Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

BPT022-01 Room:104 Time:May 24 11:45-12:00

Toward decoding environmental changes in the Pacific Ocean during the Cenozoic by using DSDP/ODP cores

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We collected core samples obtained from more than 60 sites by the Deep Sea Drilling Project/Ocean Drilling Program (DSDP/ODP) in order to elucidate environmental changes in the Pacific Ocean during the Cenozoic. Depth profiles of seafloor sediments which cover a major portion of the Pacific Ocean will give us temporal-spatial constraints on the evolution of the Pacific Ocean. Here we talk about our future plan to analyze these core samples.

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BPT022-02 Room:104 Time:May 24 12:00-12:15

Re-Os age of Besshi-type sulfide deposit associated with in-situ basalt as an age constraint for ridge subduction

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We report two Re ages from the Makimine and Shimokawa Besshi-type massive sulfide deposits distributed in the Northern Shimanto Belt. These Besshi-type massive sulfide deposits are characterized by close association with an in-situ basalt whose geochemical composition is similar to those of mid-ocean ridge basalts and sandstone/mudstone directly overlie massive sulfide layer, indicating that the Makimine and Shimokawa Deposits were formed in the shelf sea covered by terrigenous clastic rocks. We present that the Re-Os age of these Besshi-type deposits will be a powerful tool to determine a timing of the ridge subduction to the paleo-Japanese Island in the Late Cretaceous.

Keywords: Re-Os age, Besshi-type massive sulfide deposit, ridge subduction, Makimine Deposit, Shimokawa Deposit, Northern Shimanto Belt

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BPT022-03 Room:104 Time:May 24 12:15-12:30

Marine Os isotopic variations during the glacial-interglacial cycles as inferred from the Lau basin carbonates

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Silicate weathering on land is considered to control a long-term global climate change through consumption of atmospheric CO2. It has been also pointed out that the atmospheric CO2 consumption by silicate weathering was linked to even shorter-term variations such as glacial-interglacial cycles, although still controversial. The marine Os isotopic composition reflects the relative intensity of two dominant influxes into the ocean; radiogenic continental crustal detritus and unradiogenic mantle-like materials derived from oceanic lithosphere and meteorites. The difference in 187Os/188Os ratios between these two sources is very striking (1.0-1.4 for continental crust vs. ˜0.1 for mantle-like materials), which makes the Os isotopic system an excellent tracer for mantle and continental input into the marine environment. Hence, the marine Os isotope record has been increasingly used as a reliable proxy for continental weathering caused by global-scale geological processes. Because the influxes from mantle and cosmic dust were likely constant during the glacial-interglacial cycles, the marine Os isotopic composition is considered to have been determined by the intensity of silicate weathering. Here we report the marine Os isotopic variations during the glacial-interglacial cycles as inferred from the Lau Basin carbonates.

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BPT022-04 Room:104 Time:May 24 12:30-12:45

Assessment of natural forcing effects to global warming

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It is well recognized that the average surface temperature of the Earth has increased since about 1900. According to the Forth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), it is very likely that the warming since the mid-20th century is mainly caused by the increase of anthropogenic greenhouse gas concentration (IPCC, 2007). There is mounting evidence from paleoclimatic studies, however, that the Earth's surface temperature significantly fluctuated without anthropogenic effects over the last few millennia. In the AR4, the IPCC reviewed many researches reconstructing a temperature variation over the last 1300 years and then recognized that a relatively warm condition occurred in the medieval period, although the warmest is apparent in the 20th century. In order to accurately predict a future climate change, it is very important to evaluate the contribution of the natural effects to the global warming. In the present study, we assess the natural forcing effects to the past and recent global warming.

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BPT022-05 Room:104 Time:May 24 14:15-14:30

Stratigraphic lithologic correlation of Mesoarchean oceanfloor sequence: Cleaverville-Dixon Island vs Mappepe formations

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The Mesoarchean has key period to understand changing environments on earth surface, such as continental growth, atmosphere, and biosphere during Archean. We try to corelate these changes from deep ocean sedimentary sequence at 3.2 Ga from following two localities; the Dixon Island ?Cleaverville formations in west Pilbara in Australia and the Mapepe formation in the Fig Tree Group in the Barberton belt in South Africa.

