$^{87}Sr/^{86}Sr$ chemostratigraphy of Ediacaran Doushantuo Formation in the Yangtze Craton, South China

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The Ediacaran period records one of the most dramatic biological episodes in Earth's history. To track environmental changes occurring in the Ediacaran, multi-geochemical proxies have been reported by a number of studies. Ediacaran sedimentary rocks in South China figure prominently in such studies, because they are fossiliferous and accumulated at various depositional settings from shallow platform to basin facies. Recent extensive geochemical works for the Doushantuo Formation in South China demonstrate that $\delta^{13}C$ values of inorganic carbon were variable throughout the Ediacaran period. On the other hand, a drastic change in weathering influx from continents is thought to have major influences on the change in seawater composition and on biological activity. Its flux can be estimated from the $^{87}Sr/^{86}Sr$ ratios of carbonate rocks. However, the existing $^{87}Sr/^{86}Sr$ values are limited to shallow marine deposits, which leaves ambiguity in a variation of $^{87}Sr/^{86}Sr$ ratios in outer ocean.

We conducted drilling at Siduping, Tianping, and Weng'an sections in South China to obtain the Ediacaran complete sedimentary sequences deposited at slope and shoal facies. We newly report stratigraphic profiles of the $^{87}Sr/^{86}Sr$ ratios at the three sections. $^{87}Sr/^{86}Sr$ chemostratigraphy demonstrated some diachronous natures of $\delta^{13}C$ within the Doushantuo Formation. The enhanced continental weathering during Gaskiers glaciation likely promoted bacterial sulfate reduction and aerobic respiration of organic matter. These resulted in low $\delta^{13}C$ values of dissolved inorganic carbon and accumulations of phosphate and dissolved CO_2 species in seawater, and eventually induced the deposition of phosphorites at the shelf margin. High $^{87}Sr/^{86}Sr$ ratios during the largest negative $\delta^{13}C$ anomaly in the Ediacaran can be also recognized in the continental slope sediment. This fact supports that globally high continental weathering rate led to massive remineralization of organic matter and a consequent significant negative $\delta^{13}C_{carb}$ excursion.

Keywords: radiogenic Sr isotopic ratio, South China, The Ediacaran

The Late Guadalupian (Permian) Kamura event revisited: carbon isotope stratigraphy of the topmost Iwaizaki limestone in NE Japan and the expansion of oceanic OMZ

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The major extinction of marine animals occurred in the Capitanian immediately before the Guadalupian-Lopingian boundary (Permian), of which detailed stratigraphy has been analyzed in low-latitude sections, e.g. in Texas, South China, and also in Japan. The sea-level drop and the coeval selective extinction of tropical fauna during the Capitanian suggest the appearance of global cooling. The Permian Iwaizaki limestone in the South Kitakami belt in NE Japan represents a shallow marine shelf carbonate sequence that record the development of a patch reef and subsequent collapse in the high-latitude side of subtropical zone. The occurrence of large-tested fusuline *Lepidolina* and extremely low Sr isotope ratios guarantee the Capitanian age of the uppermost part of the limestone. We analyzed the secular change in inorganic and organic carbon isotope ratios for drilled core from the topmost 40 m-thick interval of the limestone. We found out that $\delta^{13}C_{carb}$ values of the Capitanian seawater reached up to +5.8 ‰during the extinction, and that organic matter had $\delta^{13}C_{org}$ value as high as -22.5 ‰. The results confirm that the "Kamura event", originally proposed solely on inorganic carbon isotopic ratio, indeed implies the high primary productivity coupled with the efficient burial of organic matter. In order to drive $\Delta^{13}C$ up to 30 ‰, additional contribution by methane-bacteria is necessary in carbon fixation, which can be best performed under reducing conditions. Similar high $\Delta^{13}C$ values detected in coeval shallow marine limestones in the Brusane section in Croatia and the Senkina Shapka section in Far East Russia suggest the global nature of the Kamura event. This unique isotopic episode likely reflected the expansion of the oxygen minimum zone (OMZ) in the superocean, which may have caused the significant extinction at the end of the Guadalupian.

Keywords: mass extinction, Permian, Capitanian, C isotope ratio

Comparative study of mass extinction: end-Ordovician and and end-Guadalupian extinction events

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Among the so-called Big-5 mass extinctions of the Phanerozoic, those at the end-Permian and end-Ordovician stand out high as the largest and the second largest of magnitude. These two mass extinctions occurred respectively before and after the irreversible big change in the biosphere, i.e. the great land foresterization during the Devonian and Carboniferous. Characteristics of these two events are compared for searching possible common causes. The end-Permian extinction was two-folded; i.e. the first at the end of the Guadalupian (Middle Permian) and second at the end of the Permian. Some similarities exist between the end-Ordovician (Hirnanthian) event and the end-Guadalupian (Capitanian) event; such as the preferential elimination of sessile biota in tropics, sea-level drop, secular changes in seawater C and Sr isotope ratios. All these observations suggest that the Hirnanthian and Capitanian extinctions were triggered probably by global cooling resulted in significant glaciation and sea-level drop, although the cause of the global cooling has not yet been identified. In contrast, their mutual differences in screening pattern of biota etc. suggest that the background conditions were significantly different between the Ordovician and Permian cases. This comparison highlighted similar cause/processes but different background conditions and biotic responses.

