

diatom assemblages in INW2012 drilling cores from Lake Inawashiro , Tohoku, Japan

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Inawashiro-ko Formation is named by a 28.13m sediment core taken from Lake Inawashiro-ko, Fukushima Prefecture, Japan. Stratigraphy and facies analysis combined with tephra and AMS radiocarbon dating were carried out on INW-2012. The Inawashiro-ko Formation are divided into three stratigraphic units: the Lower part (37.17-26.60m) consisted by medium sand-sandy silt (vertically varied in grain size) with granule and wood fragments, the Middle part (26.60-24.89m) consisted by very fine sand-silt with upper level grain refinement, and the Upper part (24.89-0.00m) consisted by dense alternation of brighter and darker clay layers including fallout tephra and Lahars by sediment gravity flow. Each unit are formed by fluvial basin before the form of the lake, early stage of the lake, lake with deep water as present, respectively. ¹⁴C dating indicate that Lake Inawashiro-ko is formed 42 cal k BP, and characteristic dense alternation of brighter and darker clay layers deposit continuously except for the most early stage of the Lake. The sedimentation rate in the upper part is 0.3-1.0(mm/yr). Additionally, We report the temporal variation of diatom assemblage and its relation to water environment in the past 2000 years from upper 2.00m of IN2012.

Keywords: Lake Inawashiro-ko, lacustrine sediment core, stratigraphy, diatom assemblage, late Pleistocene, ¹⁴C dating

Two different types of regime shift appeared in a 2900-yr record of Japanese sardine abundance

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Regime shift, revealed in climates and marine ecosystem, is one of key dynamics to predict rapid changes in marine ecosystems and fisheries resources for decades. The regime shift is defined as a relatively rapid change (occurring within a year or two) from one decadal-scale period of a persistent state (regime) to another decadal-scale period of a persistent state (Minobe 1997; King 2005). In the Pacific it has been detected in Pacific Decadal Oscillation (PDO) (Mantua et al., 1997) and species replacement between anchovy and sardine (Lluch-Belda et al., 1989). There is so far no sufficient evidence of how regime shift changes in its feature on longer timescales because of paucity of long-term high-resolution marine records in the Pacific. Here we present a 2900-year record of ecosystem regime shift in the western North Pacific using Japanese sardine abundance which can be reconstructed from fossil scales in the coastal marine sediments; timing of decreases and increases in the abundance can be used as an index of regime shift. Sardine abundance showed two different types of regime shift in the time series. One is a regime shift similar to that previously detected in the 20th century, which repeatedly occurs on interdecadal timescales. The other is a regime shift in relation to centennial-scale variability in sardine abundance, which could be followed by a centennial-scale low or high abundance period characterized by respective small or large amplitudes of decadal variations in abundance. Our estimation suggests that the maximum abundance is depleted one-quarter to one-tenth of that in the sardine regime in 1980s. Similar patterns of the latter regime shift are revealed in the time series of sardine abundance off California (Baumgartner et al., 1992) and Chile (Valdes et al. 2008), PDO index reconstructed from North America (Macdonald and Case 2005), and abnormal snow index in East Asia (Chu et al., 2008). This indicates that the latter regime shifts that we found are associated with those of marine ecosystems and climate over the Pacific. The recent high sardine abundance period lasted 200 years in the Pacific, suggesting transition to next centennial low abundance period in the near future. Careful examinations on whether the latest regime shift in 1990s is the case of the latter regime shift are important for the long-term prediction of climate and fisheries resources.

Keywords: regime shift, marine ecosystem, sardine fossil scale record, Pacific, Beppu Bay

Modern changes of sedimentary environments in the brackish Lake Shinji, the east part of Shimane prefecture, Japan

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Lake Shinji is oligohaline brackish lake in the east part of Shimane prefecture. Area of Lake Shinji is 79.1km², water depth shows less than 6m. The water column of Lake Shinji is divided into oligohaline surface water, mesohaline pycnocline, and mesohaline bottom water.

In recent years, Lake Shinji is observed environmental events such as Cyanobacterial water bloom, anomaly overgrowth of aquatic plants, decrease in the catch of Corbicula and so on. The purpose of this study is to reveal the changes in the sedimentary environment by using the comparison with the spatial investigation of surface sediments in 2006 and 2013 and the result of monitoring since 2010 in Lake Shinji.

The surface sediments in Lake Shinji in 2006 are sandy deposits shallower than 3.5m in water depth, but are muddy deposits deeper than its depth. Mean grain size of surface sediments deeper than 3.5m tend to be fine-grained with water depth, and shows 7.5 phi in deepest site. In shallower than 3.5m, many surface sediments shows fine to medium sand around 2 phi. Total organic carbon (TOC) contents of surface sediments was less than 4%. TOC contents shows high positive correlation coefficient 0.85 with mean grain size. This is suggested that the spatial distribution of TOC contents depend on grain size. Total Sulfur (TS) contents of surface sediments were less than 1%, and tend to be decreased with water depth. However, TS contents were less than 0.2% shallower than 4.5m. In deeper than its depth, TS contents decreases dramatically.

The surface sediments in Lake Shinji in 2013 are sandy deposits shallower than 3.5m in water depth, but are muddy deposits deeper than its depth. Mean grain size in 2013 was similar to the 2006. TOC contents of surface sediments were 6 to 8%. TS contents were less than 2%. TS contents were less than 0.2% shallower than 3.0m. This depth is shallow clearly than in 2006.

TOC contents in monitoring site from 2010 to 2013 fluctuated greatly in the range of 4% to 10%. TOC contents shows low values in summer season, and high values in winter season. It is considered that the fluctuation of TOC contents is caused by the dilution effect of inorganic sediment due to rainfall in the summer. In addition, TOC contents tend to increase from 2010 to 2013. TS contents fluctuated greatly in the range of 0.5% to 2.0%. TOC contents shows high values in summer season, and low values in winter season, and tend to increase from 2010 to 2013 as with the TOC contents. This is suggested that the increase of TS contents is caused by the inflow of mesohaline water and the decrease of dissolved oxygen in bottom water.

From the results of these, surface sediments and bottom water environments in Lake Shinji are a distinct change during term from 2006 to 2013. We are thinking that some of this cause.

Keywords: Lake Shinji, Surface sediments, Total organic carbon contents, Total Sulfur contents, Grain size analysis

Provenances of detrital materials in the Lake Suigetsu sediment and quantitative evaluation of their mixing ratio

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Lake Suigetsu, central Japan, is characterized by annually laminated sediment, and extremely high resolution and precise age-depth model was established using drilled cores retrieved on 1993 and 2006. For this reason, Lake Suigetsu sediment is ideal subject of high resolution and precise paleo-climate reconstruction. Detrital material accumulated in Lake Suigetsu is thought to have 3 provenances with 3 different transport paths. One is eolian dust transported by wind from Asian continent. Second is detrital material transported by small rivers from surrounding slopes. Third is suspended sediment supplied from Hasu River and transported through Lake Mikata, which is connected to Lake Suigetsu with shallow channel. Mechanism and flux of detrital materials from these 3 sources could be controlled by the behavior of westerly jet, slope failure due to flood and/or earthquake, and rainfall and erosional process within the drainage area. Therefore, if we could reconstruct the flux of detrital materials from each provenance, we could gain detailed information on histories of paleo-climate and disasters.

In this study, we did factor analysis of chemical composition of detrital fraction extracted from the sediment by chemical treatment. Each end-member extracted by factor analysis was characterized with respect to mineral composition, color, and grain-size distribution. We compared these characteristics with samples taken from probable sources and from event layers in the sediment, and tried to re-construct the flux change of each detrital component.

Keywords: Lake Suigetsu, Deglaciation, Holocene, Factor analysis, Multi-regression analysis

Wetter condition during the Heinrich Event 1? deduced from detrital flux and provenance records from Lake Suigetsu

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Stalagmites in Chinese caves, loess/paleosol sequence of the Chinese Loess Plateau, and lacustrine sediments in Asian countries are favorable to monitor the past changes in East Asian summer monsoon (EASM). However, not much is known about EASM spatial changes during the last deglaciation mostly due to the large uncertainty in the chronologies of the lacustrine and loess/paleosol sediments.

Lake Suigetsu in Central Japan is known for the varved sediments which cover at least last 70 kyr. Recently, accurate age model is established for SG06 core based on varve counting and more than 800 radiocarbon dates (e.g., Ramsey et al., 2012; Staff et al., 2013). Here we examine the precipitation changes in Central Japan during the last deglaciation from the flux and provenance changes of the detrital materials found in the SG06 core sediment.

We analysed flux of detrital materials for the last glacial part of the SG06 core (1402-1810 cm interval of the SG06 composite depth) with 1 cm resolution (corresponding to 7-13 yrs) and estimated provenance of the detrital materials using chemical and mineral compositions, grain sizes, and electron spin resonance intensity and crystallinity of the quartz. The reconstructed flux of detrital materials are characterized by the millennial-scale increases exceeding 12 mg/cm²/yr at 16,600-14,800 and 13,700-12,800 SG06₂₀₁₂ yr BP and short-lived (decadal to centennial) episodes of higher flux repeated more than thirty times throughout the deglaciation interval.

The grain size, color, chemical composition, and crystallinity of quartz records suggest that the increase of the detrital materials during 16,600-14,800 SG06₂₀₁₂ yr BP was mainly due to increase of suspended particles supplied from Hasu river through Lake Mikata, that is located immediately upstream of Lake Suigetsu and trapping most of coarse detrital grains. In contrast, the increase of detrital materials during 13,700-12,800 SG06₂₀₁₂ yr BP likely reflects local slope erosion around the lake and partly the long-distance aeolian transport from the Asian deserts. Our result suggests the wetter condition in Central Japan during the Heinrich Event 1 in contrast to the dry condition in Yangtze River Basin, China, according to the $\delta^{18}O$ stalagmite record (Wang et al., 2001).

Keywords: Lake Suigetsu, Heinrich Event, East Asian Summer Monsoon, detrital material, quartz

Variation of very fine grained elemental carbon deposition to the Rebun Island, Hokkaido, during the last 5 ky

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Elemental carbon (EC) is a combustion product which is composed of rich C and depleted O, H, S, N. Biomass burning is major source of Pre-industrial EC, while fossil fuel burning has been the most important source since the 18th century. Black carbon (BC) transferred in the atmosphere as aerosols, including EC have a great impact on the climate. EC is also the second strongest contributor to global warming, and has effect to darken snow and ice surface. On the other hand, aerosols including EC have also negative effect on radiative forcing, which lead cooling. Although it is difficult to evaluate the net EC effect on climate, it is necessary to discriminate EC produced by fossil fuel burning from those from biomass burning. EC is not a single chemical compound, but it can be classified into two types, char and soot. Char is produced by pyrolysis, while soot is formed via gas-to-particle conversion. The char particles which are countable under microscope are called charcoal. There are many researches to reconstruct paleo-fire by counting charcoal, and in the late Holocene, the fire sometimes synchronized with human activity. Therefore, it is very important to understand the past EC variation to examine the relationship between climate change and history of human.

