Japan Geoscience Union Meeting 2013
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BPT27-P01 Room:Convention Hall Time:May 19 18:15-19:30

Intensive continental weathering rate in the Lower Cambrian: evidenced from Sr isotope ratios preserved in the strata at

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One of the most important times in biological evolution was from the first appearance of soft-bodied animals and possibly Metazoan animals in the late Neoproterozoic to the sudden diversification of animals with mineralized skeletons in the Cambrian. Neoproterozoic to Cambrian fossiliferous succession is well exposed in South China (e.g., Luo et al., 1984); it has been much investigated using biostratigraphy, sequence stratigraphy and chemostratigraphy (e.g. Condon et al., 2005; Zhou and Xiao, 2007; Zhu et al., 2007). We carried out on-land drilling of the Ediacaran to Cambrian sedimentary succession in Three Gorges, South China. The drill-sampling allows us to minimize the effect of secondary alteration and oxidation on the surface and to make a very continuous chemostratigraphy at intervals of centimeters. Now, members of our group at Tokyo Tech and the Univ. of Tokyo have analyzed several kinds of isotope ratios to estimate paleo-environment; including carbon, oxygen, nitrogen and strontium isotope ratios.

The weathering influx from continents is thought to be a major influence on the change in composition of ancient seawater and on biological evolution. Its flux can be estimated from the 87Sr/86Sr ratio of carbonate rocks. We present a new detailed chemostratigraphy of 87Sr/86Sr in the Three Gorges region in South China. The result shows that 87Sr/86Sr ratios had decreased from ca. 0.709 around the Precambrian/Cambrian boundary to ca. 0.7085 at the Atdabanian stage. Subsequently, 87Sr/86Sr ratios recovered to ca. 0.709 at the end of Early Cambrian. We calculated secular variation of weathering flux using the analyzed data, suggesting intensive continental weathering rate in the Lower Cambrian.

Keywords: 87Sr/86Sr, continental weathering, Early Cambrian, Three Gorges, drill-core

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Platinum group element anomalies in the Triassic-Jurassic deep-sea sediments

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One of the biggest mass extinctions in the Phanerozoic occurred at the Triassic-Jurassic (T-J) boundary (e.g., Sepkoski, 1984). The large magmatic activity associated with the breakup of Pangaea and the initial stage of rifting in the Central Atlantic Magmatic Province (CAMP) are characteristic across the T-J boundary (McHone, 2000; Nomada, 2007). So, these magmatic activities likely changed the climate and caused biotic crisis at the T-J boundary (e.g., Deenen et al., 2010). On the other hand, Olsen and others (2002) suggested that bolide impact triggered the climatic change and mass extinction, based on an Ir anomaly preserved in the Newark rift basin. In addition, it is also proposed that the encounter with dark clouds and supernova explosion caused extreme environmental change on the earth surface (the mass extinction and glaciation; Kataoka at el., 2012). However, the possibilities of these hypotheses remain controversial because of insufficient geological evidence.

In this research, we present secular variation of platinum group elements (PGEs) concentration in the Triassic-Jurassic succession in Inuyama, central Japan. Previous Ir anomalies have been reported from sediments with high sedimentation rate, around the T-J boundary (Olsen et al., 2002; Hori et al., 2007). However, sediments with low sedimentation rate are suitable for the PGEs analyses. In the Inuyama, the depositional rate of the shale part in bedded chert is about one to two orders slower than those of the chert (Hori et al., 1993). Therefore, the best target for the PGEs analyses is the shale part in bedded chert preserved in the accretionary complex.

