Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

APE33-P01 Room:Convention Hall Time:May 24 17:15-18:30

Toward an establishment of ”Standard Paleosite” in and around Japan

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Varved sediment obtained from the Lake Suigetsu, central Japan, provides a terrestrial radiocarbon calibration model and a chronology of paleoenvieonemental change during the last 70,000 years (Nakagawa et al., in press). Likewise the Lake Suigetsu, varved sediments were found in the Lakes Ichinomegata and Ogawara, northern Japan. These varved sediments have a big potential to establish high-resolution chronology to reconstruct past climatic changes. The western North Pacific is known as a terminal region of the great ocean conveyer. In general, 14C ages of the surface water are older than the atmospheric values (marine reservoir effect). The North Pacific has very old 14C ages. Because of the large marine reservoir effect, it is hard to establish reliable age model of marine sediment cores in the North Pacific. Further, there are large uncertainties of past marine reservoir effect in the glacial to deglacial periods.

If we can tie chronologies between Lake Suigestu sediments (and other varved cores) and marine sediment cores, we will be able to evaluate past marine reservoir effect around the Japanese Islands. Reconstruction of the past marine reservoir effect reduces age model uncertainties and helps understanding past ocean circulation. A key for the connection is tephra. Tephras deposited in the Lake Suigetsu provide precise chronology. We propose an application for the tephra chronology in the Lake Suigetsu to marine sediment cores around the Japanese Islands by collaborative work between lake and ocean paleo-communities.

Keywords: Age model, Carbon cycle, Glacial Interglacial cycle, Tephra, Varved sediment, Marine reservoir effect

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Biogeochemical cycling of phosphorus in the 45˜50Ma Arctic Ocean: Constraints from speciation analysis (IODP Exp302)

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The modern Arctic Ocean plays a key role in regulating global climate system, because it is a site of high albedo by sea ice and of deep water formation as a driving force of thermohaline circulation through which heat and nutrients are transported. However, the Arctic sea ice did not always exist in the past. Integrated Ocean Drilling Program (IODP) Expedition 302 Arctic Coring Expedition (ACEX) has revealed that the seawater temperature was substantially high (10˜14^{o}C) and no sea ice was formed before 45Ma when sea ice started to form (e.g., Brinkhuis et al., 2006; Moran et al., 2006; Marz et al., 2010). In a warm Arctic Ocean, the thermohaline circulation was weak enough to stagnate the deep ocean and to develop anaerobic environment, like the modern Black Sea. Nutrient recycling is likely to have been much different from that of today. In order to clarify the geochemical cycle of phosphorus, a bio-essential nutrient element, we performed sequential extraction analyses for different forms of phosphorus using ACEX samples. We utilized a method modified after Schenau et al. (2000), which is based on a SEDEX method by Ruttenberg (1992) where phosphorus-bearing species in sediments are chemically extracted into five different forms; (1) absorbed P, (2) Fe_{oxide}-P, (3) carbonate fluorapatite (CFAP) + $CaCO_3$-P + hydroxylapatite (HAP), (4) detrital P, and (5) organic P. In the method of Schenau et al. (2000), the above (3) was divided into two phases: non-biological CFAP and biological HAP and $CaCO_3$-P.

Our working hypothesis is as follows: If the Arctic Ocean was warm and closed by surrounding continents, the seawater would have stratified and become anaerobic, where bacterial sulfate reduction was active. Phosphorus in the sediment would have been preserved mainly as organic P that likely originated from decay of plankton. Fe oxide-P is considered to be less important as a sink of P, because free Fe would have been depleted due to extensive pyrite formation (Ogawa et al., 2009). CFAP could be an important sink of P because its abundance increased with increasing age and depth (Fillippelli and Delaney, 1996). If continental weathering was enhanced by an increase in rainfall in a warm climate during the 49˜48 Ma Azolla Event, increased weathering flux of phosphorus would have enhanced primary productivity.