There are some methods for analysis of EC, and in this study, we use the method called thermal optical reflectance (TOR)-method. This method is principally used to analyze EC/OC in aerosols, where we can evaluate an interference of pyrolyzed OC produced during the temperature rise under He atmosphere by measuring the transmittance of near-infrared laser. In order to apply TOR-method to analysis of sediment, we examined thermograms for sucrose, fulvic acid, humic acid, and fullerene in advance. As a result, we confirmed that carbon fraction decomposed at 700-850 °C under O₂ atmosphere can be regarded as an EC.

The sediment sample we used was collected from the Kusyu Lake in the Rebun Island. We established the stratigraphy of the sediment core of 20 m long as well as the sedimentation rate of the surface sediment. From variation of the ratio of coarse/fine particles down to 12 m depth, the sedimentary environment would be changed from marine to fresh water at 600 cm. We analyzed EC/OC both for coarse and fine particles for 0-600 cm interval. The result shows that the variation of EC in coarse particle reflects local variation, while the EC in the fine fraction reflects local and/or distal variation. The local biomass burning increased at 521 cm. The influence of distal EC variability was larger in the interval of >217 cm, with the maximum at 217 cm and the minimum at 263 cm. The long-distance transportation of EC could be influenced not only by increase and decrease of supply from biomass burning but also by the variation of wind pathway which transports distant EC.

Keywords: elemental carbon, biomass burning, Holocene, Rebun Island

Chronological study on widespread tephras for the past 50,000 years in and around Japanese Islands

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After discovery of Aira Tn (AT) tephra, many widespread tephras have been recognized. The tephra for the past 50,000 years can be dated by the radiocarbon (¹⁴C) age determination. All ¹⁴C dates for tephras after Spfa-1 can be calibrated to a calendar year using calibration dataset "IntCal13". On the other hand, the stratigraphy and the age of tephras intercalated with core sample from marine and lake have been made highly precise. In this presentation, we review the chronological research on widespread tephras for the past 50,000 years, and then present its perspective

Keywords: widespread tephra, radiocarbon dating

MIS30-08

Room:501

Time:April 28 11:00-11:30

The door that the IntCal13 and Suigetsu dataset opened for us all

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See the Japanese abstract (the presentation will be in Japanese)

Keywords: IntCal13, Radiocarbon dating, Radiocarbon calibration, varved sediment, climate change, age-based correlation

A new high resolution dating method using tree-ring cellulose oxygen isotope ratio

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Introduction

Dendrochronology is the most accurate dating method by comparing of inter-annual variations in tree-ring width of wood samples from sedimentary layers, archaeological remains or old architectures against the predated standard ring width variations. Master chronologies of tree-ring width, necessary to be built for each region and species, have been established all over world. Some of them based on many living and buried trees cover the whole Holocene in Northern Europe and New Zealand. Tree rings contain other parameters than ring width, applicable for dendrochronological dating. Oxygen isotope ratio (d18O) of cellulose is one of them. Here, we demonstrate merits, methods and problems of the tree-ring d18O chronology in details.

Merits of tree-ring cellulose d18O chronology

Because tree-ring cellulose d18O is controlled solely by two meteorological factors, precipitation d18O and relative humidity, its inter-annual variation is usually independent from ecophysiological conditions of each tree. As the result, highly correlated tree-ring cellulose d18O variations between different trees ensure high success rate of dating. Moreover, the master chronology of tree-ring cellulose d18O built on cedar and cypress trees can be applied to date wood samples from all other tree species living in the same region and period. Therefore, many tree-ring d18O chronologies are now being created very rapidly all over Japan during the late Holocene, and the established tree-ring cellulose d18O chronologies have been applied for dating of various natural and artificial wood samples to promote new inter-disciplinary studies in both natural and human sciences.

Methods in tree-ring cellulose d18O chronology

There are two important progresses in analytical method behind the emergence of tree-ring d18O chronology. One is the combined instrument of a pyrolysis-type elemental analyzer and an isotope ratio mass spectrometer. The other is "plate method for cellulose extraction" from tree ring samples. Before 2000AD, it was extremely difficult to measure d18O of organic matter because combustion of samples to gases inevitably causes terrible oxygen contamination. The development of an instrument, which converts organic oxygen to CO without any oxidant at 1400 degree C and transfer the CO to mass spectrometer directly, solved the question how to measure d18O in huge numbers of tree ring cellulose. So far, cellulose extraction from many tree ring samples has been too time-consuming and labor-intensive to meet the huge number of samples in dendrochronological purposes. In 2010, we have developed a new method to extract cellulose directly from thin wood plates with hundreds of rings, which enabled us to start the tree-ring cellulose d18O chronology at last.

Perspectives of tree-ring cellulose d18O chronology

Although it is much more time-consuming to analyze tree-ring cellulose d18O than to measure tree ring width, we have accumulated many tree-ring d18O data from various kinds of samples and obtained many essential knowledge. While some data have successfully dated important archaeological remains, new problems have also emerged. Here, we show those problems and discuss future perspective of the tree-ring d18O chronology. <Tree Species>There are usually high correlations in tree-ring d18O time series between conifer and deciduous hardwood. But, evergreen hardwood may be somewhat different due to the longer photosynthetic season. <Spatial Correlation>Tree-ring d18O chronology in central Japan is coincident with those in western Japan, reflecting inter-annual changes of stationary rain band (Baiu front) activity in early summer. However, tree-ring d18O time series on Japan Sea side sometimes becomes complicated due to effect of heavy snow cover. <Analytical Method>"Plate method" sometimes destroys ring boundary of buried wood, so that it is necessary to further improve cellulose extraction procedure.

Keywords: tree ring, cellulose, oxygen isotope ratio, dendrochronology

Calcareous nodules for sea floor paleothermometry

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Paleothermometry is one of the most important proxies for paleoceanographers. Benthic foraminifers have been used for reconstructing paleotemperature on the bottom of the sea. They are excellent materials for calcareous ooze, while mudstone sequences shows lots of difficulty to apply this technique for terrigenous sediments distributed around Pacific. Calcareous nodules are commonly observed in mudstone sequences, however, no study discussed potential paleothermometry based on calcareous nodules. It might supplements the role of benthic foraminifers. We described occurrences at outcrops, general configurations including their cut sections, analyzed carbon content, total organic carbon, and carbon and oxygen isotopes of nodules collected from Cretaceous strata of several regions in Hokkaido including the Haboro area.

Structure suggesting consolidation just below the sea floor includes burrows that eject calcareous material from nodule. Nodules consolidated associated with anaerobic oxidation of methane with sulfate reduction appear to be just-below-the-sea-bottom origin. Such nodules show the exactly same oxygen isotope values with that of benthic foraminifers. A bivalve fossil found on one of the methane seep nodules preserved aragonite of the shell and yielded close oxygen isotope temperature with that of host nodule.

Carbonate content and oxygen isotope values had positive relation suggesting carbonate content was controlled by the depth of nodule production. Nodules with lower carbonate content (<50%) exclusively show low oxygen isotope values and inappropriate for the sea bottom paleothermometry.

Study on nodules from the Haboro area showed that selections in front of outcrops and at laboratory enable us to select "high quality nodules" for oxygen isotope paleothermometry. As it is simple procedure, large numbers of analyses are available. The cross-plot of these data can emerge "upper limit line" of oxygen isotope values. The paleotemperature based on that value could provide reliable temperature for the sea bottom. On the other hand, nodules with similar condition from the Oyubari area appeared to be recrystallized and inappropriate for paleothermometry. It might be derived from the difference of burial depth between sediments of the Haboro and Oyubari areas. Even if it was originally consolidated near the bottom of the sea, strong compaction during burial would have caused permeation of pore water into the nodule. Carbon dioxide or bicarbonate ions derived from decomposed organic matter would have caused recrystallization of calcite with oxygen isotopes as low as -10 permil in the nodule.

Keywords: nodules, paleothermometry, oxygen isotope

Identification of single pollen grains found in a glacier using a whole genome amplification method

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Pollen taxon in sediment samples can be identified by analyzing pollen morphology. Identification of related species based on pollen morphology is difficult and is limited primarily to genus or family. Because many pollen grains in glaciers contain protoplasm, genetic information of pollen grains should enable identification of plant taxa below the genus level. The present study attempted to analyze the DNA of *Pinus* pollen grains collected from subsurface snow layers on the Belukha Glacier in the Altai Mountains of Russia in the summer of 2003 in order to identify them. *Pinus* is a taxon with approximately 111 recognized species in two subgenera, four sections and 11 subsections. Each *Pinus* pollen grain was amplified using a whole genome amplification method, and some regions of chloroplast genome were sequenced. As a result, each pollen grain was identified at subsection level and was narrowed down to around 10 species.

Keywords: glacier, ice core, pollen analysis, *Pinus*, DNA, WGA

Dissolution process of *G. bulloides* shell observed by X-ray CT based on dissolution experiment

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We performed nine-day dissolution experiments with shells of the planktic foraminifera *Globigerina bulloides* at a pH of 6.7 ± 0.1 in water undersaturated with respect to calcite. *Globigerina bulloides* shells were collected from sediment trap samples in the western subarctic Pacific. The process of dissolution of the shells was quantitatively evaluated with observations made with X-ray micro-computed tomography (CT). On the basis of these observations, we divided the shell structures of *G. bulloides* shells into three categories: early-developed calcite formed during the juvenile stage, inner calcite, and outer calcite. The early-developed and inner calcites had low CT numbers (low density) and were sensitive to dissolution. In contrast, the outer calcite had high CT numbers (high density) and resisted dissolution. Both the mode and frequencies of the CT numbers of *G. bulloides* shells decreased as dissolution progressed. Temporal changes of the histogram of CT numbers as the shells dissolved were quantified in terms of the percentage of calcite volume accounted for by low-density calcite (%low-CT-number calcite volume). There was a linear relationship ($R^2 = 0.62$) between the volume ratio of low-density calcite and shell weight loss. This relationship indicates that shell weight loss can be estimated from the CT number distribution, regardless of the initial condition of the shell, such as size or thickness. We suggest that the X-ray micro-CT method may be used to estimate the extent of foraminiferal shell dissolution with respect to effects on internal structure and shell density.

Keywords: carbonate, planktic foraminifera, X-ray CT, shell weight, shell density, dissolution index

Relationship between modern speleothem formation and surface weather in an Asian tropical cave

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Introduction

For precise climate prediction, it is necessary to reconstruct high time and space resolution paleo-climate (especially past 2000 years) from paleo-climate proxies and assimilate the result to climate model. Tropical Asia, including Indonesia, is well affected by El Nino Southern Oscillation (ENSO). The ENSO does not only directly affect on precipitation in tropical Asia, but also indirectly on middle and high latitude climate through teleconnection [1]. In Indonesia, Watanabe et al. [2] suggested inverse-correlation between $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ in speleothems and instrumental precipitation. However, relationship between modern speleothem formation and surface weather is not revealed clearly.