The 3.2 Ga Dixon Island ?Cleaverville formations is one of the best preserved immature island arc setting ocean surface environment (Kiyokawa et al., 2006). Lower portion the Dixon Island Formation is highly affected volcanic rocks with hydrothermal vein. Above volcanics, hydrothermal vein related thick chert bed was deposited. Upper portion formed well laminated organic rich shale, chert pyrite thin layer. After the pillow lava volcanic event, the Cleaverville Group deposited from thick massive black shale and banded iron formation. The stratigraphic change shows depth condition from the hydrothermal related relative deep ocean environment to weakly oxic shallow ocean.

On the other hand, 3.2 Ga Mapepe Formation in the Fig Tree Group which was reported well stratified turbidity sandstone-shale sequence above volcanic rich Onverwacht Group (eg. Lowe and Byerly, 1999). We focused one example of well bedded shale-chert sequence of the Mapepe Formation along the Komati River. This section was more than 300 m continuous outcrops. We reconstruct 150m long very detail stratigraphic columns at this section. This formation formed well laminated black-greenish shale, black-white chert, iron rich red chert, magnetite rich iron formation. Lower portion preserved few m thick massive black chert and start to well laminated more than 300m thick bedded sequence. There is thick red color iron rich sandstone bed sequence overlies in this formation. The Komati river section is identified as upward increase chert and iron rich sediment and coarsening upward.

Stratigraphy of these sediments are partly resemble. Both of contains hydrothermal chert sequence at the bottom, and well laminated black shale ? chert ? shale sequences. Also, grain size, thickness of bed and iron contents in each sequence are increase to the top. This stratigraphic character shows oxic condition may be formed at these ages. Organic matter below the iron rich sediment may be identified as producer of oxygen at this time.

Keywords: Archean, Black shale, BIF, hydrothermal activity, Pilbara, Barberton

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BPT022-06 Room:104 Time:May 24 14:30-14:45

LITHOLOGICAL CHARACTERISTICS AND SULFUR ISOTOPE RATIO OF PYRITE IN 3.2GA BLACK SHALE, PILBARA, WESTERN AUSTRALIA.

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The 3.2Ga low-grade Dixon Island and the Cleaverville formations lie at coastal Pilbara greenstone belt of Western Australia. In 2007 summer, we conducted scientific drilling (DXCL-DP) in the Cleaverville Beach to understand relatively deep marine environments in Mesoarchean. In DXCL-DP, we obtained three fresh drill cores (DX, CL2 and CL1 in ascending order). In these cores, obvious stratification by black shale, gray chert and pyrite is found. Pyrite shows a laminated structure and matches well with bedding plane of cores. Detailed research for laminated pyrite is important to understand the mechanism of its formation and reconstruct the sedimentary environment at the time. Therefore we carried out visual observation by microscope and SEM and sulfur isotope analysis using EA-irMS to reveal the characteristics and general variations of sulfur isotope ratio for laminated pyrite.

Laminated pyrite in these cores is divided into two types by shape; massive layer and graded layer. Massive layer is less than 1.5 cm in thickness and shows the pinch-and-swell structure that is tensioned parallel to bedding plane. Also this type is vertically segmented into several blocks by small quartz veins, include euhedral pyrite crystals, attendant later load deformation. Graded layer is 0.5 to 4 cm in thickness and shows gradual increase in the amount of tiny pyrite crystals.

Tiny pyrite crystals in these cores are divided into three shape types, 1) spherical, 2) hollow, and 3) filled types. The spherical type is 10 to 30 micrometer in diameter and shows spherical rim, less than 5 micrometer in breadth, with inner siliceous core. The hollow type is 10 to 50 micrometer in diameter and shows a small spherical hollow in the center of a crystal. Filled type looks like hollow type in that an inner hollow is filled by pyrite. Laminated pyrite is composed of an aggregate of three types of tiny pyrite crystals. We also found that these crystals gradually overgrew from spherical type to filled type in a single layer.

The isotopic composition of sulfur in laminated pyrite and tiny pyrite crystals in black shale are -10.1 to +23.5 per mil in DX, +1.7 to +24.9 per mil in CL1 and +4.4 to +26.8 per mil in CL2. Many samples show positive values, and very heavy isotopic ratios, over +20 per mil, are found in several samples.

In the formation of tiny crystals, spherical type is first crystallized as a spherical pyrite rim and changed into hollow type by an overgrowth of outer pyrite crystal. Finally it is settled as filled type. Euhedral pyrite crystals formed in later stage do not possess these characteristics. These suggest that the laminated pyrite formed before load deformation. The spherical crystal formed during sedimentation or in very early stage of diagenesis. Also, a part of laminated pyrite in these cores reflects concentration of tiny pyrite during the early stage of sedimentation.