Keywords: mass extinction, Ordovician, Permian, global cooling

Litho- and SSF stratigraphy of the lowermost Cambrian of the Hongjiachong and Xiolantian sections in East Yunnan, South China

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Metazoans diversified dramatically in a short time during the latest Ediacaran and earliest Cambrian. Animal of small shelly fossils (SSF) were the first group that diversified much ealrlier than the well-known Burgess/Chengjiang faunas. Biostratigraphy of SSF was best analyzed in Yunnan, S. China (e.g. Meishucun, Laolin, Xiotan) because of the abundant occurrence of SSFs from various depositional environments from extremely shallow to deep basin. This study carefully examined litho- and SSF stratigraphy of Hongjiachong section and Xiaolantian section in Chengjiang area Yunnan. The two studied sections consist of the Zhijiaqing Fm, Shiyantou Fm, and Yu’anshan Fm, in ascending order. The Zhijiaqing Fm is subdivided into Daibu Mb, Zhongyicun Mb, and Dahai Mb. Although the first and second SSF assemblages were recovered at the Hongjiachong section (Sato et al., 2014), the boundary between these two assemblages was not identified yet. The first assemblage occurred in the lower Zhongicun Mb, but the overlying strata for ca. 20m thick are barren, except the second assemblage from the marker calcareous sandstone in the middle of Zhongicun Mb.

To date, the following results were obtained from the Hongjiachong section; 1) second SSF assemblage occurs from a phosphorite bed 1m lower than the previously claimed the lowest horizon at the marker sandstone in the middle of Zhongjicun Mb, 2) one unique SSF specimen with particular shell structure was extracted from a phosphorite bed ca. 4 m lower than the marker sandstone. This fossil piece is ca. 1.5 mm long and in an elongated oval shape, probably representing a fragment of nearly symmetrical shell. Along the axial cylindrical pillar, multiple small plates are aligned obliquely along one side. These features are similar to those of the SSF, *Sinosachites (Thambetolepis) delicates* (JELL) reported from Lower Cambrian in S. Australia, which is correlated to relatively younger the Shiyantou and Yu’anshan formations in China. We will also report the litho- and SSF stratigraphy of drilled core samples (ca. 87 m deep) from the Xiaolantian section currently under analysis.

Keywords: Cambrian, SSF, Xiaolantian, Hongjiachong

Stable and radiogenic strontium isotope variation ($\delta^{88}Sr$, $^{87}Sr/^{86}Sr$) in Middle-Upper Permian mid-oceanic paleo-atoll carbonates

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Stable strontium isotope ratios ($\delta^{88}Sr$) of the Capitanian (late Guadalupian) to Wuchiapingian (early Lopingian) carbonates were measured by TIMS, by correcting isotope fractionation during mass spectrometry with ^{87}Sr-^{84}Sr double spike. The studied carbonate section at Akasaka (Japan) in the Jurassic accretionary complex was originally deposited on a mid-Panthalassan paleo-seamount, which recorded a unique interval with extremely low $^{87}Sr/^{86}Sr$ values (the Permian minimum for ca. 5 m.y. throughout the entire Capitanian). We also analyzed the Wuchiapingian section at Lianshan in S. China, which was deposited on the shallow shelf. Both in $\delta^{88}Sr$ and radiogenic $^{87}Sr/^{86}Sr$ ratios, low values remained throughout the Guadalupian, whereas they increased rapidly in the Wujiapingian. The newly obtained δ^{88} Sr profile of Middle-Late Permian seawater positively correlated with that of $^{87}Sr/^{86}Sr$ ratio. As seawater $\delta^{88}Sr$ could sensitively reflect marine carbonate flux at the ocean floor, this correlation suggests that the valance between the Sr carbonate burial flux and Sr carbonate dissolution flux has changed sharply across the Guadalupian-Lopingian boundary. The Capitanian minimum and the following rapid increase in seawater $^{87}Sr/^{86}Sr$ likely reflected a major change in continental flux, probably reflecting the rapid deglaciation together with enhanced erosion/weathering of continental crusts on a global scale.

Keywords: Sr isotope, Permian, carbonate

Change of the carbon cycle in G-L boundary using numerical value calculation

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The largest extinction of Big five in Phanerozoic is observed in end of Permian period.The large extinction include two step, Guadalupian- Lopingian boundary (GLB) and Permian- Triassic boundary (PTB) (Sepkoski, 1984; Knoll et al., 1996; Isozaki, 1997; Stanley and Yang, 1994; Kaiho et al., 2005).Therefore, we need to study from GLB to PTB, in order to understand the correlation between extinction and environmental changes. we study life cycle changes and influence to oceanic environment in extinction by changes of carbon isotope ratio.
There were many previous studies of carbonate and organic carbon isotope ratio from GLB to PDB. The carbon isotope records show over +6 permil before GLB, calling to Kamura event. The d13Ccarb after Kamura event decrease to ca. 0 permil around GLB. Moreover, the d13Ccarb decreases from ca. +3 permil to ca. -2 permil at PTB and shows large excursions from PTB to middle Triassic (Isozaki et al., 2007a,b; Korte et al., 2005a,b; Payne et al., 2008). On the other hand, organic carbon isotope date show about -30~-28 permil in deep sea sediment (NIshikane et al., 2014). And decoupled carbonate and organic carbon isotope ratio is observed in Iwaizaki carbonate section, South of Kitakami belt. The section corresponds to the Kamura event before GLB (Tobita et al., in prep).
We discuss the change of carbon cycle to reproductive carbonate and organic carbon isotope changes by the numerical value calculate.We assume an inorganic and an organic reservoir in the sea. Flows (Photosynthesis and Remineralization, organic burial, carbonate burial) are a ratio of each reservoir’s size.The results suggested changing amount of organic matter in GLB. The changes might be triggered by large extinction.The large organic matter might cause a global expansion of oxygen minimum zone (OMZ).

Keywords: GL boundary, Carbon cycle, extinction