Keywords: IODP, ACEX, SEDEX method, Phosphorus phase

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Production and destruction of biogenic carbonates through the year in the Arctic Ocean

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The Arctic Ocean is one of the most sensitive realms to global climate changes in the world oceans. It is concerned that oceanic acidification accompanied by global warming allows dissolution of carbonate shells of phyto- and zooplankton and it could be affected oceanic food chain in near future. In this study, we show the result of carbonate production and destruction changes through the year in the Arctic Ocean using faunal and micro focus X-ray CT analysis. Time-series samples of sinking particles were obtained at Stn. NAP10t (75N, 162W, water depth 1,975 m) in the Northwind Abyssal Plain, the Arctic Ocean. Deployed time was from Oct. 2010 to Sep. 2011. The sediment trap cups were deployed at 300 m (shallow) and 1,300 m (deep) water depth and 26 samples were recovered from each water depths. Sampling interval for each bottle was 13-15 days.

Total mass flux (TMF, mg/cm2/day) between both water depths showed clear relationship with the seasonality. Relative higher TMF were observed in late Autumn(November - December), and Summer (August). In fact, contributors of TMF were not only carbonate shells but also some kind of phyto- and zooplankton (diatoms, Copepods, Shrimps, and other gelatinous plankton). From the perspective of biogenic carbonates, primary producers were planktic foraminifers, pteropods, and bivalves and their shells were observed in each bottles commonly. However favorable seasons for their growth were different each other: Primary producers of biogenic carbonates during the late Autumn were the pteropods and small bivalves. On the other hand, planktic foraminifers were most dominant fauna in the Summer. It suggests that faunal alternations between carbonate-shelled plankton has been occurred through the year in the Arctic Ocean. In this presentation, we will show the micro-focus X-ray CT images of planktic foraminifers, pteropods, and bivalves shells and will discuss about the carbonate dissolution in the water column.

Keywords: Arctic Ocean, time-series records, production, dissolution, calcium carbonate, micro-focus X-ray CT

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Reconstruction of marine production changes from middle to late Miocene in the Ishikari Basin, Hokkaido, Japan

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Diatom production in sea surface layer has been known to increase throughout North Pacific Ocean during the middle -late Miocene (Barron, 1998). The enhanced diatom production might result from change of biogeochemical cycles associated with coevolution between herbaceous C_4 plant and marine diatom (Falkowski et al., 2004), although the increase of diatom production was explained by change of deep water circulation. In addition, Sawada (2006) reported that increase of kerogen delta ^{13}C was almost simultaneous to increase of diatom biomarker concentrations in Neogene neritic sediments of central Japan, and suggested that marine production was presumably enhanced by more efficient input of terrigenous matter in the Neogene paleo-Japan Sea. However, there are few studies on the Neogene-order linkage between terrestrial and marine environmental changes. In the present study, we analyzed marine and terrestrial biomarkers in mudstones of the Miocene Kawabata Formation, which is mainly composed of turbidite, to evaluate interaction between marine productivity and terrestrial input.

We analyzed mudstones from the Kawabata Formation in the Higashiyama route, Yubari area, Hokkado, Japan. This formation was formed in the Ishikari Trough that had be associated with birth of Japan Islands and was filled by turbidite. The Kawabata Formation is important for evaluating tectonic history of Hokkaido including uplift of Hidaka Mountains, and therefore, deposited age was determined by fission track dating of tuff layers and diatom biostratigraphy (Kawakami et al., 2002). We used mudstone samples deposited from ca. 13Ma to ca. 10Ma. We determined total organic carbon (TOC), and analyzed solvent-extractable biomarkers by GC/MS.

The TOC values of all samples are nearly constant (0.5 % ~ 0.8 %). Sterane and hopane isomer ratios indicate that organic matters in these sediments are immature. Concentrations of diatom biomarker such as higher branched isoprenoid (HBI) alkane and HBI thiophenes, as well as dinoflagellate biomarkers such as dinosterane were higher before ca. 13Ma and after ca. 10Ma. Moreover, increase of these algal biomarker concentrations are almost simultaneous to decline of Pr/Ph ratios, so that higher primary production in sea surface layer might result in occurrence of anoxic bottom waters.