Therefore, the cave monitoring program, which included cave air temperature, relative humidity, airflow current, air CO_2 concentration monitoring and $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ analysis of dripwater and farmed speleothems, was initiated from 2011 in Petruk Cave (Central Java, Indonesia) in order to study the recording mechanism of precipitation variation into the $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ fluctuation in speleothems.

Result and Discussion

Air CO_2 concentration in Petruk Cave is fluctuated daily and seasonally until over 100 m deep site from the entrance.

It is revealed that cave air CO_2 concentration may be a significant factor that controls stable isotope value in speleothems, because temperature, humidity and drip rate in Petruk cave are nearly stable.

A scenario of precipitation recording is as follows: (1) surface rainfall cools outside air temperature; (2) cave airflow direction is inverted; (3) outside fresh air flows into the cave and air CO_2 concentration is dropped; (4) pCO_2 difference between cave air and dripwater becomes higher and calcite precipitation is promoted; (5) $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ in dripwaters and speleothems are decreased.

In addition to above discussion, we will show you $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values in dripwaters and farmed speleothems and confirm the scenario by these data.

[1] Hastenrath (1991) Climate dynamics of the tropics. [2] Watanabe et al. (2010) Palaeogeography, Palaeoclimatology, Palaeoecology 293, 90-97.

Keywords: cave monitoring, speleothem, isotope, paleo-climate

Millennial changes recorded in a stalagmite from central Gifu, Japan

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A 13-cm-long stalagmite collected from Gujyo City (central Gifu Prefecture) was formed from Marine isotopic stage 3 (MIS-3) to mid-Holocene. The stalagmite is divided into the lower and upper parts by a long-time hiatus during the Last Glacial time. Textural difference appears between the homogenous and transparent upper part and the dark-colored lower part. Oxygen isotopic values are also different; the values of the lower part are 0.5-1.0 permil higher than the values of the upper 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.

The most prominent feature of this stalagmite is cyclic changes of ~1 cm intervals in the lower stalagmite. Assuming that the lower part had grown continuous with a uniform rate, it includes a period from 56-35 ka. Eight cyclic changes could coincide to the dark layers in deep-sea sediments from the Japan Sea, which are likely associated with Dansgaard-Oeschger (D-O) events. 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.

Millennial changes in the Gifu stalagmite indicate D-O cycles, and further records regular intervals that cannot be seen in the Greenland ice sheet. Records of the lower stalagmite support the global extension of D-O events, and suggest that D-O cycles were not necessary originated from the phenomena in North Atlantic. Assuming that the oxygen isotopic values reflect precipitation intensity, it became dry during a gradual cooling period and shifted wet with an abrupt warming.

U-Th dating was performed in National Taiwan University under the guidance of Prof. C.C. Shen.

Keywords: stalagmite, oxygen isotope, late Pleistocene

Changes in precipitation over the last 2000 yrs recorded in a stalagmite and famine and disaster records in Iwate Pref.

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Stalagmites are excellent archives of terrestrial paleoclimate information. Some of them are formed in caves near the noosphere and may have recorded past climatic changes influenced human activity. Stable oxygen isotopic compositions of stalagmites especially have been utilized in many paleoclimate studies. However, many factors controlling stalagmite oxygen isotopic composition are known and the degrees of their influence varied from region to region. It is not easy to specify the main controlling factor in Northeast Japan, because the climate is influenced by the East Asian Monsoon and surrounding continental and oceanic air masses struggling with each other. Therefore stalagmite climatic studies is not advanced in this region.

We collected growing stalagmite UT-A from Uchimagi-do Cave, Iwate Prefecture, Northeast Japan. UT-A is 25 cm in height and obvious annual growth layers are found entirely under UV light. The age model of UT-A was based on these growth bands and it revealed that the mean growth rate is 0.12 mm/year and the stalagmite has continuously grown over the last 2000 years. In order to specify the major factor controlling isotopic composition of UT-A, we analyzed changes in annual layer thickness and oxygen isotopic composition of the uppermost part of UT-A and examined the correlations between these changes and weather around the cave over the last 30 years. As the changes in $d^{18}O$ correlates well with the growth rates and amount of precipitation, the oxygen isotopic profiles of UT-A could be interpreted as a proxy of precipitation change over the last 2000 years. The past precipitation deduced from oxygen isotopic composition of UT-A has a 100-200-year cycle and synchronized with famine and disaster caused by excess and lack of precipitation in regional historical records (e.g. Nihon'yanagi, 1968MS). Thus oxygen isotopic composition of stalagmites in Northeast Japan could be a good proxy of past precipitation and we can reconstruct past precipitation and possible famine and disaster events in prehistoric times. Moreover, we may be able to forecast the near future precipitation change in this region by the cyclic fluctuation.

Reference

Nihon'yanagi, S., 1968MS. *Small history of famines in Nanbu-Hachinohe Han in the Thousand Years* (in Japanese). Aomori.

Keywords: stalagmite, $d^{18}O$, precipitation, famine and disaster records, Uchimagi-do Cave, Iwate Prefecture

Skeletal records in a long-lived *Porites* coral from Okinoerabu-jima, Ryukyu Islands

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Tropical and subtropical ocean-atmosphere interactions play a significant role in global climate changes on seasonal, interannual and decadal timescales. Knowledge of past ocean variability is crucial for understanding and modeling current and future climate. However, spatial and temporal instrumental time series from tropical and subtropical oceans before 1950 are quite limited. There is, therefore, a strong need for high-resolution paleoclimate proxies such as corals and sclerosponges from the oceans that extend beyond the instrumental data.

Massive *Porites* corals, living in shallow waters of the tropical to subtropical oceans, precipitate annually banded aragonite skeletons. These colonies provide robust chronological control and allow sub-sampling at monthly-to-seasonal resolution. Oxygen isotope composition of coral skeleton reflects variations in sea surface temperature and seawater oxygen isotope composition (salinity) with the latter being closely related to the precipitation-evaporation balance at sea surface and changes in water mass transport (e.g., Gagan et al., 1998). Long-lived corals are an excellent archive for documenting high temporal resolved time series of thermal and hydrologic changes at sea surface for the last several centuries (e.g., Quinn et al., 1998). Nevertheless, there are a few published long coral records of more than 100 years in the tropical northwestern Pacific (Guam: Asami et al., 2005; Ogasawara: Felis et al., 2009; Ishigaki: Mishima et al., 2010).

We collected a 4.5-m-long skeleton core from a modern *Porites* coral colony in Okinoerabu-jima, Ryukyu Islands on October 2011. Our continuous observational data at the coral living site for the years 2009-2011 are consistent with gridded sea surface temperature and salinity products, suggesting that the site is exposed directly to open sea surface conditions. X-ray images of the coral skeleton showed well-developed annual density bands for the last several centuries. Here we present monthly-to-bimonthly resolved oxygen and carbon isotope composition time series from the coral skeleton to reconstruct secular trend of oceanographic changes before and after the Industrial Revolution. Along with previously published long coral records, our coral-based climate reconstruction will document spatial changes in thermal and hydrologic conditions in the northwestern Pacific for the last several centuries.

Keywords: coral skeleton, oxygen isotope composition, carbon isotope composition, paleo-temperature, paleo-salinity, Ryukyu Islands

Particle flux and paleoceanographic studies in the subarctic Pacific and the Arctic Ocean

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Particle flux studies employing time-series sediment traps have been very useful in obtaining novel knowledge concerning the environmental conditions in ever changing upper water columns of the subarctic Pacific since there had essentially been no such information available prior to our attempt. We employed T/S Oshoro-maru of the Hokkaido University in deploying the sediment traps in two remote areas of the subarctic Pacific during 1989-2010, for >20 years: one in the pelagic central subarctic Pacific (49.5 degree N, 174 degree E) and the other at a hemipelagic site of the Aleutian Basin of the Bering Sea (53.5 degree N, 177 degree E). Major biogenic particles in the flues include siliceous shells such as diatoms, radiolarians, and silicoflagellates as well as carbonate shells such as coccolithophores, foraminifers.

These shell-bearing plankton particles are useful in identifying detailed environmental conditions concerning seasonal and inter-annual changes. In particular, the effectiveness of biological pumps has been clarified, showing uptake of atmospheric CO₂ into the upper water columns at a different extent depending of the sites for the first time. Another important aspect of the biogenic particles is initial fossilization process during the settling phase in the water column, which also will be discussed.

Furthermore, application of what had been learnt from the particle flux studies to the sediment records of the past climate changes has been quite a challenge, but rewarding. Integrated Ocean Drilling Program (IODP) Expedition 302 (Arctic Coring Expedition: ACEX) in the vicinity of the North Pole at 88 degree N on the Lomonosov Ridge provided an opportunity of studying the middle Eocene environmental conditions of the paleo-Arctic. The conditions revealed for the first time mainly by siliceous microfossils such as diatoms, silicoflagellates, ebridians and chrysophytes are: fresh water at the top, brackish water next within the euphotic layer, and salty marine water supplied from the outside palegic realm. Another important aspect of the paleoceanographic exploration had been focused on the Bering Sea as IODP Expedition 323, for which the author proposed during the ODP era and materialized during the IODP era after 14 years of drilling preparation effort. The successful drilling down to ca. 5 Ma led to novel knowledge of many aspects such as evolution of sea-ice, the linkages both to the Pacific Ocean and the Arctic Ocean through the Beringian gateway. The Bering Sea drilling data linking to the intensification of the Northern Hemisphere Glaciation (NHG) ca. 2.7 Ma as well as the Mid-Pleistocene Transition (MPT) during 1.2-0.8 Ma are of extremely of interest and will be discussed in details.

Keywords: particle flux, Bering Sea, Arctic Ocean, Northern Hemisphere glaciation, Oceanic gateway

Calcareous nanoplanktons and nanofossils as useful tools for paleoceanography

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Microfossils are useful tools for paleoceanographic studies in two ways: age identification by detailed biostratigraphy, and reconstruction of sea state such as water temperature, productivity and dynamic properties of water mass. Needless to say, calcareous nanofossils are powerful age-diagnostic tool for oceanic sediments, but because of their minute size, its usefulness for oxygen and carbon isotopic analysis are limited. On the other hand, the unique existence of *Florisphaera profunda*, a deep photic-zone dweller, provide an useful method for paleoproductivity and dynamic analysis of water column. By the way, new discoveries or break through in any disciplines are often resulted from unexpected encounters or conversations between researchers. Personal relationships are also very important factor to progress career and to accomplish scientific achievement for young scientists. Utilizing this opportunity, I will summarize major points for paleoceanographic applications of calcareous nanofossils, and also, I will explain my own experiences of various encounters that resulted fruitful scientific achievements.

