The Induan-Olenekian boundary in Western Australia: Conodont biostratigraphy, carbon isotopes and constraints on post mass extinction anoxia

I. Metcalfe[1, 2], R.S. Nicoll[3, 4], R. Willink[5], M. Ladjavadi[6], & K. Grice[6]

[1.] Earth Sciences, Univ. New England, Australia
[2.] Earth and Planetary Sciences, Macquarie Univ., Australia
[3.] Geoscience Australia, Canberra
[4.] Research School of Earth Sciences, Australian National Univ., Canberra
[5.] Origin Energy, Milton, Australia
[6.] Dept. Chemistry, Curtin University, Perth Australia

Ocean anoxia was widespread in the latest Permian and continued episodically into the Early Triassic. These episodes of anoxia have been interpreted to be due to upward rise(s) of the chemocline, oceanic overturn(s) and/or major climatic perturbations. A significant anoxic event is recorded in the Kockatea Shale of the lower part of the Senecio-1 borehole core from the northern Perth Basin, Australia. We here present new biostratigraphic and chemostratigraphic data constraining the age of this anoxic event. The Early Triassic Induan-Olenkian Stage boundary (Dienerian-Smithian Sub-Stage boundary) has been identified in the Senecio-1 Well. This is the first international Triassic stage boundary to be unequivocally placed in Australia. Relatively abundant conodont faunas (1,000+ elements) represent three conodont zones in ascending order, the *Clarkina carinata - Neospathodus dieneri* Zone, the *Neospathodus waageni eowaageni* Zone and the *Neospathodus waageni waageni* Zone. In addition, a *Neospathodus waageni* subsp. nov. subzone is recognised in the upper part of the the *Neospathodus waageni waageni* Zone. The Induan-Olenekian (Dienerian-Smithian) boundary is placed at the base of the *Neospathodus waageni eowaageni* Zone equivalent to the first appearance of *Neospathodus* ex. gr. *waageni* utilised elsewhere and adopted by the International Union of Geological Sciences International Commission on Stratigraphy Triassic Subcommission to define the base of the Olenekian. Bulk kerogen $\delta^{13}C$ carbon isotopes define a positive peak of c. 4 per mille that essentially coincides with the Induan-Olenekian boundary and correlates with the Dienerian-Smithian carbon isotope positive anomaly reported from Pakistan, North India, South China, Japan and Italy. The upper limit of the anoxic zone recognised in the lower part of the Senecio-1 core is dated as latest Dienerian. This correlates with the late Dienerian anoxic event recognised globally indicating that this global anoxic event occurs in high-latitude Western Australia and is temporally coincident.

Late Permian (Changhsingian) and Early Triassic (Induan) conodonts and the Permian-Triassic boundary in central Peninsular Malaysia

I. Metcalfe[1, 2] & M. Sone[3]

[1.] Earth Sciences, Univ. New England, Australia
[2.] Earth and Planetary Sciences, Macquarie Univ., Australia
[3.] Department of Geology, University of Malaya, Kuala Lumpur, Malaysia

The Permian-Triassic boundary (PTB) is defined in the GSSP section at Meishan, China at the base of Bed 27c and is recognised by the first appearance of the conodont *Hindeodus parvus*. The PTB is dated at 252.3 Ma by bracketing tuff CA-IDTIMS ages and is slightly younger than the main "end" Permian (late Changhsingian) mass extinction. Despite decades of searching, the PTB has not been located precisely to date in Malaysia and it is still unclear if a stratigraphic break occurs at the boundary. In central Peninsular Malaysia, there are three mogote hill limestone sections, Gua Panjang, Gua Bama and Gua Sei, that have yielded biostratigraphic data indicating the probable presence of the PTB. The Late Permian foraminifers *Palaeofusulina* and *Colaniella*, which indicate a probable Changhsingian (but not latest Changhsingian) age have been reported from the lower parts of Gua Panjang and Gua Sei. Changhsingian conodonts including *Clarkina* spp., *Hindeodus julfensis* and *Hindeodus typicalis*, occur in the lower part of Gua Panjang but the presence of the Early Triassic has not yet been confirmed. Early Induan (Griesbachian) conodonts including *Hindeodus parvus* and *Isarcicella staeschei* (*Isarcicella staeschei* Zone) are known from the upper part of Gua Sei indicating that the PTB lies between this conodont-bearing horizon and the lower level with *Colaniella*. The lower part of Gua Bama comprising bedded tuffaceous limestones, dolomitic limestones and tuffs have yielded Changhsingian conodonts including species of *Clarkina*, *Hindeodus julfensis* and *Iranognathus movschovitschi*. Colaniellid foraminifers and brachiopods including the rare genus *Dongpanoproductus*, known elsewhere only from the upper Changhsingian of South China, have also been reported from near the base of Gua Bama. The Triassic nautiloid *Sibyllonautilus bamaensis* was recently reported from the top of Gua Bama, confirming the presence of the Triassic. The Gua Bama sequence therefore must include the PTB transition. However, basal Induan and topmost Changhsingian strata are yet to be identified in the studied sequences. This is partly due to difficulties of sampling largely inaccessible critical levels in these limestone hill sections.