Very wide range of sulfur isotope ratio of laminated pyrite indicates the very active microbial sulfate reduction. Positive isotope ratio might be created by intense sulfate reduction under sulfate-limiting condition. Very heavy isotopic ratios, like that of the modern ocean, suggest the existence of fractionated seawater sulfate in the Mesoarchean ocean.

Keywords: Archean, black shale, pyrite, sulfur isotope ratio, sulfate reduction, sedimentary environment

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BPT022-07 Room:104 Time:May 24 14:45-15:00

Geochemistry of the Archean seafloor hydrothermal alteration: implications for the Archean atmosphere and ocean

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Archean hydrothermally altered rocks have been investigated by thermodynamic reaction path models in order to put some constraints on chemistry of the Archean atmosphere and ocean.

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BPT022-08 Room:104 Time:May 24 15:00-15:15

Ecosystem and environments 2.5-2.7 Ga ago: Geochemical Records from the Hamersley Basin, Western Australia

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Through interactive evolutions of the Earth system throughout its long history, i.e., co-evolution of atmosphere, hydrosphere, lithosphere, and biosphere, microbial ecosystem and metabolic pathways have experienced complex evolution. From iron and carbon isotope compositions of 2.7-.5 Ga old drillcore black shales in Hamersley Basin, Western Australia, we tried to constrain the evolution of microbial ecosystem and environments. Near-shore sedimentary rocks are characterized by C isotope compositions of organic matter that are suggestive for C cycling that involved various aerobic and anaerobic metabolism of methane, and their Fe isotope compositions with limited variations suggest rather inactive redox cycling of Fe. On the other hand, deep-facies shales have intra-basin variations such that proximal shales presumably under oxic conditions have heavier Fe isotope compositions and distal shales deposited in anoxic environment have much lighter Fe isotope compositions. Such variations are consistent with the Fe-shuttle model driven by Fe reduction by Fe-reducing bacteria.

Keywords: Black Shales, Iron reducing bacteria, Sulfate reducing bacteria, Australia, Continental Drilling, Iron Isotope

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BPT022-09 Room:104 Time:May 24 15:15-15:30

A rise of atmospheric oxygen triggered by the Paleoproterozoic deglaciations: Insights from osmium isotopes

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The Paleoproterozoic era is one of the most interesting periods in Earth's history to understand interaction between the atmosphere-ocean system and early life. A number of geological and geochemical evidences suggest that the atmospheric oxygen dramatically increased during the Paleoproterozoic, known as the Great Oxidation Event (GOE). Since repeated, severe glaciations also occurred at the time of the GOE, it is suggested that climate change would have played a key role in the rise of atmospheric oxygen. However, due to lack of detailed geochemical records constraining the redox conditions in the atmosphere and oceans during and immediately after the glaciations, the relationship between the GOE and the Paleoproterozoic glaciations remains poorly understood.

Here we investigate the evolution of the redox conditions in the atmosphere and oceans immediately after the first and second Paleoproterozoic glaciations based on the abundance and isotopic compositions of redox sensitive element osmium (Os) and rhenium (Re) in the sedimentary rocks in the Huronian Supergroup, Ontario, Canada. We found enrichments of Re and Os with high initial 187Os/188Os ratio immediately after the both glaciations. These results suggest an input of radiogenic 187Os to the sediments at the time of deposition. Considering that mobilization of continental radiogenic 187Os in the hydrological cycle requires moderately oxygenated atmospheres, our findings suggest that the atmosphere and shallow oceans have been oxygenated sufficient to deliver continental Os to the oceans (pO2 ˜ 10-5-10-4 times the present atmospheric level) immediately after the both of the glaciations. Based on the Os records together with other geochemical data of the present study, we conclude that the climatic recovery from the Paleoproterozoic glaciations would have promoted photosynthetic activities, leading to the rise of atmospheric oxygen. Coupled with previous geochemical data, oxygen spikes would have occurred in the aftermath of the first and second Paleoproterozoic glaciations possibly in the similar mechanism. Our results support the hypothesis of stepwise rise of atmospheric oxygen in response to the repeated glaciations during the Paleoproterozoic.

Keywords: Paleoproterozoic, glaciation, Great Oxidation event, Os isotope, geochemistry

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BPT022-10 Room:104 Time:May 24 15:30-15:45

N, S and C isotopic fluctuation as proxies for bacterial dominant oceanic environment recorded in 1.9 Ga Gunflint Fm.