Keywords: paleoceanography, calcareous nanofossils, biostratigraphy, water dynamics, lower photic-zone

Mechanism of ice age cycle and paleoclimate modeling

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The 100-kyr cycle of the waxing and waning of the large Northern Hemisphere ice sheets and fast termination of the glacial cycles are the prominent pattern known from paleoceanographic records which can not be explained by the summer insolation proposed by the Milankovitch theory alone. Conceptual models imposing a threshold for the terminations by a large size of the ice sheet and/or large insolation can reproduce the patterns of glacial cycles, however, a physical explanation was not given. Here we simulated the past seven glacial cycles successfully with an ice sheet model in combination with a general circulation model imposing the time series of insolation and atmospheric CO₂. The response of climate to ice sheet, greenhouse gases and orbital forcings is examined with high resolution. The stationary wave feedback of ice sheet is also taken into account. Our model reproduces 100-kyr periodicity of the glacial cycles even with the astronomical forcing alone under a certain range of CO₂ level for the case of North America ice sheet. We show that the threshold which leads to the termination of the glacial cycle is governed by how the ice sheet responds to a given insolation. The characteristics of how the ice sheet responds to external forcing strongly depends on the climatic condition, such as the north-south temperature gradient and the topographic condition for each continent.

Keywords: climate, paleoclimate

Cretaceous-Paleogene stratigraphy in Northwest Pacific and its significance for paleoenvironmental study

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The Cretaceous – Paleogene period is known as the latest Greenhouse climate in the history of earth. In order to understand ocean – climate system during past Greenhouse climate, numerous attempt has long been made for the marine sequences in the Atlantic and Southern oceans and the Tethyas Sea. The Pacific Ocean was the outstandingly largest ocean during Cretaceous – Paleogene, and it may have played important roles in Earth's ocean – climate system. Despite its importance, very little work has been done to establish detailed paleo-oceanographic changes during Cretaceous – Paleogene. This is largely because most of the Cretaceous – Paleogene Pacific oceanic crusts have subducted under continents, and bad recoveries of Cretaceous – Paleogene sediments of the ODP and DSDP cores from the Pacific sites have prevented researchers from studying paleoenvironmental changes of the Pacific Ocean.

First, we establish the detailed integrated stratigraphy (planktic foraminiferal and dinoflagellate cyst biostratigraphy, carbon isotope stratigraphy and U-Pb dating of tuff beds) of the Cretaceous – Paleogene marine sequences exposed in Hokkaido Japan because the resolution of international stratigraphic correlation of these strata is not enough to identify important climatic and/or extinction events such as the OAEs, K/Pg, PETM and others. The strata used in this study is as follows; the Yezo Group (early Aptian – early Campanian: 125 – 75 Ma), the Nemuro Group (Campanian?– early Eocene: 75?– 53 Ma), the Poronai Formation (late Eocene: 42 – 35 Ma) and the Onbetsu Formation (late Eocene – early Oligocene: 34 – 32 Ma). Our integrated stratigraphy enables to identify the exact horizons of following climatic and extinction events. The Cretaceous Oceanic Anoxic Events (OAEs) of the OAE1a (125.5 – 124 Ma), Leenhadlt Level of OAE1b (110 Ma), OAE1c (107 Ma), OAE1d (101 Ma), OAE 2(94 – 93.5 Ma) are identified in the Yezo Group exposed in Oyubari and Tomamae areas. Although no so-called black shales were found in these horizons, evidences of oxygen depletion were identified from the most of these horizon based on the analyses of benthic foraminifera, degree of pyritization and sedimentary structure such as degree of bioturbation. The horizons of the K/Pg (66 Ma) and PETM (Paleocene Eocene Thermal Maximum; 56 Ma) in the Nemuro Group and Late Eocene Warming (37 Ma) in the Poronai Formation exhibit no obvious differences in lithology. Especially, the strata across the K/Pg boundary in the Shiranuka Hill consists of massive mudstone and a few intercalations of thin felsic tuff and turbidite sandstone. The middle – late Eocene cooling (40 – 39 Ma) is characterized by abundant occurrences of glendonites and buliminids (benthic foraminifera) in the middle part of the Poronai Formation, which indicates that cooling and eutrophication of surface water occurred in the northwest Pacific. The prominent positive excursion of oxygen isotope around Eocene/Oligocene boundary (34 – 33.6 Ma) is placed at the top of the Urahoro Group. The overlying Onbetsu Formation includes Oi-1a and Oi-1b of early Oligocene. Flood occurrence of buliminids in the lower part of the Onbetsu Formation suggest that surface water eutrophication occurred in response to global cooling after the Oi-1 glaciation.

The horizons of climatic and extinction in Hokkaido have continuous outcrop without significant hiatus and faults. High resolution analyses of these horizons will improve our understanding of climatic and environmental changes in northwest Pacific during the latest greenhouse period.

Keywords: Cretaceous, Paleogene

Milankovitch forcing and carbon cycle during the Toarcian Oceanic Anoxic event

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One of the most profound environmental changes in the Mesozoic took place during Toarcian (Early Jurassic), including oceanic anoxia (Toarcian Oceanic Anoxic Event; T-OAE). The T-OAE is characterized by negative carbon isotope excursion (CIE) of up to ~8 ‰. The T-OAE is considered to have resulted from the release of CO₂ by Karoo-Ferrar volcanism and possible methane hydrate dissociation. However, the origin of these perturbations remains strongly debated, primarily due to lack of radiometric age constraints across the T-OAE (e.g. Palfy and Smith, 2000; Kemp et al., 2005, 2011; Suan et al., 2008).

Here we present the orbitally-tuned bio-, and $\delta^{13}\text{C}_{org}$ stratigraphy of the Lower Jurassic deep-sea bedded chert sequence at the Katsuyama-Sakahogi section, in the Inuyama area, central Japan, which covers the T-OAE (Ikeda and Tada, 2013; Ikeda and Hori, in review). The sedimentary rhythms of the bedded chert display a full range of climatic precession related cycles; ~20 kyr cycle as a chert-shale couplet and ~100 kyr, 405 kyr, ~2000 to 4000 kyr cycles as chert bed thickness variations (Ikeda et al., 2010; Ikeda and Tada, 2013). Chert-shale cycles and variations in chert bed thickness are interpreted as resulted from changes in the burial rate of biogenic silica (Hori et al., 1993).

By using 405-kyr eccentricity cycle of constant and stable periodicity (Laskar et al., 2004) observed in the Inuyama bedded chert, we established the astronomical time scale (ATS) by counting 405 kyr cycle (~20 bed cycle; Ikeda and Tada, 2013). Then, this ATS is anchored at the end-Triassic radiolarian extinction level of which age is estimated as 201.4 ± 0.2 Ma based on projection of the U-Pb date measured at the Pucara section, Peru, using the conodont and radiolarian biostratigraphy (e.g. Carter and Hori, 2005; Schoene et al., 2010; Ikeda and Tada, 2013).

This astronomical time scale suggests the absolute ages of the T-OAEs. The timing of two black bedded chert intervals (T-OAEs 1 and 2) and the negative CIE of ~5 ‰ are within the time interval of radiometric ages from the Karoo-Ferrar Lips (Svencen et al., 2007; Jourdan et al., 2008). This result supports the volcanic degassing origin of these carbon cycle perturbations (Palfy and Smith, 2000; Suan et al., 2008).

The termination of black shale deposition occurred at the minimum of 40 kyr obliquity and 100 kyr and 405 kyr eccentricity cycles. These temporal relations imply the possible impacts of these orbital forcing on the stabilization of carbon cycle perturbation through Earth system dynamics, such as weathering and nutrient cycles.

Keywords: Milankovitch cycle, carbon cycle, volcanism, silica cycle, hydrological cycle

Paleoceanographic evolution of Miocene to Pliocene mud sea in the Ryukyus based on calcareous nannofossil assemblages

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The Cenozoic sedimentary succession in Okinawa-jima, including the upper Miocene to Pleistocene siliciclastic deposits (Shimajiri Group) and the Pleistocene reef to shelf deposits (Ryukyu Group), suggests a drastic paleoceanographic change from a mud sea to a coral sea. To delineate the paleoceanographic evolution of the mud sea, we quantified the stratigraphic distribution of the calcareous nannofossil assemblages from the Shimajiri Group in a 2119.49 m-deep well (Nanjo R1 Exploratory Well) drilled in southern Okinawa-jima (Ryukyu Islands, southwestern Japan). Four late Miocene and Pliocene datum planes were found in the studied interval. The calcareous nannofossil assemblages suggest the existence of oligotrophic conditions between 5.3 and >8.3 Ma followed by eutrophic conditions and a return to oligotrophic conditions at 3.5 Ma. Micropaleontological evidence suggests that these oceanographic changes were likely caused by local tectonic movement (shallowing of the sedimentary basin in which the Shimajiri Group was deposited). We will report calcareous nannofossil records from two exploratory wells drilled in southern Okinawa-jima in 2013 – 2014 as well.

Keywords: calcareous nannofossil, Miocene, Pliocene, Ryukyu Islands

East Antarctic deglaciation and the link to global cooling since the Pliocene

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Reconstructing past variability of the Antarctic ice sheets is essential to understand their stability and to anticipate their contribution to sea level change as a result of future climate change in a high-CO₂ world. Recent studies have reported a significant decrease in thickness of the East Antarctic Ice Sheet (EAIS) during the last several million years. However, the geographical extent of this decrease and subsequent isostatic rebound remain uncertain and a topic of debate. In this study, we reconstruct magnitude and timing of ice sheet retreat at the Sor Rondane Mountains in Dronning Maud Land, East Antarctica, based on detailed geomorphological survey, cosmogenic exposure dating, and glacial isostatic adjustment modeling. Three distinct deglaciation phases since Pliocene for this sector of the EAIS are identified, based on rock weathering and ¹⁰Be surface exposure data. We estimate that during the Plio-Pleistocene the ice sheet thinned by at least 500 m. This thinning is attributed to the reorganization of Southern Ocean circulation associated with the global cooling into the Pleistocene, which reduced the transport of moisture from the Southern Ocean to the interior of EAIS. The data also show since the Last Glacial Maximum the ice surface has lowered less than ca.50 m and probably started after ca. 14 ka. This suggests that the EAIS in Dronning Maud Land is unlikely to have been a major contributor to postglacial sea-level rise and Meltwater pulse 1A.

