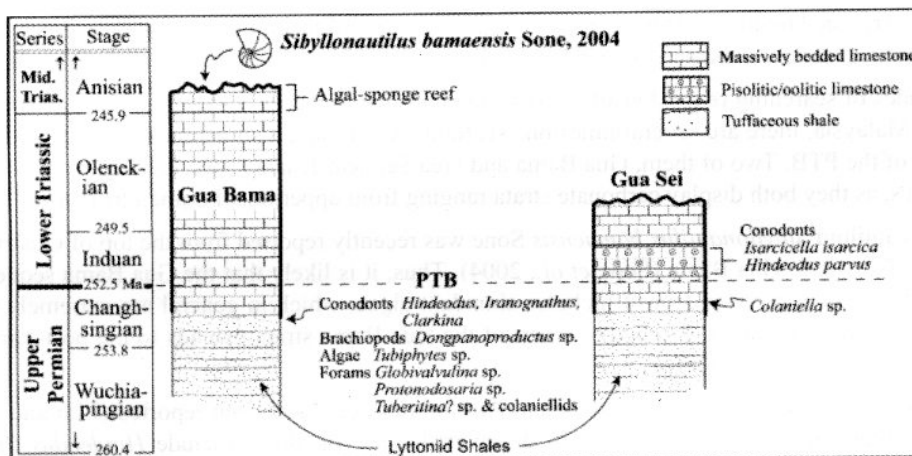


Figure 1. Correlation chart between Gua Bama and Gua Sei (modified from Sone *et al.*, 2004). Boundary ages after Gradstein *et al.* (2005) except for the PTB isotopic age (Mundil *et al.*, 2004).