Systematics and biostratigraphy of Australian Early Cretaceous belemnites with contributions to the timescale and palaeoenvironmental assessment of the Australian Early Cretaceous System derived from stable isotope proxies

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ABSTRACT

Belemnites are particularly common in Australian Early Cretaceous sequences but have attracted little contemporary examination. They offer potential for biostratigraphic zonation, as evaluated in the study presented here, based on an examination of very extensive collections that have accumulated in museum and university collections over more than a century. Most of these are from the Great Artesian Basin of eastern Australia and the Carnarvon Basin of Western Australia but small collections from the Maryborough Basin (coastal Queensland) and the Money Shoals Basin (Northern Territory) are also included in the study. Systematic revision has identified distinctive taxa of the Austral Family Dimitobelidae, and has determined their stratigraphic ranges. Contrary to the existing literature, the Aptian Stage is characterized by just two species: robust *Peratobelus oxys* Tenison-Woods characterized by an unusually large phragmocone, previously described under the name *P. selheimi* Tenison-Woods, and gracile *P. bauhinianus* Skwarko. Albian taxa include long-ranging *Dimitobelus diptychus* McCoy and *D. stimulus* Whitehouse but also the short-ranging *D. plautus* sp. nov. (early Albian), and *D. liversidgei* Etheridge (late Albian). *Dimitobelus hendersoni* sp. nov. is recognized from the Albian of Western Australia but its precise range is not known. A distinctive new, diminutive, Cenomanian belemnite genus *Microbelus* gen. nov. is established with two component species, *M. haigi* sp. nov. and *M. tumidus* sp. nov., based on collections from the West Australian Carnarvon Basin.

Many of the belemnite guards have retained pristine biogenic calcite, free from diagenetic overprint, as demonstrated by the luminescence properties of polished thin sections examined by electron microprobe imaging and by analysis for trace element contents by inductively coupled plasma technology. Belemnite guards arranged in stratigraphic sequence for the eastern Australian Great Artesian Basin and from drill core from the Carnarvon Basin have been analysed for Sr-isotope contents. Strontium isotopic curves for these two sequences have been used for timescale resolution of the Australian Early Cretaceous System, by comparison with the global curve established from a range of northern hemisphere studies. The evaluation indicates that some adjustment to biostratigraphic zonations applied in Australia for timescale purposes, particularly that related to dinoflagellates, requires adjustment. Substantial paraconformities are indicated for both documented successions, embracing the Aptian-Albian boundary interval.

Oxygen and carbon isotopic analysis has been applied to the same sample set examined for strontium contents, with the objective of illuminating the palaeoenvironmental context of Australian shallow marine environments of Early Cretaceous (Aptian-Cenomanian) age. The data indicate that oxygen and carbon isotopic systematics of epeiric association were perturbed by partial isolation from the global ocean. Isotope signatures for the sequence of the Great Artesian Basin reflect a combination of local scale influences, including dilution by riverine runoff, exchange with volcaniclastic sediment, unusual temperature regimes that applied in very

extensive, shallow epicontinental water bodies and the peculiarities of organic recycling in such an environment.

Oxygen-isotope values obtained from the Carnarvon Basin, representing an open-ocean continental margin sediment system, indicate southern hemisphere mid-latitude late Aptian sea surface temperatures, that differ little from those which presently apply. A warming trend is apparent for the Albian-Cenomanian interval, representing greenhouse climatic conditions. Carbon-isotope values through the same interval show a complementary negative trend in $\delta^{13}C$, attributed to CO_2 enhancement in the atmosphere that accompanied global warming. Short period temperature excursions of as much as 5°C are identified in the record, suggesting that climatic shifts of similar scale to those which characterised the Pleistocene Epoch also applied in the mid Cretaceous. Relative to values of $\delta^{13}C_{carb}$ available from other studies of Albian – Cenomanian biogenic carbonate, those obtained from the Carnarvon Basin are unusually low, suggesting that low productivity characterised the water body in which its sedimentary succession accumulated through this time interval. The carbon-isotope record is incomplete for the intervals that should register oceanic anoxic episodes 1a (early Aptian), 1b (Aptian-Albian boundary interval) and 1d (latest Albian). OAE 1b is expressed by a positive $\delta^{13}C_{carb}$ excursion across the euxinic interval of the Toolebuc Formation in the Great Artesian Basin succession and a correlative positive excursion is apparent for the succession of the Carnarvon Basin. It is dated as early late Albian, ~ 105Ma, but its global significance is open to question. A matching negative excursion in $\delta^{13}C_{org}$ across the Toolebuc interval of the Great Artesian Basin is attributed to the influence of organic matter of continental provenance.

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