Past 2 Myr Radiolarian Assemblages and Paleoceanographic Changes off the Southwestern Japan (IODP Site C0001)

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The effects of Quaternary paleoceanographic events on the Kuroshio Current off the southwestern Japan, including the mid-Pleistocene Transition (MPT) (1,200?700 ka) and the mid-Brunhes event (MBE) (400?300 ka), are poorly documented at this time because of a lack of long core recovering the MBE and the MPT. In this context, this study aims to establish paleoceanography of this region since the Early Pleistocene, using radiolarian assemblages as paleoceanographical proxy. The Holes C0001E and F, drilled by the R/V Chikyu during IODP Expedition 315 at a depth of 2198 m in the Shikoku Basin off the Kii Peninsula on the slope of the Nankai accretionary prism (southern Japan) are used in this study. The upper 190 m LSF sediments cover the Quaternary based on the shipboard results, the dominant lithology consisted of greenish-gray to grayish-green mud. The age model of Site C0001 is based on calcareous nannofossils datums, planktic foraminifers datums, radiolarians datums and *Globorotalia inflata* oxygen isotope stratigraphy. In this study, 240 samples of 20 cc, covering the Early to Middle Pleistocene, were used for radiolarian faunal analysis. The examination of the polycystine radiolarians was performed using an optical microscope at a magnification of 100?400x. In each sample, 400 to 1000 polycystine radiolarians were identified. The radiolarian-based sea surface temperature (rSST) was estimated using a Modern Analogue Technique (MAT). Several warming event is recorded during the Early Pleistocene. However, the strongest warming event is recorded during the MPT, where the subtropical fauna abundances increased consequently.

Keywords: Pleistocene, Paleoceanography, Mid Pleistocene Transition, Radiolarian

Sea-ice conditions in the Okhotsk Sea during the last 550 kyr deduced from environmental magnetism

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Reconstructing past sea-ice conditions in the Okhotsk Sea is important because sea-ice conditions vary in response to global climate changes, which in turn may affect global ocean circulation through intermediate water mass formation. We conducted an environmental magnetic study of six cores from three stations in the central Okhotsk Sea to better understand temporal and spatial sea-ice variations. Inter-core correlations and age estimations are based mainly on geomagnetic paleointensity; an oxygen-isotope stratigraphy is available for one station. Magnetic susceptibility (MS) minima are accompanied by maxima in color b^* , the ratio of the anhysteretic remanent magnetization susceptibility to saturation isothermal remanent magnetization ($k_{ARM}/SIRM$), and the S-ratio, which indicates a higher proportion of biogenic to terrigenous magnetic components. This reflects enhanced ocean productivity. First-order reversal curve diagrams and IRM component analyses support the dominance of biogenic magnetite at MS minima. In contrast, color b^* , $k_{ARM}/SIRM$, and S-ratio values are low when MS is high, which indicates an increased proportion of the terrigenous component that was probably transported as ice-rafted debris (IRD). For the southern two stations, IRD accumulation increased in glacial and deglacial periods, which implies mobile sea-ice conditions even in full glacials. This was succeeded by extremely enhanced ocean productivity in early interglacials, which suggests nearly ice-free conditions. For the northernmost station, on the other hand, IRD accumulation was low in glacials and increased in early interglacials, which indicates perennial sea-ice coverage with little mobility in glacials. Succeeding ocean-productivity enhancement was delayed compared to the southern stations.

Keywords: Okhotsk Sea, paleoceanography, environmental magnetism, sea ice, IRD

Pliocene and Pleistocene paleoceanography in the northwestern Pacific and the Bering Sea based on diatom analyses

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Late Pliocene-Pleistocene fossil diatom assemblages from Ocean Drilling Program (ODP) Leg 145 Hole 884B in the western Subarctic North Pacific were investigated and the paleoceanographic records were compared with those at Integrated Ocean Drilling Program (IODP) Expedition 323 Holes U1341B and U1343E in the Bering Sea for an interval of 2.5-0 Ma.

As the results, in Hole 884B, five diatom zones, from the *Neodenticula koizumii*-*N. kamtschatica* Zone to the *N. seminae* Zone, were identified. The cold-water indicators from Hole 884B, which represented high abundances throughout the interval, suggest the cold environmental conditions analogous to the modern sea-surface conditions in the western subarctic Pacific. The drastic decrease of the temperate-water species at ca. 2.2 Ma is related to a rapid cooling event at ~2 Ma. Sporadic appearances of sea-ice related species from ca. 2.3 Ma and a slight increase of neritic species observed at ca. 2.0 Ma may be reflection of a series of the Northern Hemisphere Glaciation (NHG) events. Slightly higher abundances of the sea-ice related species at 1.0-0.8 and 0.4 Ma and those of the neritic species at 2.0, 1.8, 1.2, and 0.9 Ma are likely to correspond to the southward advance of the subarctic front and drop in sea-surface temperature mentioned by Sancetta and Silvestri (1986).

The age differences of the distinct decreases of temperate-water species recognized at ca. 1.9 Ma for Hole U1343E, ca. 2.1 Ma for Hole U1341B and ca. 2.2 Ma for Hole 884B indicate that the East Kamchatka Current in the Western Subarctic Gyre was strengthened and the westward advection of the Alaskan Stream was weakened at ca. 2.2 Ma. In the Bering Sea, the limited input of temperate waters via the Near Strait resulted as a decrease of warm water supply to the region around Site U1341 at ca. 2.1 Ma, while the eastern Bering slope region had been still affected by the warm water masses advected from the Amchka and Amukta Passes. Further global cooling might have restricted the continuous warm water supply to the Bering slope region around Site U1343 at ca. 1.9 Ma.

Keywords: diatom, paleoceanography, subarctic Pacific, Bering Sea, IODP Expedition 323, ODP Leg 145

Millennial-scale rock-magnetic variation indicating instability of North Atlantic environments during MIS 100

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Ocean thermohaline circulation (THC) plays an important role in global climate change linked with continental ice sheets. To clarify the variation of ocean THC in the early stage of glaciations in the northern hemisphere, we studied a deep-sea sediment core with high sedimentation rate recovered at IODP Site U1314 in the North Atlantic. Rock magnetic study of the sediments during marine oxygen isotope stage (MIS) 100 indicated links between the millennial-scale variability in deep water circulation and iceberg discharge. The observed abrupt decreases of magnetic coercivity associated with ice-rafted debris (IRD) are interpreted to be reduced transport of high-coercivity material from Icelandic source indicating reduced formation of North Atlantic Deep Water (NADW). In these periods, a current from the south, Lower Deep Water, transports sediments with low magnetic coercivity contributed by coarse grained magnetite of continental sources. Repetition of vigorous and weakened NADW production linked to IRD was observed during MIS 100 in a similar manner to that in the last glacial suggests that the regime of climate change in the millennial-scale was already established in the early stage of glaciations in the northern hemisphere.

Keywords: rock magnetism, thermohaline circulation, North Atlantic Deep Water, Ice rafted debris

Paleoceanographic reconstruction of the Holocene Arctic Chukchi Sea using fossil diatoms

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The Chukchi Sea, in the Arctic Ocean, receives the warm outflowing waters of the Bering Sea. These waters are one of the causes of Arctic sea ice decline, and change their flow according to the sea ice distribution in the Chukchi Sea. Sea ice in the global climate system has a significant impact on the global environment (e.g., atmospheric circulation, biological production and ocean circulation), due to the albedo effect, maintenance of low temperatures, and high salinity bottom waters. Therefore, the reconstruction of the past sea ice history of the Chukchi Sea is important in understanding the climate system of the Arctic Ocean as well as the global climate system. However, piston cores previously obtained from the Chukchi Sea were too short and/or contained few or no microfossils, making detailed paleoenvironmental analyses and age determinations difficult.

I started working on the diatom analysis of sediment cores taken during the HLY0501 cruise of the United States Coast Guard icebreaker cutter "Healy" in 2005. They took 8 sediment cores, although diatoms were not obtained at six of the sites. So here I show the diatom analysis results from the remaining two cores (cores 5 and 8).

Keywords: Chukchi Sea, Diatom, Holocene

Thermal threshold of the Atlantic meridional overturning circulation as a trigger for glacial abrupt climate changes

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Abrupt climate changes known as Dansgaard-Oeschger events (DO events) took place frequently during glacial climate. Geological evidences support the idea that changes of the Atlantic meridional overturning circulation (AMOC) are related to these events, but question on what triggers the AMOC changes remains unsolved. Although most studies have regarded freshwater flux from melting ice sheet as a cause of the AMOC changes, we recently identified the existence of the thermal threshold of the AMOC during glacial climate. Here, from the results of numerical simulations about the glacial AMOC, we report that the thermal threshold of the AMOC serves as a triggering mechanism of DO events. We investigated the structure of the thermal threshold in glacial climate by conducting ocean general circulation model simulations under various thermal conditions in which degrees of sea surface cooling are systematically changed separately or simultaneously in northern and southern hemispheres. The results suggest that the threshold is located near the condition under which the climate is slightly warmer than the coldest glacial conditions. We also found that the amplitude of AMOC changes in crossing the threshold depends on thermal conditions in northern and southern hemispheres. The most prominent threshold is identified where the southern hemisphere is somewhat warmer than the coldest glacial conditions. It is also demonstrated that gradual warming in the southern hemisphere from the colder glacial climate leads to crossing this threshold and can cause significant strengthening of AMOC. Our results indicate that the thermal threshold could be a triggering mechanism of DO events, especially for those accompanying the gradual warming of southern hemisphere before their abrupt warming in northern hemisphere.

Role of Southern Ocean stratification in glacial atmospheric CO₂ reduction

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The global temperatures and atmospheric carbon dioxide (pCO₂) concentrations varied during the last 800 thousand years. During the glacial times, such as Last Glacial Maximum (LGM), the atmospheric partial pressure of carbon dioxide (pCO₂) was about 80-100ppmv lower than interglacial times, such as Holocene. Compared to interglacial conditions, terrestrial carbon stocks were reduced during glacial conditions. Marine carbon cycles must have been the main driver for lowering atmospheric pCO₂ during ice ages. A number of candidate mechanisms to explain the reduction in glacial atmospheric pCO₂ have been proposed. However, they failed to explain full amplitude of 80-100ppmv reduction. Based on paleo-proxy reconstructions, $\delta^{13}\text{C}$ gradient between surface and deep ocean was larger than today, suggesting that the glacial ocean circulation state was different from today. In the deep glacial Southern Ocean, very saline water was identified from paleo proxy data. Moreover, radiocarbon record showed the existence of radiocarbon-depleted old waters in glacial ages. One hypothesis that has been proposed to explain the glacial atmospheric pCO₂ is the isolated reservoir hypothesis: a carbon-rich, radiocarbon-depleted water mass was isolated from the atmosphere during the glacial periods. The stratification of the Southern Ocean water column may have contributed to a reduction of atmospheric pCO₂.

In this study preindustrial and LGM marine carbon cycle sensitivity experiments are conducted to estimate a role of stratification in glacial Southern Ocean quantitatively, by using an ocean general circulation model (OGCM). In the control case, atmospheric pCO₂ between Modern case and LGM case is about 44ppmv, which was comparable to previous AOGCM study. However, LGM case cannot explain the saline glacial Southern Ocean.

Previous study using intermediate complexity models suggested that glacial atmospheric pCO₂ and $\delta^{13}\text{C}$ distribution can be reproduced by considering brine induced stratification.