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Geochemical analyses were performed on the ca. 1.9 Ga Gunflint Formation, Canada in order to constrain the microbial ecosystem of Paleoproterozoic oceanic environments. The examined samples were divided in shallow- and deep-water sequences based on their lithologies. Hematitic oolites were the representative lithology for the shallow-water sequence and the deep-water sequences contain sideritic banded iron formation. Such contrast in water depth is corresponded to stratified oxic-anoxic ocean situation deposition of the Gunflint Formation.

Kerogens were extracted from rock samples by HCl and HF treatment. Their stable carbon isotope compositions were ranging from -33.6 to -25.1 permil (PDB). 2alfa-methyl hopane were identified by GC-MS analyses of lipid-biomarker. These results suggest that cyanobacteria were the major primary producers to support the ecosystem both in oxic and anoxic parts of the Gunflint ocean. Pyrite bearing oolite sample suggests high productivity of cyanobacteria forming thick microbial mats at the shallow part of oceans. Intensive carbon recycling was occurring in such mats, supporting anaerobic life, including methanogens.

S(pyr)/C(org) ratios of examined samples were higher than the results of previous studies (Poulton et al., 2004). The stable sulfur isotope compositions of pyrites were range from -1.1 to +26.9 permil (CDT). These results indicate that 1.9 Ga Gunflint ocean was sulfate-rich ocean, promising high activity of sulfate reducers in particular thick microbial mats in the shallow part of the Gunflint ocean.

The stable nitrogen isotope compositions of representative kerogens were measured. The results indicate the amount of nitrogen, which has no relation with original organic matter, is ignorable in analysis. The values range from +3.7 to +9.9 permil suggesting that certain nitrification-denitrification cycling was developed in thick microbial mat. In addition, nitrogen isotope compositions fluctuated according to lithological changes. Such fluctuation is also seen in sulfur isotope compositions and total organic carbon concentrations, while carbon isotope compositions showed opposite trend. Those fluctuations are most likely corresponded to activity change of primary producers, thus cyanobacteria.

Here we propose that very high activity of cyanobacteria in the Gunflint shallow ocean caused high activities of anaerobic heterotrophs, including sulfate reducers, and then yielded in heavy nitrogen and sulfur isotope compositions. Those enhanced microbial processes also linked to development of the stratification of the Gunflint ocean water. In addition, the results of micro scale observation of organic matter by electron microscope are going to be discussed.

Keywords: Paleoproterozoic, Gunflint Formation, nitrogen stable isotope, kerogen

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BPT022-11 Room:104 Time:May 24 15:45-16:00

Long-period astronomical cycles form Triassic-Jurassic bedded chert sequence and Newark Supergroup

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Attention has historically focused on the 20, 40, 100, and 405 ky Milankovitch periods, but long-period cycles of up to several million years are present in the orbital solutions through Phanerozoic. These long-period astronomical cycles have been occasionally recognized in sedimentary records, and may imply associated changes in global

climate. Astronomical theory predicts that the long-period astronomical cycles may not have had constant periodicities because of the chaotic behavior of the planets (Lasker et al., 2004). It is possible that geological records preserve the evolution in frequency of long-period astronomical cycles in the past (Olsen & Kent, 1999; Ikeda et al., 2010a). To explore the evolution of long-period astronomical cycles, bedded chert sequence and lacustrine Newark Supergroup have been used to construct an astronomical time scale of approximately 30 m.y. duration from the Late Triassic to Early Jurassic that shows a hierarchy of the sedimentary rhythms of astronomical cycle origin including all of the main precession-related periods (Ikeda et al., 2010b; Olsen and Kent, 1986, 1999). Wavelet analysis of the 405-kyr tuned record revealed the presence of approximately 2 m.y. cycle whose periodicity was modulated between ˜ 1.6- and ˜ 2.4 m.y.. The timing of frequency modulations and dominant frequency of the approximately 2 m.y.. cycle are synchronized with the two sequences. Our results of frequency modulation of approximately 2 m.y. cycles can provide new constraints for orbital models and the cyclostratigraphic template for establishing a high-resolution chronostratigraphy.

