Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS34-P01 Room:Convention Hall Time:May 27 18:15-19:30

Paleoenvironmental changes in NW Panthalassa through the Toarcian OAE: Stratigraphy and geochemistry of the Toyora area

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The early Toarcian (Early Jurassic) oceanic anoxic event (T-OAE) was a significant palaeoenvironmental perturbation that led to marked changes in ocean chemistry and climate, and which also had a severe impact on marine ecosystems. In addition, this event is characterized by the widespread occurrence of a ˜3?7 ‰ negative excursion in the carbon-isotope (δ^{13}C) composition of marine organic and inorganic matter and terrestrial plant material. This feature of the event indicates a pronounced perturbation to the global carbon cycle. Despite such global impacts of the event, the precise palaeoenvironmental changes during the event from sections outside of the Boreal and Tethys realms are uncertain. Thus, to resolve this issue and further expand our understanding of the nature of the event, here we investigated the Nishinakayama Formation of the Toyora area, southwest Japan, which represents shallow-marine strata deposited at the northwestern margin of the Panthalassa Ocean. First, we established high-resolution carbon-isotope chemostratigraphy. A characteristic δ^{13}C negative excursion was recognized around the middle part of the Nishinakayama Formation, allowing accurate international correlation. Then, we carried out geochemical analyses to reconstruct palaeoenvironmental conditions at the northwestern Panthalassic margin. Our results indicate that in the studied succession, organic-matter enrichment persisted through the early Toarcian, but elemental redox proxies and ichnofabrics do not support persistent bottom-water anoxia through the δ^{13}C excursion. Analysis of terrigenously derived major and trace element abundances and palynology, coupled with sedimentological observations, revealed an increase in coarse-grained sediment, phytoclast size, and terrestrial organic-matter close to the onset of the δ^{13}C negative excursion. These lines of evidence potentially suggest a marked strengthening of detrital sediment flux and hence hydrological cycling and continental weathering. This is consistent with previously published evidence from Boreal and Tethys realms.

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Silicoflagellates and surface water-mass variation at ODP Site 704 in the South Atlantic Ocean for the last 10Myrs

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At ODP Site 704 (46.9○S, 7.4○E) in the South Atlantic Ocean, we estimated latitudinal migration of subpolar and subtropical surface water masses for 10 million years on the basis of silicoflagellate fossil assemblage variations in the sediment core samples. Biogeographical silicoflagellate distribution corresponds to cold water and subtropical water masses. This distribution pattern can be applied to the estimation on latitudinal migration of subpolar/subtropical boundary. Although the fossil preservation was poor in the oldest period from 10Ma to 6.5Ma, the extinct genus *Bachmannocena* considered as a temperate or cosmopolitan species was observed for the period. Continuous occurrence of the cold water genus *Distephanus* was observed from ˜6.5Ma to present. The modern annual sea-surface temperature (SST) is 5.6 ℃ at the studied site, and silicoflagellate assemblage is composed of the genus *Distephanus*. The relative abundance of sea ice-related species in the silicoflagellate assemblages increased from 2.7Ma. However, subtropical genus *Dictyocha* intermittently dominated the assemblage from 5.7Ma to 4.0Ma. The co-occurrence of cold and subtropical water species suggest that the subpolar/subtropical boundary or the mixed water had covered the studied site. The temporal increase of subtropical silicoflagellates at the same periods had been reported at ODP Site 1165 (64.4○S) located in further south near the Antarctic. However, it should be noted that alkenone SST did not show the clear increase at the study site for the occurrence period of *Dictyocha*.

Keywords: silicoflagellate, biogeography, paleoceanography, Ocean Drilling Program (ODP), South Atlantic Ocean

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Relative sea level records using high-resolution radiocarbon dating based on new sediment cores from the Bonaparte Gulf

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Sea level is the best indicator of the ice volume change, which plays an important role on the global climate in the Quaternary period (e.g., IPCC AR5). The last glacial maximum (LGM), centered around 20,000 years ago, is a key period for understanding the climate system because the global ice volume reached its maximum. However, the sea level record during the LGM is not enough to understand the relationship between the climate and ice volume changes. Here we present the sea level records during the LGM using the new cores from the Bonaparte Gulf, northwestern Australia.

The Bonaparte Gulf is a suitable site for reconstructing the ice volume change since this region is located at far-field site: location that is distant from the former ice sheet and the adjustment of glacio-hydro-isostatic effect is relatively small. During the cruise of KH11-1 in winter 2011, more than 20 cores were obtained from the various water depths, which provide the continuous sea level records in the Bonaparte Gulf. In this study, over 400 radiocarbon dates of molluscs and organic matters were measured together with total organic carbon, total nitrogen and stable carbon isotope of organic matters. Moreover, cores were investigated by the sedimentology using a CT scan and major elemental analysis. Furthermore, the results were compared with the paleo tidal model to assess the sea level error by the tide in this region. We suggest that sea level fall occurred at ˜21,000 years ago and the duration of the LGM is shorter than the previous studies (eg, Clark et al., 2009, Lambeck et al., 2014).