We conducted geological survey at the Inuyama section, because of good exposure of the T-J boundary. We developed detailed geological map of the study area and collected rock samples bed-by-bed to determine the secular variation of PGEs concentrations. In particular, we collected about 250 samples from shale part in the bedded chert and analyzed the PGEs concentrations of 20 shale samples across the T-J boundary. For whole-rock analyses of PGEs, all shale samples were powdered in an Alumina planetary mill. After chemical separation from coexisting matrix elements using a chromatographic technique, PGEs concentrations were analyzed by coupled plasma mass spectrometry (ICP-MS) at Tokyo Institute of Technology. The PGEs concentrations were determined by isotopic dilution method. The results show that Ir concentration reach ca. 1 ppb just above the T-J boundary. As compared to the previous works (Olsen et al., 2002; Hori et al., 2007), the Ir anomaly is the highest across the T-J boundary and attributes to the difference of their depositional rate and/or sampling resolution. Olsen and others (2002) suggested the possibility of volcanic or impact events for origin of the Ir anomaly. The Ir anomaly in this research also may be associated with impact event, despite the lack of shocked quartz and other index of impact origin (e.g., Grieve et al., 1996). In order to recognize the correlation between PGEs concentrations and CAMP, we need additional stratigraphic and isotopic analyses.

In this presentation, we would like to discuss the origin of the Ir anomaly and its relation to evolution of life.

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Keywords: the Triassic-Jurassic boundary, deep-sea sediments, platinum group elements

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Detection of cosmogenic material in deep-sea sediments based on platinum group element (PGE) abundances

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Snowball Earth events are widely recognized to have occurred in both the Palaeoproterozoic and Neoproterozoic. All present-day animal phyla appeared following the Marinoan-Snowball Earth, which is the last recorded global glaciation. The primary objective of this research is to determine the cause of this Snowball-Earth event, which is likely associated with the evolution of life. Three models that attempt to explain the onset and termination of Snowball-Earth events are: (1) episodic decrease of greenhouse gases, (2) changes of the albedo of the Earth accompanied by the arrangement of the continents, and (3) an increase in cosmic-ray bombardment to the Earth due to Starbursts in the Milky Way Galaxy or transects of Earth through nebula.

Based on recent investigations, the effects of cosmic fluxes on the Earth are estimated here through the measurement of the abundances of platinum group elements (PGE) in sediments.

Pelagic sediments composed of interlayered shale and/or mudstones are optimal for PGE-abundance analysis because of their low sedimentation rate. Pelagic sediments used for PGE-abundance analysis in this investigation are comprised of bedded shales and/or mudstones sampled from the accretionary complex of Anglesy-Llyen, U.K. The Anglesy-Llyen reportedly was formed by an accretionary orogeny in the Neoproterozoic. During the geological survey, samples were acquired from a pelagic sedimentary sequence, which records late Cryogenian to early Cambrian sedimentation. A relatively high PGE concentration and its flat C1-normalized PGE pattern indicate possible high cosmic fluxes on the Earth during the emplacement of this sequence when compared to average upper continental crust composition.

Keywords: PGEs, deep-sea sediment, Cambrian

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High-resolution litho- and chemo- stratigraphy across the Middle-Late Permian boundary in the mid-oceanic limestone

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The extinction around the Guadalupian-Lopingian boundary (G-LB) recorded the first major biodiversity drop during the Permian. In order to clarify the relevant global environmental changes immediately before the G-LB, high-resolution chemostratigraphy of $^{87}Sr/^{86}Sr$ and $d^{13}C_{carb}$ was analyzed for the Middle Permian paleo-atoll limestone at Akasaka and Ishiyama in central Japan.

Both limestones were derived from a paleo-atoll complex deposited primarily in the low latitude a mid-Panthalassa. At both sections, the Middle Permian black limestone is overlain by the Upper Permian light gray limestone. An interval of white-black striped limestone occurs between the two, and its top marks the G-LB horizon. Fusuline biostratigraphy indicates that the black limestone belongs to the Yabeina Zone (Capitanian; late Guadalupian), whereas the light gray limestone to the Codonofusiella-Reichelina Zone (Wuchiapingian; early Lopingian). The ”barren interval” between them is divided into the lower 1) black limestone, and the upper 2) striped limestone without smaller foraminifer and gastropod.

The lithofacies of the black limestone and of the striped limestone indicates that the depositional setting was subtidal zone and intertidal zone, respectively.