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Keywords: Chert, Newark Supergroup, Triassic/Jurassic, lacustrine, astronomical cycle, cyclostratigraphy

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BPT022-12 Room:104 Time:May 24 16:00-16:15

The Late Archean diversity of organisms: evidence from morphology and in situ iron isotope analyses of pyrites in variou

Kazumi Yoshiya[1*], Manabu Nishizawa[2], Yuichiro Ueno[1], Tsuyoshi Komiya[3], Shigenori Maruyama[1], Naohiro Yoshida[4], Takafumi Hirata[5]

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The timing of the emergence and flourish of oxygenic photosynthetic organisms is still controversial. However, it is one of the key issues of the biological evolution in early Earth. Reconstruction of redox state of the late Archean seawater is important for understanding the relationship between biological activity and oxygenation.

Ferrous and its compounds were one of the major reduced species in the anoxic Archean seawater. It is widely recognized that the iron isotopic ratio changes largely through redox reactions, especially oxygen limited environment (Beard and Johnson, 2004; Johnson et al., 2004). The iron isotopic ratio of marine sedimentary minerals is useful for understanding the ocean's redox state and iron biogeochemistry in the geological past (e.g., Johnson et al., 2008). Based on the detailed geological survey of the Fortescue Group in Redmont area, we carefully selected 44 samples, which include stromatolitic carbonate rock, sandstone, mudstone, and alternation of calcareous sandstone and mudstone. We analyzed d^{56}Fe value of 225 pyrite grains in these samples, and discovered an extremely large variation of d^{56}Fe value from -4.1 to 3.0 permil.

From the result of microscopic observation, we found the relationship between pyrite grain morphology and iron isotope ratio. Most of pyrite grains with the positive d^{56}Fe values show hexagonal, rectangle, and parallelogram shapes, which are consistent with crystal system of iron-oxides: hematite, magnetite, and goethite, respectively. In contrast, pyrite grains with the negative d^{56}Fe values show pseudo-hexagonal and irregular forms. The pseudo-hexagonal shape corresponds to a monoclinic system that is crystal system of pyrrhotite. The correlation allows the possibility to solve the origin and the formation process of each grain of pyrite. We estimate the d^{56}Fe value of seawater from the positive d^{56}Fe value pyrites in stromatolitic carbonate rock and experimental data of previous studies (Welch et al., 2003; Butler et al., 2005). Based on this estimation, we consider that the d^{56}Fe value of pyrite lower? than ?estimated d^{56}Fe value of sulfide was formed biologically. The quite low carbon isotope ratio of organic carbon with a nadir down to -47 permil indicates the activity of aerobic or anaerobic methanotrophy. On the other hand, the lowest d^{56}Fe value of the pyrite grain, -4.0 permil, indicates the biological iron-reducing: dissimilatory iron-reducing microorganism (DIR) or recently found iron-dependent AOM (AOM/IR). The co-occurrence indicates the oldest evidence for activity of the iron-dependent AOM. On the other hand, the d^{56}Fe values of pyrite grains in the mudstone layer of upper Mingah Member have relatively wide variation from -4 to +2 permil. The positive d^{56}Fe values suggest the partial oxidation of iron in oxygen limited surface environment. The $d^{13}C_{org}$ values are also lower than 40 permil. This suggests the presence of organic carbon from methanotrophs. Iron and carbon isotopes reveal the divergence of microorganisms in Late Archean shallow sea.

Keywords: pyrite, oxygen-producing photosynthetic bacteria, methanotrophy, stromatolite, iron reducing bacteria

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BPT022-13 Room:104 Time:May 24 16:30-17:00

Three steps evolution of multicellular animals

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The period from the Ediacaran to Cambrian is one of the most exciting periods when the first multicellular animals appeared and quickly evolved. The biological evolution is very unique because it takes very long time, >2000 my, until multicellular animals appeared after the emergence of eukaryotes, and because appearance of new phylum is limited to this period (Cambrian explosion). Previous works combined two biological evolutions of emergence and diversification, and investigated its origin. This work estimates environmental changes from the Ediacaran to Cambrian, from geochemistry of drill core samples in Three Gorges area, South China, and proposes that distinct environments between the Ediacaran and Cambrian contributed to the emergence and diversification, respectively.

We made chemostratigraphies of C, O, Sr, Fe and Ca isotopes and Fe, Mn, REE and P contents of carbonates, Mo isotopes of black shales and C and N of organic matters to estimate primary productivity, continental weathering influx, temperature, nutrient contents (P, N), and redox condition of seawater. Sr isotopes display positive excursions and indicate high continental influxes at ca. 580, 570-550 and 540 Ma. P content of carbonate rock was very high until ca. 550 Ma, and then decreased, suggesting the seawater was enriched in P until then. High N and Ca isotope values indicate that seawater was depleted in N and Ca contents until ca. 550 Ma, and then increased. Mo isotopes of black shale, and Fe and Mn contents and REE patterns of carbonate rocks indicate that seawater became more oxic since ca. 550 Ma.