Keywords: Last Glacial Maximum, Relative Sea Level, Radiocarbon Dating, Marine Sediment Core

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Variations in sedimentary environments around the Ryukyu Arc since 25 kyr based on CNS elements

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In this study, we analyzed $_{14}C$ dates, grain size, and CNS element contents using sediment cores collected at the eastern edge of the backarc and forearc of the Ryukyu Arc, and demonstrated different temporal variations in $CaCO_3$ contents and C/N ratios compared with previous studies of the Okinawa Trough cores. Increases in $CaCO_3$ contents and decreases in C/N ratios, from the Last Glacial Maximum to the Holocene, in the Okinawa Trough backarc basin correspond with sea-level changes. These results demonstrate that the sedimentary environment in the Okinawa Trough is influenced by sediment supply from mainland China, and reveal temporal variations reflecting changes in the Yangtze River mouth that accompany sea-level changes. In contract, $CaCO_3$ contents of cores in this study are double those in the Okinawa Trough cores, and show an increasing trend at 7.5-6.0 cal kyr BP. Additionally, in the forearc core, the profile of $CaCO_3$ content decreases at 11.5-8.1 cal kyr BP. These variations of $CaCO_3$ contents suggest that marine productivity changed with trophic conditions in sea surface. In addition, the lateral transport of terrigenous sediment by the Kuroshio and Ryukyu currents might contribute to an increased $CaCO_3$ content by reducing the influence of dilution. Variations in the C/N ratio after 7.8 cal kyr BP suggest that the Kuroshio Countercurrent has varied in strength at 1-2 kyr intervals since the early Holocene, influencing the deposition of terrigenous organic matter from the Okinawa Islands in the deeper parts of the east backarc.

Keywords: CNS elements, deposition process, sea level change, Kuroshio Current, Ryukyu Islands

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Biogenic opal changes in the Gulf of Alaska for the last 50 kyrs

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Gulf of Alaska is known as high productivity area mainly by diatoms. Diatom is a phytoplankton with biogenic frustules and can be frequently preserved in sediments. Therefore, sedimentary biogenic opal content is used as a proxy for past diatom productivity (e.g. Ragueneau et al., 2000). During the Integrated Ocean Drilling Program (IODP) Expedition 341 held in 2013, Site U1418 was drilled near the continental margin of the Gulf of Alaska (58 ′ 46.6 ″ N, 144 ′ 29.6 ″ W, and 3,667 m water depth)(Expedition 341 Scientists, 2014). At Site U1418, continuous sediments for the past 1 Myrs with foraminifera and diatoms were recovered from five holes. Age model was constructed by oxygen isotope stratigraphy of planktonic foraminifera (*Neogloboquadrina pachyderma* sinistral) supported by paleogeomagnetic and microfossil datums (Asahi et al., 2014). In this study, biogenic opal contents for the last 50 kyrs were measured using 120 samples from upper 60 m core depths. Biogenic opal was analyzed by extracting with an alkaline solution (2M $NaCO_3$) and molybdenum yellow colorimetric method (Mortlock and Froelich, 1989). In order to estimate paleo-flux of biogenic opal, accumulation rate (AR; g cm^{-2} kyr^{-1}) was calculated based on wt% of biogenic opal, sedimentary density, and sedimentation rate between age control points. Averaged biogenic opal ARs at Site U1418 during the Marine Isotope Stages (MIS) 2 and 3 were 3.60 g cm^{-2} kyr^{-1} and 6.89 g cm^{-2} kyr^{-1}, respectively. Note that most of Holocene sediments were not recovered at U1418. Because of low biogenic opal AR during MIS 2, it is possible to consider that diatom productivity was low during deep glacial period. The present Gulf of Alaska is known as high nutrient low chlorophyll (HNLC) region owing to lack of iron which phytoplankton needs in their production. It is also well-known that eolian dust increased in glacial periods and provided iron to the sea (e.g., Kohfeld and Harrison, 2001). Decreased biogenic opal AR during MIS 2 at U1418 does not support iron fertilization scenario which expects increased productivity by iron supply from eolian dust during glacial period. As these results, the decrease in diatom productivity may have been driven by increased light limitation due to expanded sea-ice cover in the Gulf of Alaska (de Vernal and Pedersen, 1997).

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Keywords: Biogenic opal, Gulf of Alaska, Last glacial period, IODP

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Paleoenvironmental changes during last interglacial and MIS 6 in Kuroshio region off Honshu based on planktic foraminif

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Introduction

The Kuroshio Current is the western boundary current, that is a part of the North Pacific subtropical gyre. The Kuroshio plays a main role in heat transport from the tropical ocean to the subarctic North Pacific. Paleoenvironmental changes in the Kuroshio region during the last glacial period to the Holocene were studied during several decades (e.g., Oda and Takemoto,1992,Ujiie and Ujiie,1999,Ikehara et al., 2009). Before the last glacial period, paleoenvironmental changes of the surface and intermediate waters in the Ryukyu Arc region were investigated based on planktic foraminiferal analyses (Ujiie and Ujiie, 2006). However, there are no many study examples for the Kuroshio variability before the last glacial period in the south of Japanese islands. Therefore we studied to reconstruct a paleoenvironmental changes during last interglacial and Marine Isotope Stage (MIS) 6 in the Kuroshio region.