Therefore, we also consider the effect of brine induced stratification. We partly succeeded in reproducing the saline glacial South Atlantic Ocean by imposing body forcing near the bottom in the Weddell Sea, Ross Sea and Eastern Antarctica, whereas saline glacial Southern Ocean resulted in increased northward flow of AABW and increased atmospheric pCO₂. Additionally, we used stratification-dependent vertical eddy diffusivity parameterization suggested by Gargett (1984) to discuss changes in vertical eddy diffusivity in Southern Ocean. Contrary to our expectation, vertical eddy diffusivity in high latitude becomes very higher under glacial conditions, and sequestered carbon in deep ocean was released into the atmosphere and resulted in higher atmospheric pCO₂.

Finally, very stratified Southern Ocean achieved by extremely small vertical eddy diffusivity also cannot reduce glacial atmospheric pCO₂. Other processes, which are not taken into account in our study may be important to reproduce the glacial condition.

Keywords: ocean carbon cycle, Last Glacial Maximum, Southern Ocean, Ocean general circulation model

A tree-ring oxygen isotope chronology from Yakushima Island and its dendroclimatic potential

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Recent progress in isotope dendroclimatology showed that tree-ring oxygen isotopes are a promising proxy to reconstruct past precipitation and/or relative humidity. In the present study, we developed a 300-year tree-ring oxygen isotope chronology using Japanese cedar (*Cryptomeria japonica*) growing in Yakushima Island, southern Japan, and explored its dendroclimatic potential. Two tree samples that were crossdated by visually matching ring-width variations were used for oxygen isotopic analysis. The resulting oxygen isotope series for the period 1700-2009 C.E. were highly correlated with each other ($r = 0.68$), indicating that common signals related to local climate are preserved in these data. Both the delta-18O series were individually normalized to have zero mean and unit variance, and the resulting series were averaged to build the final chronology. Response analysis with monthly climatic records (temperature, precipitation and relative humidity) from the Kagoshima station revealed that tree-ring delta-18O was primarily controlled by relative humidity and precipitation in the summer season (May-September). Perhaps the most striking feature of the delta-18O chronology is a significant increasing trend over the 20th century, indicating a decrease in summer relative humidity in the study region. We will present an extended version of the tree-ring delta-18O chronology over the past 1000 years or so.

Keywords: tree ring, oxygen isotope ratios, Yakushima Island, monsoon

Assessment of Sungkai tree-ring $\delta^{18}\text{O}$ proxy for paleoclimate reconstruction

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We measured annual $\delta^{18}\text{O}$ variations of two sungkai trees that were collected in the same area as previous study, in order to assess the reproducibility of sungkai $\delta^{18}\text{O}$ as paleoclimate proxies. Two sungkai $\delta^{18}\text{O}$ variations has a significant correlation ($r = 0.80$; $P < 0.001$) with each other and also with the previous analysis, suggesting that $\delta^{18}\text{O}$ values of sungkai are affected by external climatic factors. The annual $\delta^{18}\text{O}$ of SungkaiNAN7 has significant, positive correlations with temperature, sunlight hours and air pressure whereas it has significant, negative correlations with relative humidity and SOI. Moreover, the seasonal $\delta^{18}\text{O}$ variation acquired during severe drought of 1997-98 El Nino event shows that the maximum $\delta^{18}\text{O}$ value around 1997 latewood corresponds to rainfall/relative humidity minimum and temperature/sunlight hours/air pressure maximum with a significant time lag.

Keywords: tree ring, cellulose, stable isotope geochemistry, tropics, paleoclimate

Characteristics of ESR and TL of natural quartz from river bed sediments

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The sediment provenance would give important information on the erosion processes, uplift of the mountains and so on, suggesting the environments at the time of sediment transportation. The sediment is made of fine grains such as sand and silt. When a new procedure for clarifying provenance of such sediments is established, it will be useful to elucidate the provenance of sediments in the geohistorical environments, which may occasionally be related to stream piracy, regional tectonic setting and/or the environment changes of the hinterland.

There have been already some Electron Spin Resonance (ESR) and luminescence studies on sediment provenance. The intensity of the E₁' center in quartz is shown to be a useful parameter to investigate the provenance of aeolian dust as well as of sediments [1][2]. The crystallinity index (CI) in combination with ESR is employed to discriminate two different sources of eolian dust in the sediment core taken from the Japan Sea [3]. Quartz of four distinct origins can be distinguished using impurity (Al, Ti-Li, Ti-H, Ge) centers observed after beta irradiation [4]. Shimada and Takada (2008) and Shimada et al. (2013) also show that the Al, Ti-Li and E₁' center signal intensities from the natural quartz are useful to distinguish the sediment provenance [5][6]. Volcanic quartz is reported to emit stronger red thermoluminescence (TL) than blue one whereas plutonic quartz does vice versa [7]. Quartz of eolian origin transported from China can be distinguished from volcanic quartz originated in Japanese tephra by looking at TL color of quartz grains [8].

In this study, we report the characteristics of ESR and TL of quartz taken from present river bed sediments, to discuss the possibilities of identifying sediment provenance.

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Keywords: Electron Spin Resonance, Sediments provenance, Quartz, Sediments, Thermoluminescence, River bed sediments

A chronostratigraphic study of the upper Anno formation, in the Awa group

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We took oriented mini-core samples for paleomagnetic and rockmagnetic measurements at 79 sites and rock samples to extract fossil foraminifera from sites from the upper Anno formation distributed along the Shikoma river. We carried out rock magnetic, paleomagnetic, oxygen isotopic and carbon isotopic measurements.

Magnetic carrier was interpreted as pseudo-single domain magnetites based on the results of hysteresis and thermal demagnetization, thermomagnetic analyses.

We carried out analysis of principal component to results from the thermal demagnetization and extracted Characteristic Remanent Magnetizations (ChRMs). In the result, a relatively short reversed polarity zone found in the previous study is defined as the Mammoth subchronozone.

We obtained an oxygen isotopic curve from the result of isotopic measurements which is correlatable with the LR04 oxygen isotopic standard curve (Lisiecki & Raymo, 2005). Then we detected 6 tie points to establish an age model for this sequence

Keywords: paleomagnetic stratigraphy, oxygen isotopic stratigraphy, chronostratigraphy

Palaeoclimatic analysis for 600 ka based on the TOC contents of MD01-2407 core from the Oki Ridge, Japan Sea

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We have measured total organic carbon (TOC) and total nitrogen (TN) contents of a sediment core, MD01-2407 (932 m depth, 55.28 m length), at 2 cm interval. This core was taken from the Oki ridge at the southern part of the Japan Sea in AD 2001. We used the age model which shows age-depth relation for MD01-2407 core proposed by Kido et al. (2007). This age model used 6 marker tephra layers, 7 ¹⁴C dates, 3 TL layers and 14 delta ¹⁸O events. This core covers the past 670 kyr.

TOC content is generally high in MIS 15, 13, 11, 9, 7, 5, 3 and 1 (about 1.5 - 5.0 %), and low in MIS 16, 14, 12, 10, 8, 6, 4 and 2 (about 0.8 - 1.2 %). This fluctuation pattern is very similar to the marine oxygen isotope curve LR04. TN content shows similar fluctuation with TOC. C/N ratio is constantly 9 - 10, suggesting that TOC is originated mainly from marine planktons. Temporal change of TOC of the sediment can reflect the change of biological productivity in the Japan Sea (Oba and Akasaka, 1990), which may be controlled climate change. This is an excellent record of paleoclimate over Middle and Late Pleistocene in the middle latitude region.

Keywords: TOC, TN, Japan Sea, MD01-2407

A standard local chronology of late Quaternary based on the TOC profiles of the sediment cores from the Japan Sea

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The TOC content was measured for the late Quaternary sediments of the Japan Sea with high time resolution (ca. 100 yrs interval), and show the good similarity to the delta ^{18}O curve of NGRIP not only in the orbital scale but also the D-O cycle scale (Urabe et al., 2013). In this study, we use TOC profile of the MD179-3312 core from the Japan Sea, and we align the TOC profile to the delta ^{18}O in NGRIP using signal matching, the Match protocol (Lisiecki and Lisiecki, 2002). Before this matching process, there were ca. 4000 years gaps in maxima between both signals, and the gaps are variable. Based on the matched TOC profile, we calculated the ages of TOC peaks, and we proposed a new age of TL layers recognized in MD179-3312 (Kakuwa et al., 2013) on the basis of the matched chronology.

Recently, detailed TOC profiles of the sediment cores were reported from several sites in the Japan Sea, and they show very similar profiles. Therefore, we tried to compile the TOC profiles, using the same match protocol. The matched MD179-3312 profile mentioned above is used as a tentative standard, and TOC profiles of three sediment cores, namely MD179-3304 off Joetsu, MD01-2407 at Oki bank and MD01-2408 off Akita were matched to the tentative standard. This compiled TOC curve (TOC_{JSCOM}; Japan Sea TOC compile) has a reliability due to averaging the four cores data. This TOC_{JSCOM} have a good similarity with the TOC profiles from lake sediments in Japan. When we compared the TOC_{JSCOM} with the delta ^{18}O of stalagmites from the Hulu/Sanbao caves in the south of China (Wang et al., 2001, 2008), we found the improved chronological correspondence between both proxies in MIS 1/2 boundary, lower MIS 3, 4, 5.1, and 5.2. The difference of the trends is recognized in MIS 5.5, and a part of this discordance is due to the local environmental condition of the Japan Sea.

Keywords: Late Quaternary, Japan Sea, TOC, Chronology

A Long-term pollen record of the C9001C core from the deep-sea bottom, off Shimokita peninsula, northeastern Japan

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We used a pollen analysis method for a deep-sea core to reconstruct paleoclimatic changes with the Milankovitch time scale.

In this study, we obtained a continuous pollen record and reconstructed paleovegetation and paleoclimate changes for the past several kyrs from the C9001C core, drilled from off Shimokita Peninsula.

We have applied the Modern Analogue Method to obtain a quantitative paleochimate reconstruction. In the results, a positive correlation has shown on between the paleotemperature parameter and the glacial - interglacial cycle. On the other hands, the summer precipitation parameter matches with the precession cycles but not with the glacial - interglacial cycles. The annual temperature parameter variability show strong negative correlation. These results are support hypothesis of the East Asia monsoon fluctuation mechanism

Keywords: pollen, monsoon, marine core

Carbon and oxygen stable isotope records of benthic foraminiferal shells at DSDP Site 296

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Carbon and oxygen stable isotope records of benthic foraminifera at DSDP Site 296 (2920 m water depth) from the Kyushu-Palau Ridge were measured. Sediment samples for upper 300 m of DSDP Site 296 were taken at every ~2 m and freeze-dried and washed on a 63 micro m mesh sieve and dried in an oven at 40 degree C. The dry samples were sieved through a mesh with 250 micro m opening. Two epifauna species, *Cibicides wuellerstorfi* and *Cibicidoides mundulus* were picked for isotope measurements. The foraminiferal shells were cleaned by soaking them in 99.5% methyl alcohol, followed by ultrasonication until all chambers were open. After confirming that all dirt had been removed, we washed the shells in Milli-Q water and dried them in an oven at 40 degree C. The dried samples were analyzed using IsoPrime mass spectrometry (Center for Advanced Marine Core Research, Kochi University). Analyses were calibrated to the CO-1, and the average analytical errors for delta 13C and delta 18O were less than 0.03 permil and 0.10 permil, respectively.