The geochemical evidence suggests that the emergence of Metazoan in the Early Ediacaran was caused under the relatively less oxic and P-rich condition, whereas their diversification occurred under oxic, N and Ca-rich condition. Especially, the transition from P to N-rich seawater possibly supported increase of Redfield ratio and contributed to diversification of more mobile multicellular animals.

Keywords: multicellular animals, surface environmental change, Snowball Earth, Cambrian explosion, Cambrian-Precambrian boundary, Multi-elemental, isotope analyses

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BPT022-14 Room:104 Time:May 24 17:00-17:15

The analysis of D47 and oxygen isotope ratio of the Ediacaran Doushantuo Formation South China

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The Ediacaran period was one of the most important periods in the history of life when multicellular animals first appeared on the earth (Brasier and Antcliffe, 2004). However, the relationship between the abrupt biological evolution and environmental change is still ambiguous. In order to examine the environmental change, for example seawater temperature through the Ediacaran, we analyzed the carbon and oxygen isotope compositions of carbonate rocks from drill cores from the Three Gorges area, South China. In addition, we analyzed the D47 from the same samples. The core samples include the Nantuo tillite, corresponding to the ca. 635 Ma Marinoan glaciation, through the Doushantuo to the lower Dengying formations in ascending order.

D47 values allow to estimate the change of seawater temperature (Ghosh et al., 2007). So far, there were no D47 data in the Ediacaran because of the new analytic method. On the other hand, the d18O values of carbonate rocks depend on seawater temperature and oxygen isotope ratio of seawater (Kim and O'Neil, 1997). So, the combination leads to separately estimate the change of seawater temperature and oxygen isotope ratio of seawater through the Ediacaran Period.

Tahata and others (2011) showed a positive oxygen isotope excursion in middle Ediacaran and argued that it corresponds to the Gaskiers glaciation. On the other hand, preliminary D47 data shows that the interval also has high D47 values. The D47 values in the Gaskiers glaciation show about 0.610, calculated to be about 23 degrees C. The change of D47 is consistent with the change of d18O. We first showed the change of D47 in Ediacaran, so we first cleared the change of seawater temperature in Ediacaran Period.

Keywords: D47, Ediacaran, South China, oxygen isotope ratio

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Infrared microspectroscopic characterization of Ediacaran microfossils from Doushantuo Formation, Weng'an area

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Phosphatic embryo-like fossils (500-700 um in diameter) from the Ediacaran Doushantuo Formation in Weng'an area, southern China (about 580 million years ago) were analyzed by micro-Fourier transform infrared (FTIR) spectroscopy in order to obtain organic signatures for classification of the microfossils. Transmission IR spectra of the microfossils have absorption bands around 2960 cm-1 and 2925 cm-1, together with that around 1600cm-1, indicating the presence of aliphatic hydrocarbon (aliphatic CH3 and aliphatic CH2, respectively) and aromatic moieties (aromatic C=C). In addition, IR microscopic mapping indicates the distribution of aliphatic CH2 and CH3 groups inside the microfossils. Two types of phosphatic embryo-like fossils (Megasphaera and Megaclonophycus) have distinctive 2960/2925 cm-1 (CH3/CH2) peak height ratios (R3/2 values) from ˜0.6 to ˜0.8, which are higher than R3/2 values of Proterozoic acritarchs and bacterial fossils (Marshall et al., 2005, Precam Res; Igisu et al., 2009, Precam Res). These results are inconsistent with suggestion that they are bacteria and acritarchs. Conversely, this implies that the Doushantuo microfossils analyzed in this study are kinds of animal embryo, while chemical signatures for taxonomy of animals need to be explored.

Keywords: embryo-like microfossil, Doushantuo Formation, FTIR imaging, aliphatic hydrocarbon

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Stable carbon isotope ratio of n-alkanes and isoprenoids from the Cambrian section in the Three Gorge area, South China

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The Cambrian period (542 ? 488 Ma) is one of the most important intervals for the evolution of life. After the Ediacaran/Cambrian (E/C) boundary, the Cambrian-type shelly biota radiated. In the Atdabanian, almost all of modern phyla had appeared, namely Cambrian Explosion. Although it is expected that the biological evolution influenced geochemical cycle in the ocean, the detail is still ambiguous. Logan et al. (1995) used carbon isotope ratios of n-alkanes and pristine to point that carbon cycles changed around early Cambrian because of the appearance of fecal pellets, which efficiently transport organic matters from sea surface to sea floor. However, the exact timing of the change and relationship between the ratio and carbon isotope values of the biomarkers, and carbon isotope values of carbonate and organic carbon are not obvious yet because of only few analyses in the previous work.