Sample and Methods

A long piston core MD012422 (32?08.7'N, 133?51.8'E, water depth 2737m) was obtained from the continental slope off Shikoku and a piston core KR09-15 PC1 (33?17.7348N, 136?38.3966E, water depth 1951m) was also obtained from the Kumano Trough. In these cores, the planktic foraminiferal assemblage was analyzed for penultimate deglaciation (Termination Ⅱ) from the glacial MIS 6 to the last interglacial period (MIS 5e) to reconstruct variation of the Kuroshio Current. The age model of MD012422 was built based on the oxygen isotope stratigraphy of *Globigerinoides ruber* (Ikehara et al., 2006). The age model of KR09-15 PC1 was also established based on the oxygen isotope stratigraphy of *Globorotalia inflata*. Each sample was washed through 63 μm opening sieve, prior to the drying procedure. After that each dried sample was again sieved thought 125μm opening sieve for planktic foraminifera faunal analysis.

Result and Discussion

A total of 36 planktic foraminiferal species were identified in this study in MD012422 off Shikoku. Twenty-six species were also identified in PC1 off Kumano. The obtained assemblage data are classified into four groups (Ujiie et al., 2003, Ujiie and Ujiie, 2006), which are related with surface water conditions. In this study, we focused on the Kuroshio species, which are composed of *Pulleniatina obliquiloculata* and *Neogloboquadrina dutertrei*. The abundance of Kuroshio species showed high in both sites for MIS 5e. But, their abundance decreased off Kumano for MIS 6. Therefore we interpreted that the Kumano Trough region was not influenced by a warm Kuroshio during the penultimate full glacial MIS 6. For the last interglacial MIS 5e, the Kuroshio was flowing through the similar position with modern.

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Change in monsoon climate and lake-water-level recorded in middle Pleistocene Paleo-Kathmandu Lake sediments

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In order to reconstruct terrestrial Indian monsoon record during the MPT (Middle Pleistocene Transition) and to clarify the causes of lake-water-level changes, pollen and other microfossils analyses were conducted on the lacustrine sediments in the southern Kathmandu basin on southern slope of the Central Himalaya.

We reconstructed continuous record of vegetation and climate changes from ca. 1000 ka to 500 ka on the basis of pollen analysis of a 114-m-long drill core at Champi. In addition, changes in ratio of other proxy: sponge spicules, phytoliths and plant fragments are analyzed and compared with the reconstructed climatic record

On the basis of changes in relative abundance and assemblage of fossil pollen, nine pollen zones are constructed. Pollen zone 9, 7, 5 and 3 indicate cold and dry climate and zone 8, 6, 4 and 2 indicate warm and wet climate. Cold index (*Abies* and *Tsuga*) and dry index (*Artemisia* and Chenopodiaceae) increase during period of cold climate after zone 7. Cold index (*Abies* and *Tsuga*) and dry index (Gramineae) increase much more under cold climate after zone 5 and at the same time, ratio of arboreal pollen begins to cyclically change. A comparison of pollen zones with MIS (marine isotope stage) and magnetostratigraphic study indicate that pollen zones from 8 to 2 correspond to MIS 27-15. The pollen diagram suggests that climate of the Kathmandu Valley became cool and dry at 900 and 700 ka (pollen zone 7 and 5), and cyclic climatic change started at 700 ka. These changes seem to correspond to abrupt increase and cyclic changes of global ice volume in the MPT.

Sponge spicule decreases its ratio during the period of dry climate, therefore it could be ascribed to shrinking of habitat of sponge due to the lowering of lake-water under dry climate. Abrupt and rapid decrease of sponge spicule and diatom at around 50 m in depth suggests rapid lowering of lake-water-level for a moment. This change possibly is caused by drain of lake water owing to occasional break of the dam, because the pollen zone 2 indicates warm and wet climate which implies increase of lake-water-level.

Keywords: Indian monsoon, Kathmandu basin, lacustrine sediments, pollen analysis, sponge spicle

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Reconsideration of the existence of marine clay beds in KD-1 and KD-2 drilling cores in Kyoto Basin

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Research programs including seismic reflection surveys and deep drillings were carried out at the Kyoto Basin between 1998 and 2002 for clarifying underground structure of the basin. Deep drilling cores taken at three sites, KD-0 in the southern part of the basin (Ogura-ike), KD-1 in the central part (Hokotate Park south of JR Kyoto station) and KD-2 in the northern part (Nijo-jo Castle), were composed of thick strata of the Osaka Group and Pleistocene terrace deposits. Marine clay beds, the key beds in the Osaka Group, were identified at five horizons in KD-0 and KD-1 cores (Ma3, Ma4, Ma5, Ma6 and Ma9 beds) and three in KD-1 core (Ma5, Ma6 and Ma9 beds) according to the color of sediments, results of fossil and pollen analyses and stratigraphic correlations of volcanic ash layers (Kyoto City, 2003). Kitani and Kamo (2010) reconsidered the stratigraphy of KD-0 core, and identified 13 marine clay beds in the Osaka Group (Ma0, Ma0.5, Ma1, Ma1.3, Ma2, Ma3, Ma4, Ma5, Ma6, Ma7, Ma8, Ma9 and Ma10 beds) and one marine clay bed in terrace deposits (Ma12 bed).