At the Akasaka Limestone, a very thin ($<$5 mm-thick) light greenish non-carbonate layer occurs between the striped limestone and the light gray limestone, which was once reported as a felsic tuff. This layer is enriched in elements such as Al, Fe, K and Cr. The source was not yet identified, however, this layer is possibly correlated with the Wangpo Bed, i.e., the G-LB marker in South China.

This study confirms that $^{87}Sr/^{86}Sr$ ratios stayed extremely low around 0.7068 throughout the Capitanian and increased rapidly to 0.7074 at the G-LB, and that the ”Permian minimium” has persisted throughout the entire Capitanian for more than 5 million years. The $d^{13}C_{carb}$ values stayed extremely high, +6 permil, throughout the Capitanian, and dropped to +2 permil at the G-LB. This records, no doubt, the Capitanian Kamura event of the very high primary productivity of surface ocean. These isotope profiles are correlated well with those of the coeval Iwato Formation in Kyushu, thus likely reflecting the general trend of the low latitude mid-superocean seawater.

The change in lithofacies towards the G-LB recorded that the depositional setting reached the shallowest during the deposition of striped limestone. This implies that sea level became shallower towards the G-L boundary. In accordance with the lowest sea level around the G-L boundary, this may suggest that global cooling has appeared immediately before the G-L boundary and possibly caused the end-Capitanian extinction.

Keywords: G-L boundary, Akasaka Limestone, Ishiyama Limestone, carbon isotope, strontium isotope

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Litho-, bio-, and C, Sr isotope stratigraphy of the Middle Permian mid-Panthalassan paleo-atoll carbonates

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The Wordian-Capitanian (Middle-Upper Guadalupian, Permian) Iwato Formation in East Kyushu is composed of shallow marine carbonates in an accreted paleo-atoll complex primarily developed on a paleo-seamount in the low-latitude doamin (12 degree S) of mid-Panthalassa. By analyzing the Wordian interval, we could newly reconstruct a continuous C-isotope profile of the upper half of Guadalupian, and discuss the environmental changes in the low-latitude mid-superocean. We confirmed that the high C isotope interval ($>$ 5 permil) had started already in the Wordian. The onset of the Kamura cooling event likely started much earlier than previously believed, and affected the diversity of the Guadalupian biota.

Keywords: Permian, Iwato Formation, paleo-seamount, Panthalassa, Kamura event, fusuline

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Detailed stratigraphy of the uppermost Iwaizaki limestone (Middle Permian) in the South Kitakami beltin

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The Permian Iwaizaki Limestone in the South Kitakami belt represents a shallow marine carbonates of continental shelf facies. The previous fusuline stratigraphic researches clarified that the upper half of the limestone belongs to Capitanian (Upper Guadalupian, Middle Permian). Nonetheless the topmost ca. 30 m-thick interval was not well analyzed in lithology and age. Here we report new detailed lithostratigraphy of this interval and discuss the environmental changes near the extinction horizon of the large-tested Capitanian fusulines dominated by Lepidolina multiseptata.

Keywords: Permian, Iwaizaki limestone, South Kitakami belt, fusuline, mollusc, Capitanian

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Paleogeographic position of the Permian Iwaizaki limestone in South Kitakami belt

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The Gudalupian (Middle Permian) Iwaizaki limestone in the South Kitakami belt, NE Japan, represents an isolated block of ancient continental margin that features non-metamorphosed Lower Paleozoic to Mesozoic shallow marine sequences. We detected for the first time a bivalve assemblage that features alatoconchidae from the upper part of the Iwaizaki limestone. According to the 10 previous reports from the world, the occurrence of alatoconchidae is strictly limited to low-latitude, i.e. paleo-equatorial domains. Their unique habitat in shallow warm-water, oligotrophic setting was likely related to photosymbiosis. Together with large-tested fusuline (e.g., Lepidolina) and rogose coral, the Capitanian tropical trio from Iwaizaki positively indicates the intimate connection between South Kitakami belt and South China during the Permian. This further suggests that the eastern extension of South China continues all the way through the main pat of Japan up to NE Japan, and that the South Kitakami belt represents its eastern extremity ever confirmed.

Keywords: Permian, paleogeography, South Kitakami belt, Panthalassa, South China, Guadalupian