It is important to reveal the relationship of such evolutional invention and environmental change, and the reason why. We conducted high-resolution analyses of the ratio and carbon isotope values of the biomarkers to determine the exact timing of the change and to estimate the surface environmental change.

Samples are cut out from a pristine drilling core drilled in South China. Its date is from the end of Ediacaran to Atdabanian (Ishikawa et al., 2008). n- Alkanes and isoprenoids are ubiquitously detected from samples, and their stable carbon isotope ratios are measured.

According to Logan et al. (1995), in Precambrian carbon isotope ratio of n-alkanes are higher than that of pristine, but in Cambrian their relation reversed. In this study, such change is found across Nemakit-Daldynian / Tommotian (ND/T) boundary. The carbon isotope ratios of carbonate drastically change to negative around ND/T boundary (Ishikawa et al., 2008), and they interpret the negative shift as an effect of global cooling. Such environmental change might promote mutation evolution, such as inventing fecal pellets.

Keywords: molecular fossil, carbon isotope, Cambrian, South China

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A chemostratigraphy of organic nitrogen isotope ratio from Ediacaran to Cambrian

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The Ediacaran is one of the most important periods in the history of evolving life when multicellular animals firstly appeared on Earth. However, it is still unclear what caused the emergence of the animals and biological evolution at that time.

Nitrogen is one of the essential elements of life and the limiting nutrients, which include nitrogen, phosphorus, silica and iron at present. Therefore, reconstruction of past nitrogen cycle from the Ediacaran to early Cambrian is important to understand bioactivity and biological evolution at the time, though data of nitrogen isotopic ratio of organic matters in the Ediacaran to Cambrian still lacks. This work presents the nitrogen isotope ratios of drill core samples from the Ediacaran to the early Cambrian in order to estimate transition of seawater nutrients in the Ediacaran to Cambrian.

It is well known that the Three Gorges area section in South China still preserves fresh and continuous strata from the Ediacaran to Cambrian. We collected drill core samples from the latest Cryogenian Nantuo tillite through Doushantuo and Dengying Formations (Fms) in the Ediacaran to the early Cambrian Yanjiahe and Shuijingtuo Fms in ascending order (e.g. Ishikawa et al., 2008; Sawaki et al., 2010). We analyzed nitrogen and carbon isotope ratios of organic matters of black shale, limestone and dolostone in the drill core sample from the Doushantuo to the Shuijingtuo Fms with EA-IRMS at JAMSTEC.

The d15N values are scattered around +6 per mil in the lower and middle Doushantuo Fm., and they gradually decrease from ca. +6 per mil in the upper Doushantuo Fm through ca. 1 per mil in the lower Yanjiahe Fm and 0 per mil around the Yanjiahe/Shuijingtuo boundary to -1 per mil in the middle Shuijingtuo Fm. On the other hand, d13Corg values are settled around -30 per mil in the lower and middle Doushantuo Fm, and fall to -38.7 per mil just below the Doushantuo/Dengying Fm boundary. They rise back to ca. -30 per mil in the Dengying Fm, and stay around -30 per mil to the Shuijintuo Fm. The correlation between d15N and d13Corg values is obscure.The d15N values are scattered around +4per mil in middle and late Cambrian.

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Geochemical analyses of the 2.2 Ga fluid inclusions: Impact of Snowball Earth on eukaryote diversification.

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Study of biomarker suggests eukaryote was present 2.7Ga, but a body fossil is not found until 1.9Ga. The time gap may reflect the eukaryote survived at restricted environments in the Late Archean, and became widely diversified after the Paleoproterozoic. Possibly, seawater composition played an important role on the diversification. At 2.2Ga, surface of Earth was completely (or near completely) covered with icesheet (Snowball Earth event), possibly influencing on both bioactivity and surface environments. Kirschvink et al. (2000) predicted Fe and Mn contents of seawater were very high during the event. On the other hand, previous works suggested that the event also reduced the bioactivity due to the extreme low temperature and restriction of liquid water. However, the influence of changes in seawater composition on the bioactivity is still ambiguous.