In order to reconsider the existence of marine clay beds in KD-1 and KD-2 cores, we performed measurements of electric conductivity (EC) and pH of stirred clayey sediments in water on 15 mud layers in KD-1 core and 14 layers in KD-2 core based on the method of Yokoyama and Sato (1987). In KD-1 core, samples of marine clay beds identified in Kyoto City (2003) showed high EC and low pH values, and were regarded as marine sediments based on the criteria of Yokoyama and Sato (1987). A mud layer above Ma9 bed was also found to show high EC and low pH values, and marine diatom fossils were found in the mud sample by smear slide observations. The layer may be correlated to Ma10 bed. In KD-2 core, samples of Ma5 and Ma6 beds had high EC and low pH values. Other samples including that of Ma9 bed had low EC and higher pH of 6-7, and were regarded as fresh water sediments. It may be implied that the sea water invasion occurred at the formation age of Ma10 bed (about 0.34Ma) in the central part of the Kyoto Basin, and that the northern part has been under the fresh water environment after the formation age of Ma6 bed (about 0.62Ma).

Keywords: Kyoto Basin, marine clay bed, Osaka Group

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The response of terrestrial climate variations in the orbital cycles based on a marine pollen records

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A pollen analysis of drilled marine core, that is effective for long-scale and continuous paleoclimate reconstruction because marine sediments have direct d18O-based timescales, which is absent in terrestrial materials. In this study, we carried out pollen analysis to the core C9001C drilled off Shimokita Peninsula, for paleoclimate reconstruction and compose pollen stratigraphy during the Brunhes paleomagnetic chron. As a result, during the interglacial periods is dominated by cool temperate pollen assemblages that is similar to the present-day Shimokita vegetation. In contrast, during the glacial periods is dominated by subarctic pollen assemblages, and the weak glacial periods or the transition periods of interglacial to glacial dominated by cool mixed pollen assemblages. In order to extract more detailed paleoclimate information we apply the modern analogue technique to our pollen records. As a result, paleoclimatic parameters suggested two different variations of paleo-temperature and paleo-precipitation, these are good correlates glacial-interglacial cycles and summer insolation variations, respectively.

Keywords: pollen, paleoclimate reconstruction, marine core

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Paleolimnological changes of Lake Maruwanminami-ike and Maruwan-Oike in Soya Coast, East Antarctica during the Holocene

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The Antarctic Ice Sheet is the largest mass of ice on Earth. In the Antarctic Ice Sheet, there are huge amount of freshwater, approximately 60 % of all freshwater on earth. Furthermore, the present Antarctic Ice Sheet contains enough water to raise sea level almost sixty meters, so that only a small change in their volume would have a significant effect to the earth. Antarctic coastal lakes are invaluable archives of paleoclimate and paleoenvironment changes due to the retreat of Antarctic Ice Sheet. In Soya Kaigan (Coast) of Lutzow-Holm Bay region, there are many coastal lakes in ice-free areas. Hydrological changes of coastal lakes located below 20 m ASL from marine to freshwater environments are result from the recession of glaciers and subsequent isostatic uplift.

In this study, we estimate the Holocene environmental change of Soya Kaigan inferred from the analyses of a lake sediment core of Lake Maruwan-Oike (Mw4C-01) and Maruwanminami-ike (MwS4C-01) in Rundvagshetta ice-free area. We conducted Radiocarbon dating and Elemental Analyses by Matsumoto et al. (in prep) to carry out Total Carbon, Total Organic carbon, Total Nitrogen and Total Sulfur. In addition to these results, I clarify assemblage changes of fossil diatoms in the sediment core Mw4C-1 using a characteristic of diatoms living apart by water conditions such as salinity. From the results of diatom analyses and previous analyses, we will report about the Holocene hydrological and environmental changes in detail.