Age model of DSDP Site 296 is established by planktic foraminiferal and calcareous nannoplankton stratigraphy (Elias, 1975; Ujiie, 1975). Continuous stable isotope records except for a stratigraphic gap at ~250 mbsf are obtained for the past 20 Myrs. These records are basically consistent with those by Zachos et al. (2001).

Keywords: North Pacific, Benthic foraminifera, Stable isotope, Miocene, Pliocene

A Southern Ocean trigger for Northwest Pacific ventilation during the Holocene?

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Holocene ocean circulation is poorly understood due to sparsity of dateable marine archives with submillennial-scale resolution. Here we present a record of mid-depth water radiocarbon contents in the Northwest (NW) Pacific Ocean over the last 12,000 years, which shows remarkable millennial-scale variations relative to changes in atmospheric radiocarbon inventory. Apparent decoupling of these variations from regional ventilation and mixing processes leads us to the suggestion that the mid-depth NW Pacific may have responded to changes in Southern Ocean overturning forced by latitudinal displacements of the southern westerly winds. By inference, a tendency of in-phase related North Atlantic and Southern Ocean overturning would argue against the development of a steady bipolar seesaw regime during the Holocene. This study was also published in Scientific Reports.

Keywords: Holocene, Northwest Pacific, Radiocarbon, Southern Ocean overturning, Southern westerly winds

Multiple early Eocene hyperthermals reconstructed from the Indian Ocean deep-sea sediments

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From the late Paleocene to the early Eocene (ca. 56 Ma), an extreme global warming by 5-8 °C occurred within several thousand years, which is termed as the Paleocene-Eocene Thermal Maximum (PETM). The PETM is known to accompany severe ocean acidification and a prominent negative carbon isotope excursion in both marine and terrestrial environments, which indicate a massive and rapid injection of isotopically light (¹²C-enriched) greenhouse gas into the ocean-atmosphere system. Recently, additional PETM-like global warming events (called as "hyperthermals") have also been identified during the early Eocene period of ca. 56-52 Ma [2]. As is the case with the PETM, the early Eocene hyperthermals also accompanied rapid and pronounced negative carbon isotope excursions. Besides, the hyperthermals appear to be in phase with the oscillations in the eccentricity of Earth's orbit [2, 3], which suggests that the orbital forcing affected to earth's climate and global carbon cycle even in the warmer Earth without large continental ice sheet during this period.

Geologic records of the hyperthermals have so far been reported from all over the world (e.g., the Pacific, the Atlantic, the Arctic, Europe and North America). The Indian Ocean, however, is the exception where only few published data are available for reconstruction of the hyperthermals and thus, the global extent of the hyperthermals remains uncertain. Here, we analyzed $\delta^{13}\text{C}$, $\delta^{18}\text{O}$ and CaCO_3 contents of 376 bulk sediment samples taken from four DSDP/ODP cores (DSDP Site 213, DSDP Site 259, ODP Site 738C, ODP Site 752). The analytical results show that sediments from Site 738C and Site 752 contain multiple negative carbon and oxygen isotope excursions and reductions of carbonate contents, which appear to corresponding to the PETM and the early Eocene hyperthermals. Observed hyperthermals from the both sites are inferred to be H1 (Eocene Thermal maximum 2; ETM2)/H2 and I1/I2 events [3]. The observed carbon isotope excursions of ETM2 event ($\sim -1\text{‰}$ at Site 752 and $\sim -0.5\text{‰}$ at Site 738C) and I1 event ($\sim -0.6\text{‰}$ at both sites) are comparable with those reported from the other regions, such as the Pacific and the Atlantic Oceans. Our results strongly suggest that the hyperthermals in the early Eocene period were a global event including the Indian Ocean.

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Keywords: deep-sea sediment, Indian Ocean, climate change, hyperthermals

Preliminary analyses on a LGM simulation using MIROC-ESM :climate and dust aerosol representation

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Future Projection using Earth System Model (ESM) is an important contribution for Intergovernmental Panel on Climate Change Assessment Report 5 (IPCC AR5) from the modelling studies. Therefore, it is important to investigate ability of models and improve them. Especially, Last Glacial Maximum (LGM, 21,000 years before present) is recognized as a benchmarking period because it is the coldest time during relatively recent past. We report the preliminary analyses on climate and dust aerosol representation of the LGM experiment using an ESM, MIROC-ESM (Watanabe et al. 2011).

MIROC-ESM which contributed to IPCC AR5 was used for the study. The resolution of the Atmosphere General Circulation Model is T42 with 80 layers for the vertical levels and the resolution of the Ocean General Circulation Model part is about 1° with 44 vertical levels. An aerosol module SPRINTARS (Takemura et al. 2000, 2002, 2005) is calculated online.

Following the protocol of Coupled Model Intercomparison Project phase 5, we performed two experiments. One experiment is called PI, which corresponds to pre-industrial time, i.e., 1850 A.D. The other is called LGM, which is supposed to represent climate at LGM (Sueyoshi et al. 2013). The differences of the boundary condition from PI are lower greenhouse gases, the orbit of the Earth and the topography (ice sheets and sea level drop).

The climate of PI is reasonably well represented as a state-of-the-art model (Watanabe et al. 2011). The sea surface temperature drop at LGM is reasonably comparable with MARGO dataset (MARGO project members 2009). However the 7 to 10 °C temperature drop suggested by the Antarctic ice cores (Stenni et al. 2010, Uemura et al. 2012) is reasonably represented, the 21 to 25 °C cooling suggested by the Greenland ice cores (Cuffey et al. 1995, Jonsen et al. 1995, Dahl-Jensen et al. 1998) is not enough simulated in the model. The modelled net cooling over the Greenland summit is about 15 °C. Tackling this defect is important to improve future projection. One of the conceivable reasons is the problem on representing enhancement of mineral dust aerosol in the model, which has been pointed out in IPCC AR5. We have compared the modeled dust amount with a dataset called DIRTMAP (Kohfeld and Harrison 2001). As a result, there are problems on the representation of dust over the Greenland both for PI and LGM. In the LGM experiment, the plant functional types (PFT) are basically unchanged from PI. Taking into account the change of PFT may lead more dust generation at LGM and enhance the cooling. The Antarctic dust is significantly lower than the dataset at LGM. The dust emission from Patagonia, the major dust source of the Antarctic ice core, is too low in the LGM experiment. This seems to be caused by too high soil moisture. The precipitation over Patagonia is already too high in the PI. Improving the PI precipitation amount may also affect the LGM precipitation amount and improve the soil moisture conditions.

We present the preliminary analyses on the dust at LGM using MIROC-ESM. As a result, there is a difficulty on representation of the dust enhancement over the ice sheets. Further improvements of the model, for example, taking into account the PFT change or better representation of the precipitation at PI may work to better representation of dust amount/distribution at LGM. Over the Antarctica, the cooling at LGM is expressed in the model but the dust amount is far from the estimation of the ice core data, i.e., the current simulated cooling may be a result of wrong reasons. We are going to improve the processes of the dust emission and investigate deposition procedures and estimation of radiative forcing.

Keywords: LGM, dust, climate sensitivity, Earth System Model

MIS30-P12

Room:Poster

Time:April 28 18:15-19:30

A 3.3-kyr record of environmental changes in Asian continental interior by Lake Baikal core analysis

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We report chemical analysis (TOC, TN, TS, BioSi, and etc) of Lake Baikal sediment.

Observation of stalagmite laminae for paleoclimate reconstruction at Taga Mine Cave, Shiga Prefecture, Japan

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A lot of studies on paleoclimate reconstruction using stalagmites have been done all over the world. However, there are only a few stalagmite paleoclimate researches in Japan. In this study, we observe laminae of stalagmites collected at Taga Mine Cave, Shiga Prefecture, Japan (TAGA3, TAGA5, TAGA7, TAGA11, TAGA12) for paleoclimate reconstruction.

Stalagmite paleoclimate reconstruction has a potential to get high-resolution (annual~decadal) age proxy data, if stalagmite samples have annual laminae. However, some stalagmites have a few types of laminae within a sample (Baker et.al,2008). In this case, it is important to elucidate which types of laminae is annual.

When we observe the thin section of our samples by microscope, all samples show laminae. These laminae consist of natural organic matters because of fluorescent by UV excitation (Baker et.al,2008). Laminae interval is variable from several μm to a few hundred μm . Laminae of our samples are similar to the one from China and Turkey (Tan et.al,2006 , Baker et.al,2008).

Especially, sample TAGA3 has more obvious laminae than the other samples, but has the laminae which looks like sub-annual or supra-annual laminae reported in China (Tan et.al,2006). In addition, laminae are wavy in some parts of TAGA3. If we can distinguish annual laminae by U-Th age and find the feature of annual laminae, we will get high-resolution paleoclimate proxy data.

Keywords: stalagmite, laminae, paleoclimate

New age model of off Takashima drilling sediment

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Several kinds of studies have been carried out regarding Off Takashima drilling core in Lake Biwa, Japan and a lot of achievements have been reported. In recent years, we have been carrying out chemical analysis on biogenic silica content of cored sediment with high time resolution. However, there have been some age problems regarding uppermost part of the core, namely the last 45 k years. In order to solve the age model problem, we carried out piston core sampling near the Off Takashima drilling site in 2012. About 30 carbon-14 data have been obtained. In addition to well-known wide spread tephra dates, these C-14 dates are converted into new age model. Correlation between Off Takashima drilling core and newly obtained piston core sediment enabled to establish new Off Takashima age model. Last year we reported tentative correlation based on water content profile of both cores. This time, we analyzed grain size, total organic carbon content and total nitrogen content of piston core sediment and compared with those of Off Takashima drilling core. Based on total organic carbon content, correlation between two cores and age model of Off Takashima drilling core are improved greatly.

Keywords: Lake Biwa, sediment, paleoenvironment, age model

Climate change history of the last 45ka of Lake Biwa based on grain size and TOC, TN of BWK12-2 piston core

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Based on newly established age model of BWK12-2 piston core sediment, obtained near the Off Takashima drilling station in Lake Biwa, Japan and with about 30 C-14 dates and well dated wide spread tephra, we analyzed grain size and total organic carbon (TOC) and total nitrogen (TN) contents of the sediment. Analyzing interval of those sediments were, 4cm to grain size and 2cm to TOC and TN whose time resolutions were 30 to 120 years and 15 to 60years respectively. Comparison with Marine Isotope Stage profile shows distinct resemblance to MIS1, however, difference between MIS2 and MIS3 is not clear. On the other hand, abrupt cooling events, such as Heinrich events and Younger Dryas, are clearly recognized. Abrupt warming, such as Dansgaard Oeschger events are not clearly recognized.