We present microthermometry and PIXE analysis of fluid inclusions in hydrothermally precipitated quartz within basaltic lavas, which probably erupted in the Snowball Earth (Kirschvink et al., 2000), in 2.2 Ga Ongeluk Formation, Kaapvaal Craton, South Africa to obtain the information of seawater composition during the period.

We selected primary fluid inclusions from 5 to 40 micrometers across, characterized by the occurrence as three dimensional clusters or parallel to growing planes of a host mineral based on detailed petrography of over 100 fluid inclusions. These inclusions show final melting temperatures of ice from -31.4 to -3.6 C with the bimodal distribution from -7.0 to -3.6 C and from -11.0 to -31.4 C, respectively, final melting temperature of hydrohalite from -47.0 to -21.7 C, and homogenization temperatures from 64.4 to 160.0 C. All primary inclusions, which form as a plane parallel to growth zoning of host minerals constitute the high-saline group. The result suggests that low-saline fluid inclusions are secondary; nevertheless little petrographic difference. We discuss about the primary fluid inclusions with high salinity. Assumed the NaCl-CaCl2-H2O system, we calculated the salinity of fluid inclusions from their melting points. Estimated compositional variation shows two end-members: (1) a low NaCl and high CaCl2 and (2) a high NaCl and low CaCl2 end-members.

We also performed PIXE analyses of relatively large fluid inclusions (ca. 20 to 30 micrometers) at Tsukuba University. The result of PIXE analysis shows concentration of each element (mmol/kg): (Cl) 674.0 to 3835.5, (K) 17.6 to 803.4, (Ca) 9.8 to 1113.8, (Mn) 0 to 10.2, (Fe) 1.8 to 283.9, (Cu) 0 to 20.9, (Zn) 0 to 7.9, (Br) 1.0 to 8.8, (Rb) 0 to 8.4, (Sr) 0 to 5.2, and (Pb) 0 to 10.6, respectively. We calculated sodium concentration (Na_{cal}) from charge balance of the PIXE data. The result shows negative correlation between Ca and other cations (Na_{cal}, K, Fe, Cu, Zn, Mn and Pb), especially between Ca/Cl and Na_{cal}/Cl with a slope of 1/2, and consistent with result of microthermometry.

The negative correlation between Ca/Cl and Na_{cal}/Cl and the slope of 1/2 strongly suggest that these fluid inclusion compositions are derived from albitization between basaltic andesite and water, and that the Ca-rich fluid is hydrothermal end-member whereas another end-member is seawater. The 2.2Ga seawater composition is estimated below: (Cl) ca. 3000, (Na_{cal}) 2236.3, (K) 731.5, (Ca) 134.5, (Fe) 2.7, (Cu) 20.9, (Zn) 7.9, (Mn) 10.1 and (Pb) 10.6 mmol/kg, respectively.

Ongeluk seawater during Snowball Earth event is characterized by extremely high chlorinity and high Fe and Mn contents (at least 1000 times higher than the modern). The first quantitative estimate of the high Fe and Mn contents indicates reduced condition of seawater at the Snowball Earth, supporting Fe and Mn accumulation during the period (Kirschvink et al., 2000). The quite high salinity significantly affected bioactivity of eukaryotes, and the dilution of Cl after the Snowball Earth, liberated the environmental pressure and expanded the niche for eukaryote.

Keywords: seawater, fluid inclusion, eukaryote, proterozoic, salinity, Ongeluk

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Paleogenomics: amalgamation of earth and life sciences

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The history of life and the earth can be studied using the clues contained in geological strata, fossils, and genomes. The former two have been explored to some extent, but the value of historical information engraved in our genomes started to be appreciated only recently. With a wealth of genome sequence data, together with a reliable phylogenetic tree and a simple logic, it is possible to reconstruct ancient genomes (DNA sequences, gene contents, and gene orders) of the common ancestors between any extant organisms, allowing us to trace down through every branch of the Tree of Life back to the last common ancestor of all life. The reconstructed genome can then be used to deduce the ancestral metabolic pathways, developmental cascades, and other features of the genome, such as GC content. Those programmes and features may directly reflect the traits of the hypothetical ancestors and indirectly reflect the ancient environments that they inhabited. The inferred metabolic pathways may also help predict the chemical fossils that can be preserved, and help identify the metaloproteins that might have left certain atomic fossils, such as Fe, Cu, V, Mo, etc. When integrated with the clues obtained from strata and fossils, these pieces of information shall prove useful to gain insight into the interactions between life and environments at any time in the past.