Keywords: Antarctic coastal lakes, Paleoenvironment, Paleolimnology, Diatom analysis, the Holocene

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Heinrich events and activities of winter monsoon recorded in bottom sediment of Lake Inawashiro

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Coastal areas along the Japan Sea are regarded as second largest rainy area in Honshu Island. Relatively heavier rainfall in these areas is caused by heavy snowfall during winter thus named heavy snowfall area by Heavy snowfall area special measures law. In order to know future trend of this snowfall, we selected Lake Inawashiro of Fukushima prefecture, Tohoku region as a monitoring site where melted snow from surrounding mountains flows in during spring. We analyzed grain size of 5 millimeter thick sediment at 2.5 centimeter interval which were drilled at the central part of the lake with 28 meter length. The sediment is composed chiefly of thinly bedded alternation of light and dark layers which have several millimeters thickness and is intercalated by 15 tephra layers and 30 pairs of light and dark layers with several centimeters thickness. We made an age model using dates of widespread tephras and radiocarbon ages of sediments and converted depths of sediments into ages. We analyzed frequency of grain size change with REDFIT method. The result shows 7000 year cycle from 45ka to 10ka. In addition, dates of maxima of grain size well correlates with those of Heinrich events. Also those dates well correlate with those of ice rafted debris weight in Japan Sea sediment. Grain size profile shows reverse grading at the lower part of thick light and dark layers and normal grading at the upper part. In addition, light colored lower parts are rich in periphyton diatoms living preferably in acidic water. These results show that sediment in lake Inawashiro is intercalated by many flood sediments. Based on the results that ages of maxima in grain size profile well correlate with those of Heinrich events and that event sediments are flood sediment origin, we concluded that abrupt cooling made winter monsoon stronger and caused heavy snowfall along Japanese island and large floods by melting snow. Report of IPCC WG1 does not suppose abrupt cooling during this century. Consequently, global warming is expected during this century. In that case, winter monsoon will be weakened and it will be apprehensive that water resources for rice planting and hydroelectric power generation will be decreased.

Keywords: Heinrich events, winter monsoon, lake sediment, drilling core, climate change

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Heinrich events and activities of winter monsoon recorded in bottom sediment of Lake Biwa

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Coastal areas of Honshu Island along the Japan Sea have heavy snowfall and second rainy areas to coastal areas along the Pacific Ocean. This heavy snowfall supplies large volume of melting water and is used for rice planting and become energy source for hydroelectric power generation. Snowfall in winter is firmly related to winter monsoon which blows over the Japan Sea. Consequently, monitoring snowfall can lead to monitoring the intensity of winter monsoon. In order to clarify historical winter monsoon intensity change, we selected Lake Biwa where Mount Ibuki that has heavy snowfall is very near. We carried out chemical analysis of bottom sediment of 18 meters long piston cored at the central part of Lake Biwa. The sediment consists chiefly of muddy sediment and is intercalated by some tephra layers. Depths of the sediment were converted into ages by the age model based on the age of wide spread tephras and radiocarbon dates of sediment. The result shows that frequency of 6ky is present in the total carbon content profile and that of biogenic silica. Ages of minima of total carbon content together with those of total carbon/total nitrogen ratio correlates well with those of Heinrich events. Calcium content profile shows 7ky frequency and minima of calcium content correlate with Heinrich events. On the other hand, phosphorus content shows the same frequency, however, maxima of this content correlate with those of Heinrich events. Among these profiles, that of phosphorus well correlates with that of lake level change which is shown by sand content profile obtained from drilling sediment near the river mouth of Echi river. Phosphorus content is lower during higher lake level. This result shows opposite tendency that manganese and phosphorus contents are higher during high lake level. Based on those results following sedimentation model is proposed. During the periods of abrupt cooling, snowfall was heavier than other periods. At the time of cooling, large volume of melted snow transports calcium rich detritus materials in spring which are supplied from Ibuki mountains those composed mainly of limestone. On the other hand, production of organic materials decrease during cold periods and transportation of organic materials also decreases. Furthermore, because chemical weathering on land is weakened, transportation of phosphorus and manganese becomes smaller. Therefore, calcium content shows normal correlation to snowfall volume whereas that of phosphorus shows reverse correlation. Based on the fact that the ages of this kind of sedimentation correlate with those of abrupt cooling, activities of winter monsoon was stronger at those periods and snowfall became larger which made lake level higher than usual owing to large volume of melting snow.

Keywords: Heinrich events, winter monsoon, lake sediment, drilling core, climate change

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Continental response to millennial-scale climate change during the last glacial to Holocene period

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Here we report analytical results of minor elements in Lake Baikal sediment which contain environmental response to the climate changes during the last 33 kyr.

Keywords: Conitnental interior of Asia, Lake Baikal, Terrestrial environmental system, Minior elements, Uranium, Climate changes

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Relationship between early summer precipitation in Japan and the El Nino-Southern Oscillation over the past 400 years

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The El Ni$\tilde{n}$o-Southern Oscillation (ENSO) potentially influences East Asian Summer Monsoon (EASM) rainfall, but the relatively short instrumental rainfall record hinders the progress of a longer-term understanding of this relationship. To partially overcome this issue, we reconstruct precipitation from tree-ring oxygen isotopes (δ^{18}O) in central Japan from AD 1612 to 1935. Our results show that tree-ring cellulose δ^{18}O is significantly correlated with May-June (MJ) rainfall in central Japan, allowing us to examine the relation between the EASM summer rainfall and ENSO during the past 400 years. Time- and frequency-domain comparison of the tree-ring δ^{18}O record and recent ENSO reconstructions show a common high-frequency (3-8 year) variability that characterized the mid-17th, late 18th and late 19th centuries. Similar analyses of instrumental MJ precipitation and several ENSO indexes during the 20th century reveal that this high-frequency oscillation reappeared from AD 1980. Comparison of ENSO and Pacific Decadal Oscillation (PDO) indexes reveals that the ENSO-EASM relationship is strong when ENSO variance is high, and the PDO phase may modulate the ENSO-EASM relationship over the past four centuries.

