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A unique carbon isotope record across the Guadalupian–Lopingian (Middle–Upper Permian) boundary in mid-oceanic paleo-atoll carbonates: The high-productivity "Kamura event" and its collapse in Panthalassa

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Abstract

Middle to Upper Permian shallow marine carbonates in the Kamura area, Kyushu (SW Japan), were derived from a paleo-atoll complex developed on an ancient seamount in mid-Panthalassa. The Capitanian (Upper Guadalupian) Iwato Formation (19 m-thick dark gray limestone) and the conformably overlying Wuchiapingian (Lower Lopingian) Mitai Formation (17 m-thick light gray dolomitic limestone) are composed of bioclastic limestone of subtidal facies, yielding abundant fusulines. A secular change in stable carbon isotope ratio of carbonate carbon ($\delta^{13}C_{carb}$) was analyzed in the Kamura section in order to document the oceanographic change in the superocean Panthalassa with respect to the mass extinction across the Guadalupian–Lopingian boundary (G–LB). The Iwato Formation is characterized mostly by unusually high positive $\delta^{13}C_{carb}$ values of +4.9 to +6.2‰, whereas the Mitai Formation by low positive values from +1.9 to +3.5‰. The negative excursion occurred in three steps around the G–LB and the total amount of the negative shifts reached over 4‰. A remarkably sharp drop in $\delta^{13}C_{carb}$ values, for 2.4‰ from 5.3 down to 2.9‰, occurs in a 2 m-thick interval of the topmost Iwato Formation, after all large-shelled fusulines and bivalves disappeared abruptly. Such a prominent high positive $\delta^{13}C_{carb}$ plateau interval in the end-Guadalupian followed by a large negative shift across the G–LB was detected for the first time, and this trend in the mid-superoceanic sequence is correlated chemostratigraphically in part with the GSSP (Global Stratotype Section and Point) candidate for the G–LB in S. China. The present results prove that the end-Guadalupian event was doubtlessly global in context, affecting circum-Pangean basins, Tethys, and Panthalassa. The end-Guadalupian interval of a high positive plateau in $\delta^{13}C_{carb}$ values over +5‰ is particularly noteworthy because it recorded an unusually high bio-productivity period that has not been known in the Permian. This end-Guadalupian high-productivity event, newly named "Kamura event", suggests burial of a huge amount of organic carbon, draw-down of atmospheric CO_2 and resultant global cooling at the end of Guadalupian, considerably after the Gondwana glaciation. The low temperatures during the Kamura event may have caused the end-Guadalupian extinction of large-shelled Tethyan fusulines and bivalves adapted to warm climate. On the other hand, the following event of ca. 4‰ negative shift in $\delta^{13}C_{carb}$ values across the G–LB indicates a global warming in the early Lopingian. This may have allowed radiation of the new Wuchiapingian fauna, and this trend appears to have continued into the Mesozoic. These observations are in good agreement with the global sea-level curve in the Middle–Late Permian. The smooth and gradual pattern of the negative shift suggests

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that the causal mechanism was not of catastrophic nature (e.g. bolide impact, sudden melting of methane hydrate) but was long and continuous.

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1. Introduction

The mass extinction at the Paleozoic–Mesozoic or Permian–Triassic boundary (P–TB) was the greatest in magnitude among the five major extinction events of the Phanerozoic (e.g., Sepkoski, 1984; Erwin, 1993; Hallam and Wignall, 1997; Erwin et al., 2002). This so-called Late Permian mass extinction was lately revealed to have comprised two independent extinction events that occurred in a relatively short time interval less than 10 Myr, i.e., one at the Guadalupian–Lopingian boundary (G–LB) and the other at the P–TB *sensu stricto* (Jin et al., 1994; Stanley and Yang, 1994). Stanley and Yang (1994) pointed out that the extra-large magnitude of biodiversity loss at the end-Permian might be explained by such a shortage in recovery time between the two devastating events for the biosphere. The G–LB mass extinction was of an almost equivalent magnitude to the P–TB event, terminating preferentially immobile invertebrates with a passive respiratory system, such as brachiopods, rogose corals, bryozoans, fusulines, etc. (Fig. 1).

In contrast to the P–TB issue (e.g., Yin et al., 2001), however, the G–LB event and relevant environmental conditions have been less analyzed in all aspects. For example, detailed stratigraphic descriptions of the G–LB sections with full paleontological data have been in fact restricted mostly to South China (Jin et al., 1994), and only fragmentary data were sporadically reported from Transcaucasia, Iran, Pakistan, and Texas (e.g., Iranian–Japanese Research Group, 1981; Pakistani–Japanese Research Group, 1985; Leven, 1996; Wilde et al., 1999). The Laibin area in Guangxi (South China), in particular, exposes hitherto the most complete section for this interval, and it is nominated as the Global Stratotype Section and Point (GSSP) for the G–LB (Jin et al., 1998). Under these circumstances, much more information is needed from the rest of the world to assess the nature of the G–LB mass extinction event and relevant environmental change probably of a global scale. Inevitably, the data are relevant for the wide superocean Panthalassa that occupied nearly 70% of the planet's surface in the Permo-Triassic interval. The deep-sea chert from mid-Panthalassa recorded a clear redox change from oxic to anoxic nearly at the G–LB (Isozaki, 1994, 1997a), and this suggests an oceanographic change of a global scale had appeared at the G–LB in the superocean.

The Late Permian to Jurassic accretionary complexes in Japan contain numerous allochthonous blocks of not

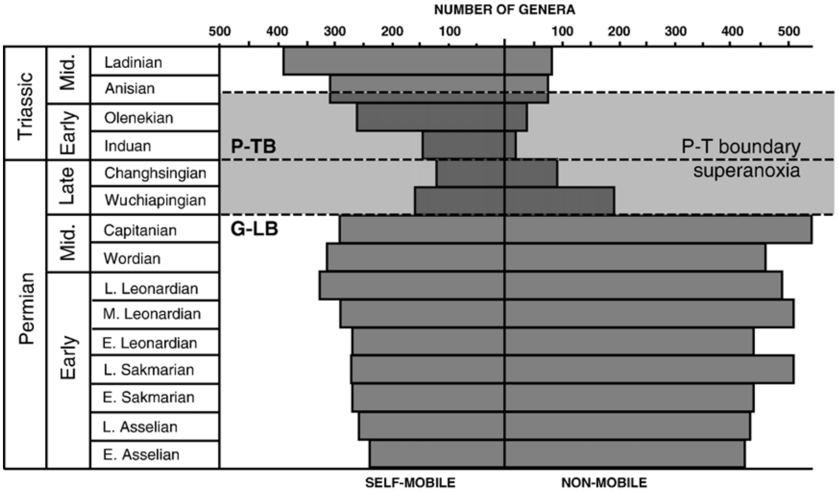

Fig. 1. Secular change in biodiversity in the Permo-Triassic interval (modified from Knoll et al., 1996). Note the bottleneck pattern of diversity loss across the P-TB, and the temporary coincidence with the superanoxia (Isozaki, 1994, 1997a) that started at the G-LB and culminated at the P-TB.

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