Keywords: Lake Biwa, sediment, paleo climate, grain size, TOC, TN

Late Holocene change in lacustrine environment inferred from diatom fossil analysis of lake bed core

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Detail diatom fossils analysis of a lake bed core provided successive reconstruction of lacustrine environmental change after ca. 4700 cal BP in the Lake Hamana, central Japan, with high temporal resolution. In addition, two suspected thin layers as some kind of event deposits were recognized based on allochthonous sediments and/or diatom fossils.

Lake Hamana is a coastal brackish lake located along the Enshu-nada coast. Ikeya *et al.* (1990) performed numerous geological and paleontological analyses on lake bed sediments and reconstructed roughly the Holocene lacustrine environment and geomorphological development of the lake. According to them, after sea area had expanded landward associated with the Jomon Transgression, an inner bay and a fresh water lake occurred at a relatively stable sea-level condition. Furthermore, Morita *et al.* (1998) suggested that fresh water and brackish water conditions had been formed alternately during the Late Holocene, which indicating geomorphological changes presumably caused by some mega thrust earthquakes occurred in the Nankai trough. However, lower temporal resolution made impossible them to clarify detail lacustrine environmental changes.

In order to reconstruct detail lacustrine environmental change of the Lake Hamana during the Late Holocene, diatom fossil assemblages of the 350 cm-long lake bed core were investigated. The core sediments consisted of muddy deposits mainly including a thin sandy layer and two obvious tephra layers. The refractive index of volcanic ashes and core stratigraphy indicated that the lower tephra layer was the Amagi-Kawagodaira pumice (Kg, 3126-3145 cal BP, Machida and Arai, 2003) and the upper one was the Fuji-Osawa scoria (Os, 2.5-2.8 ka, Machida and Arai, 2003). The age model of the core was reconstructed based on the tephra layers and seven radiocarbon ages.

Six diatom zones were identified based on major species composition changes in the diatom assemblages. Stepwise development of the lacustrine environment in the Lake Hamana was suggested as below: Vigorous seawater inflow inferred by marine diatoms (Stage I, 4600-4700 cal BP); A closed inner bay environment with laminated sediments due to formation of sand barriers (Stage II, 4500-4600 cal BP); A circulative brackish lacustrine environment by active mixture of riverine fresh water with enhanced inflow of seawater since 3500 cal BP (Stage III, 2650-4500 cal BP); Gradual salinity decrease of the lake water by reduced seawater inflow (Stage IV, 2250-2650 cal BP); Lake water from brackish to fresh since 2250 cal BP with intermittent salinity increase in the middle of this period, water depth of the lake getting deeper (Stage V, 1498 AD-2250 cal BP); Re-development of an inner bay environment after the Meio earthquake in 1498 AD with temporal salinity increase during 1600 AD to 1750 AD (Stage VI, after 1498 AD).

Additionally, two possible event layers (A and B layer in ascending order) were found. The A layer, during 321-322 cm depth, was characterized by exceptionally high percentage of *Plagiogramma* sp. This temporal abundance accompanying increases of *Thalassiosira* sp. and *Thalassionema nitzschioides* indicates an abrupt environmental change and/or an allochthonous sediments supply. Nevertheless, it is difficult to specify the cause of this layer because the habitat of *Plagiogramma* sp. is still unknown. On the other hand, the B layer was corresponding to the thin sand layer in the range of 285-288 cm depth showed short-term abundance of fresh water diatom species. This indicates that relative coarse sediments supplied abruptly from fresh water environment, ponds and/or marshes, around the lake to the central part of the lake.

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Keywords: LakeHamana, lacustrine environment, coastal lagoon, diatom fossil, 1498 Meio earthquake, Holocene

Reconstruction of the Last glacial to Holocene climate changes in Shaamar loess-paleosol succession, northern Mongolia

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Two atmospheric circulation systems, the mid-latitude Westerlies and the Asian monsoon, play key roles in northern-hemisphere climatic changes. However, the variability of the Westerlies in mid-latitude Asia and their relationship to the Asian summer and winter monsoon remain unclear. We examined the variations in the grain size and elemental composition from the 30 m long loess-paleosol succession in Shaamar area, northern Mongolia, which could be recorded the interplay of the Westerlies and Asian winter monsoon for the last 30 k.y. We then compared our results with the multi-proxy paleoclimate records (e.g., eolian grain sizes, lake levels, pollen assemblages) of the Asian summer and winter monsoon regions and the Westerlies affected region.

According to the compiled data of the Wang and Feng (2013), the Holocene climatic variation patterns (mainly from lake levels and pollen records) in Asia are categorized into 4 characteristic regions, such as the Summer monsoon region (southern and northeastern China), Westerlies affected region (northwestern China), Winter monsoon region (southern Siberia), and Mixture of westerlies and winter monsoon affected region (Mongolia). Specifically, summer monsoon region is characterized by dry earliest Holocene (12-11 ka), humid early to middle Holocene (11-6 ka), and the moderate-humid late Holocene (last 6 ka), corresponding to the Northern hemisphere summer insolation changes. Westerlies affected region is characterized by dry early Holocene (12-8 ka) and humid middle to late Holocene (last 8 ka). Winter monsoon region is characterized by the humid early Holocene (12-8 ka) and dry middle to late Holocene (last 8 ka). On the other hand, Mongolian records (e.g., Lake Khuvsgul, Lake Gun Nuur) demonstrate humid early Holocene (12-9 ka), dry middle Holocene (9-5 ka), and humid late Holocene (last 5 ka), which seems mixture of westerlies and winter monsoon affected region.

Shaamar loess-paleosol succession record is characterized by the humid early Holocene (12-8 ka) and dry middle to late Holocene (last 8 ka), similar to the winter monsoon region in southern Siberia. Thus, it is suggested that the eolian sediment record in Shaamar could be affected more strongly by winter monsoon influence, although Shaamar section is located closely to the mixture of westerlies and winter monsoon affected region (e.g., Lake Khuvsgul and Lake Gun Nuur). Except for the Chinese Loess Plateau, Shaamar loess-paleosol succession is only the continuous eolian sediment record in mid-latitude Asia. Thus, Shaamar loess-paleosol succession should provide us rare glimpse for understanding the interplay of westerlies and winter monsoon in Asian mid-latitude. We will further examine the Last glacial records of the Shaamar loess-paleosol succession and compare with other records of the Asian summer and winter monsoon regions and the Westerlies affected region.

Keywords: Mongolia, Loess-paleosol succession, Westerlies, Winter monsoon, Holocene, LGM

Reconstruction paleoenvironment by using diatom fossil assemblage analysis in Imuta-ike wetland, Satsumesendai, Kagoshim

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Paleoenvironmental reconstruction, using diatom assemblage analysis have been carried out in Imuta-ike, Satsumasendai, Kagoshima, Japan. In this site, there are deposit peat layer which is rare in west Japan, 6 visible tephra layer and 2.5m depth laminated layer. Boring survey conducted center of Imuta-ike at Feb. 2011, we was able to got 25m depth core. It can be traced back to 30,000 years past, can be reconstructed until modern environment from ice age. Following environment changes are reconstructed. Since about 30,000 years ago, peat and silt continuously has deposited, but accumulate speed has changed.

About 30,000 yr BP to 23,400 yr BP, we can't reconstruct detail environment change, because of the small number of diatom. About 23,400 yr BP to 13,600 yr BP, inflow river has been existed. And edge of the lake, moor has been formed. About 13,600 yr BP to 10,800 yr BP, moor became land, then pH rose. About 10,800 yr BP to 4,600 yr BP, it starts the postglacial age, increase precipitation and water level was rose. After K-Ah, tephra deposited the lake and water depth was shallow. About 4,600 yr BP to 1,500 yr BP, those days was dystrophic lake and it started to form wet land in west side of the lake. About 1,500 yr BP to present, it continues aggradation, water depth has been shallow. It progresses wet land formation so that water pH was dropped.

Keywords: diatom, Holocene, climatic change, pH change, volcanic stratigraphy, annually laminated lake deposit

Reconstruction of Paleo-environment at coastal lakes along the Soya Coast, Antarctica, using fossil diatom assemblages

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Soya Coast, located at East Antarctica distribute wide ice-free areas such as Langhovde, Skarvsnes, Skallen and Rundvagshetta. The research areas of this study are five lakes in the ice-free coast as follows; Lake Nurume-ike and Lake Yukidori-ike at Langhovde, Lake Oyako-ike at Skarvsnes and Lake Maruwan-minami-ike and Lake Maruwan-oike at Rundvagshetta.

Matsumoto et al.2014 described the Holocene paleo-limnological changes at Lake Oyako-ike. They described soft-x-ray analysis, carbon 14 dating, elemental analyses, Chlorophyll compounds and carotenoids, and algae and cyanobacteria analyses. The paleo-environment of the lake shifted from the open coastal environment, through stratified saline lake, and then to high productive fresh water lake during these two thousand years. They presume that these environmental changes have been affected by isostatic uplift by retreating continental glaciers.

Diatom fossil assemblages at the lake deposit (Ok4C-1) divided into five assemblages zones, from Zone 1 to Zone 5 to upward. The dominated species of each zone is as follows. Zone 1:*Paralia sulcata*, marine species, Zone 2:*Staurosira construens*, Zone3:*Tryblionella littoralis*, marine species, Zone4:*Chamaepinnularia cymatopleura*, brackish species and Zone 5:*Amphora oligotraphent* *Navicula gregaria*, *Diadsmis* spp., freshwater species. The shifts of diatom assemblages presumed the lake water environment shifted from coastal marine environment through freshwater lake environment. This result was fitted to the results of the previous study. Now, we are analyzing other four lake sediment cores.

Keywords: Antarctic coastal lakes, paleolimnology, diatom, the Holocene, Sediment core

Holocene climate changes detected in the bottom sediments of the glacier lake, southern Peru

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We attempt to reconstruct climate changes during the Holocene by using a glacier lake on the southern Peru. For this, we had undertaken field investigation as echo sounding and piston coring at Lake Yauriuri, which is 130 km apart from Nazca city. The lake is one of typical glacier lake at height of 4,384 m. By the seismic record of the lake bottom from echo sounding, it is identified that 10-m thick mud layer with the intercalated fine sand layers on the bedrocks. And, two sediment cores were taken from the southwestern point at 50 m in water depth. The length of the cores is 50, and 170 cm, respectively. Lithology of the sediment shows that almost homogenous dark grey slit with two thin brownish flood-origin layers. We have analyzed physical properties, magnetic susceptibility, color reflectance, chemical compounds by XRF, CNS and ICP-AES with multiple radiocarbon dating for the whole core section. Our results indicated abrupt changes of S and Ti contents at 4,000 and 7,000 cal BP, suggesting that past lake level fluctuation and precipitation over the last 11,000 years caused by climate changes. These past environmental variations in Lake Yauriuri may have the similar pattern with other records in inland area of Peru as well as off shore Peruvian marine records.

Keywords: Peru, Laguna YauriUri, climate change, Nazca Culture