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Oxygen isotopic records of stalagmite OT02 collected Gujo City, Gifu Prefecture

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A 13-cm-long stalagmite OT02 from Gujo City (central Gifu Prefecture) recorded climatic information of two separated periods of Marine isotopic stage 3 (MIS-3) and Holocene. Oxygen Upper and lower parts of the stalagmite differ in oxygen isotopic values; the lower MIS-3 part are 0.5-1.0 permil higher than the upper Holocene part. This difference is comparable to one that has been reported from stalagmites in south China, revealing that the Gifu stalagmite was formed under the influence from East Asian summer monsoon (case 1). However, meteoric water samples collected at a reference site (Ogaki City) clearly indicate seasonality in the oxygen isotope values. Meteoric waters in winter generally record low isotopic values, and the records of OT02 can be the change in the winter proportion of meteoric water (case 2). OT02 is unique in terms of different periodicity recorded in the oxygen isotopic composition; ˜650-yr cycles in the Holocene interval and millennial-scale changes in the lower MIS-3 interval. The Holocene cycle are most likely responded to the swell of solar activity that affected to proportion of winter rainfall (case 2). In contrast, the millennial-scale changes in the lower OT02 are likely associated with Dansgaard-Oschger (D-O) events. Eight bands of low oxygen isotope during a period of 55-35 ka follow the spacing of the dark layers in deep-sea sediments from the Japan Sea. In each cycle, the stalagmite increases transparency to the upward, and suddenly becomes darker at the base of the upper cycle. Similarly, oxygen isotopic values gradually increase in each cycle and rapidly decrease at the base of the upper cycle. Although some of millennial changes in the Gifu stalagmite indicate D-O cycles cannot be seen in the Greenland ice sheet, our records suggest that the central Japan was under the influences of D-O cycles. Oxygen isotope records of the lower OT02 are consistent to case 1 interpretation rather than case 2. Assuming this, it became dry during a gradual cooling period and shifted wet with an abrupt warming.

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Oxygen isotopic records of the stalagmite KA01 from Kiriana in Mie Prefecture, Japan

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It has been considered that the stalagmite oxygen isotope is reflected from rainfall intensity of the water reserve area. Especially, the records from south China have been treated as proxy of the intensity of the East Asian Summer Monsoon (EASM). However, some resent studies suggested that the Chinese stalagmite records rather indicate the change in proportion of the Indian Monsoon from southwest and the Asian Monsoon from southeast. In Japanese Islands located at the east margin of the Asian Monsoon area, the rainfall during summer is almost exclusively brought from EASM. Thus, the EASM intensity was more directly recorded in the Japanese stalagmites than in the Chinese stalagmites.

We studied the stalagmite KA01, a 35-cm-long specimen that has been formed from 12.6 ka to 1.3 ka. KA01 and some Chinese records share similar features, such as higher values around 12 ka, depressed intensity during 7-9 ka, and the trend change from increasing to decreasing at 2.8 ka. However, KA01 exhibits smaller amplitude of the isotopic change than the Chinese specimens. The reduced amplitude of KA01 was likely attributed to the shorter distance of the vapor transportation, which reflected on the condensation ratio. Thus, our isotopic profile of KA01 is probably more faithful record of the EASM and therefore can be valuable for considering the Holocene evolution of the East Asian climate system.

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Observation of fluorescent laminae structure in stalagmites for lamina counting and results of U-Th dating

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Stalagmites are recognized as a powerful tool to reconstruct paleoclimate. However, it is difficult to date stalagmites. Dating methods of stalagmites are mainly U-Th dating and laminae counting. U-Th dating sometimes shows stratigraphic inverted results, whereas laminae counting has a problem that we have little information about the annual laminae (for example, when and how they are formed? or what they look like?). In this study, I analyzed stalagmite samples collected at Taga Mine, Shiga Prefecture, Japan. I try to reveal the characteristics of laminae in stalagmites and investigate U-Th age.

Stalagmite samples have fluorescent laminae, which can be divided into three types: lamina A, lamina B and wavy lamina. Lamina A is normal type, lamina B is relatively ambiguous lamina and wavy lamina is of wavy shaped. According to FE-SEM image, both lamina A and wavy lamina consist of small particles (diameter is several 10˜100nm). Lamina B can not be observed by FE-SEM probably because particles smaller than 10nm can not be resolved due to polishing scratches. Wavy lamina has many gaps filled with mud. This indicates that wavy lamina is formed when mud covers the stalagmites and prevents calcite growing.

In previous researches, main component of fluorescent laminae may be fulvic acid. Thus the small particles of FE-SEM images may be fluvic acid. To confirm this, I use micro-Raman spectroscopy, micro-FT-IR, SEM-EDX. However, all analyses can not reveal what the small particles are, probably because the small particles are too small to analyze. The result of EPMA indicates that laminae A contains mud. However, the strength of laminae A is not proportional to that of Si and Al peaks, hence Si and Al are not Principal component of lamina A.

I dated stalagmite samples by U-Th dating and I got stratigraphic inverted results: the upper parts of stalagmites are older than the lower parts of them. I calculate the quantity of contamination substance in stalagmite which can influence the U-Th age. In consequence, the stratigraphic inverted results of U-Th dating are probably because of contaminations by mud. On the other hand, humic substances in stalagmites possibly influence U-Th dating.

Keywords: speleothem, lamina, paleoclimate

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Cave air monitoring and chemical analysis of drip water at Inazumi cave, Oita, Japan

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10 month cave air monitoring and chemical analysis of drip water were conducted at Inazumi cave, Oita, Japan, from February to December, 2014, to understand the processes and mechanism of recording paleoclimate in stalagmite. Cave air CO_2 was measured for the cave monitoring, and EC, pH, HCO_3^- and Ca^{2+} were measured for chemical analysis of drip water.

Special sampling techniques were designed for two sampling sites, SS2 and SS3, to highlight the relationship between cave air CO_2 and drip water chemistry. At SS2, the drip waters, before and after hitting on three handrails arranged in tandem in limestone cave (SS2-U, -M2, -M3 and -L, respectively), were sampled. At SS3, the drip waters, befor contacting with the cave air (BCWA) and after hitting on the artificial stalagmite, were sampled (BCWA, SS3-U, -M, -L, respectively).

At SS2, as the drip water hit on the handrails, HCO_3^-, Ca^{2+} and EC showed decreasing trend respectively and this trend became significant during winter when the cave air CO_2 was low. Only pH was negatively correlated with other drip water parameters the above. This suggests that the two conditions, 1) the cave air CO_2 is lower and 2) water film gets thinner as the drip water hits on the handrails, promote more CO_2 degassing and $CaCO_3$ precipitation.

At SS3, HCO_3^- and Ca^{2+} between BCWA and the drip water after contacted with the cave air showed almost the same concentration during summer, high cave air CO_2 season, however, marked significant margin between them during winter, low cave air CO2 season. This result suggests that once drip water contacts with lower cave air CO_2, more CO_2 degassing and CaCO3 precipitation are promoted.

S.I.cc, standing for Saturation Index of Calcium Carbonate, and $\triangle pCO_2$, the difference of partial pressure of drip water ($pCO_{2-dripwater}$) and of cave air ($pCO_{2-caveair}$), were calculated if CO_2 degassing and $CaCO_3$ precipitation takes place or not. S.I.cc showed positive value at SS2 and SS3 during almost all monitoring periods, indicating $CaCO_3$ is produced almost all the time. However, $\triangle pCO_2$ showed frequently negative value at SS2 and SS3, indicating that CO_2 is not degassed from the drip water and the following $CaCO_3$ precipitation is not taken place and that most of drip water sampled already degassed CO_2.

This research implied that CO_2 variation is a main forcing factor to control HCO_3^- and Ca^{2+}, main components in drip water to form $CaCO_3$-made-laminae used for reconstructing paleoclimate; however, the calculation of $\triangle pCO_2$ showed that $CaCO_3$ would not be produced from drip water. To solve the contradiction, another approach such as development of new sampling method will be necessary.

Keywords: Paleoclimatology, Stalagmite, drip water, cave air monitoring

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Characterization of Aeolian Dust, Sediment, with SEM-EDS Automated Particle Analysis

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SEM-EDS automated particle analysis, which is the automated particle analysis combined with a scanning electron microscope (SEM) with energy dispersive X-ray spectroscopy (EDS), is a very powerful method to characterize particle mixtures of several different substances. With this method, we can analyze a large number of particles, more than 10,000 particles one by one, directly. The analyzed data, the shape and size as well as the composition of each individual particle, are stored for the characterization of the mixtures and classified into about some groups with similar composition, same minerals, and so on automatically. We have successfully applied this method to the characterization of a few rocks and sediments by using this method [1], [2] and [3]. Detailed analysis of rocks and sediments would give important information on mountain uplift, river contention and erosion process. In this study, we extend our efforts to aeolian dusts and sediments, for example Beijing Urban Aerosols and Gobi Kosa Dust. They were purchased from National Institute of Environmental Studies (NIES), which distributes them as environmental certified reference materials. Classification was made of their composing particles. Furthermore, statistically averaged concentrations of elements obtained in the present study were compared with those listed in the NIES document. For example, in Beijing Urban Aerosols, we analyzed 30,000 particles and classified by their composition. The average of the particles size is 6 μm and the distribution of the particle size is 1- 40 μm. These particles contained quartz, feldspar, gypsum, calcite and other material. In addition, a lot of hydro sulfates and sulfides were detected with clay minerals. In the presentation, we will show more detailed descriptions of the correlation between Beijing Urban Aerosols and Gobi Kosa Dust, and other sediment analysis results.

[1] H. Muto, A. Shimada, 2014, SEM-EDS Automated Particle Analysis of Mineral Compositions of Rocks, the Japan Geoscience Union Meeting 2014.

[2] H. Muto, A. Shimada, 2014, Characteristics of Granitic Rocks around Lake Biwa with SEM-EDS Automated Particle Analysis and ESR Signals, the 2014 annual meeting of Japan Association Mineralogical Sciences.

[3] H. Muto, A. Shimada, 2014, SEM-EDS Automated Particle Analysis of Mineral Compositions of River Sand, the annual academic conference of the Japan Society of Microscopy 2014.

Keywords: Sediment, Aerosol, SEM, EDS, Particle analysis

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A chronostratigraphic study of the upper Anno Formation, Awa Group, distributed in the middle part of the Boso Peninsula

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Since the Awa Group, distributed in the central Boso Peninsula, has a good continuous exposure, abundant microfossils and many intercalated treiceable tephra beds, a lot of stratigraphic studies have been conducted so far. Okada et al (2013) reported magnetostratigraphy of the upper Anno Formation exposed along the Minato and Shikoma rivers, which concluded that the Mammoth reversed subchronozone (3.207-3.330Ma) and the Gilbert-Gauss boundary (3.596Ma) were recognized at the horizon of between the An155 and An157 tephra beds and at the horizon near the An127 tephra bed, respectively. However, sampling resolution, which is about 10m in the stratigraphic interval at the Shikoma river route, is not sufficient to deny a possibility that the subchronozone is recognized as the Kaena reversed subchronozone (3.116-3.032Ma). We therefore conducted resampling with a higher resolution in order to refine the magnetostratigraphy with a better temporal resolution.

For paleomagnetic, rockmagnetic and oxygen isotopic measurements, we sampled 1-5 mini-cores and sedimentary rocks with about 300g by dry-weight at 117 sites, respectively. The samples were taken downward from the horizon just below the Kurotaki unconformity in Shikoma river route.

We performed alternating-field demagnetization (AFD) and thermal demagnetization (ThD) in order to extract primary components from the specimens. Additionally, we carried out a magnetic hysteresis parameter analysis and a thermomagnetic analysis to detect rockmagnetic parameters. The results exhibit that most specimens consist pseudo-single domain magnetites as the magnetic carrier of natural remanent magnetizations. Characteristic remanent magnetizations (ChRMs) calculated from both of AFD and ThD results did not pass the reversal test, indicating that secondary magnetization components are not able to be removed completely with the both demagnetization technics. However, we judged that the ChRMs from ThD would be reliable to evaluate the polarities, since the secondary components are quite small. Accordingly, we confirmed polarity boundaries at depths of 96-98.4m, 22.5-26.6m and 11.4-14.7m. Because the polarity boundary at the deepest site is near the An127 tephra bed as well as the previous study, it is compared to the Gilbert-Gauss boundary. The polarity boundaries at depths 22.5-26.6m and 11.4-14.7m correspond to the upper and lower boundaries of the Mammoth reversed subchronozone, respectively, since there is no other polarity reverse from the deepest polarity boundary to the middle polarity boundary. Sedimentation rate between the Gilbert-Gauss boundary and the lower boundary of the Mammoth reversed subchronozone, and between the lower and the upper boundaries of the Mammoth are evaluated as about 27cm and about 9cm, respectively. The significantly decreased sedimentation rate observed during the Mammoth subchron corresponds to the horizon between the An155 and An157 tephra beds. Nakajima and Watanabe (2005) reported that the horizon between the An155-2 and An156-4 tephra beds was eroded by a slump at the Shikoma river route. We consider that the significantly decreased sedimentation rate attributes a hiatus due to erosion by slump.

We, hence, plan to extract foraminifers from sedimentary rock samples from the same sites of paleomagnetic mini-cores, and measure oxygen isotopes. After that, we are going to discuss chronostratigraphy using oxygen isotope stratigraphy and magnetostratigraphy.

Reference

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Keywords: Magnetostratigraphy, Oxygen isotope stratigraphy, Chronostratigraphy

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On the glacial carbon reservoir in the deep-sea

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Numbers of studies has been performed to seek the glacial carbon reservoir in the deep-sea. Radiocarbon age offset between co-existing benthic and planktic foraminifers is widely used to estimate ventilation rate of the glacial deepwater. However, reconstructed results in previous studies were divided into two groups: comparable to the present and much older than the present. The discrepancy is caused by sediment disturbance inferred from major change in depth-age curve and estimation of regional marine reservoir age. These suggest an importance of primary information on sediment core sample and radiocarbon data.

Keywords: Glacial period, Carbon reservoir