It is also found that terpenoid biomarkers originated from terrestrial higher plants are abundantly contained in the Kawabata Formation. The terpenoid biomarker-based higher plant parameter (HPP), which varies depending mainly on conifer abundances, decreased from the lowermost layers except around 10 Ma. This suggests that conifer-dominant vegetation declined in paleo-Hokkaido areas from the late to middle Miocene. In addition, concentrations of terrestrial plant terpenoids frequently varied throughout the Kawabata Formation. This variation might be attributed to those of terrestrial input as organic matters in the Ishikari Basin. We will present more detailed discussion for marine productivity change related to terrestrial organic matter input by using both marine and terrigenous biomarkers.

Keywords: Neogene paleoceanography, land - ocean interaction, marine primary production, paleo-Japan Sea, turbidite, biomarker

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Temporal change of the sources of aeolian dust delivered to Japan

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Change of atmospheric circulation system in the past is an important issuefor studies of paleoclimate. Bulk chemical compositions, trace elements,isotopic ratios have been used as proxies to investigate such materialtransportation on the surface of the earth. However, chemical processes suchas weathering may affect such proxies. Utilizing the feature that the oxygenvacancies in quartz correlate with ages of host rocks in the range up to1Ga, Toyoda and Naruse (2002) found that the origin of aeolian dustaccumulated in Japan are different between in MIS 1 and 2. Nagashima et al.(2007) found that the origin of Japan Sea sediments changed with time from the oxygen vacancies and the crystallinity indexes.

In the present study, the temporal variation of possible origin of aeoliandust accumulated in Japan in the recent past is investigated. Dust samples representing atmospheric deposition were collected in a 1.5m^2 plastic open surface collector installed in the observation field of observatories at Akita for one month.Finer grainsize fractions in 1969 and in 1971 showed higher value of oxygen vacancies, which are estimated from the intensity of the E_1' center in quartz. This may be due to the fact that finer faction came from China as aeolian dust whilecoarser fractions are local.

The value of oxygen vacancies in finer fractions decreases with time between1960 and 1988 while crystallinity indexes are constant. These resultsindicate that aeolian dust originated from China has changed its origin inthe recent past. This may correspond to the previous observation that $^{90}Sr/^{137}Cs$ in the deposition decreases with time (Igarashi et al., 2009).

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YR11 and SG12: Paired projects to explore linkage between East Asian Summer Monsoon and Westerly Jet during the Holocene

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Hydrological cycle in Asia is strongly influenced by spatial pattern and intensity of East Asia Summer Monsoon (EASM). Recent study by Sampe and Xie (2010), based on detailed analysis of meteorological data set, revealed a close genetic relation between the westerly jet (WJ) and EASM front. Preliminary examination of our paleoclimatic data set also suggests the relationship between the position of WJ over East Asia and the intensity of EASM precipitation over South China on millennial time-scale during the Holocene. In order to confirm this relationship and test whether the similar relationship is maintained on shorter time-scales, we organized two projects YR11 and SG12.

YR11 is a project to reconstruct distribution of EASM precipitation over the Yangtze River drainage during the late Holocene with decadal time-scale. To accomplish this objective we first examine provenance of detrital silt and sand throughout the drainage of modern Yangtze River so as to develop a new method to estimate relative contribution of detrital sediments from various branches of Yangtze River to the sediments discharged to the Yangtze River Delta. Next, we will drill the Yangtze River Delta to retrieve sediment cores that are expected to preserve high resolution record of Yangtze River discharge with flood events. By applying a newly developed method to quantitatively estimate the provenance, we hope to reconstruct changes in the area of heavy precipitation over the Yangtze River drainage.

SG12 is a project to reconstruct the changes in the position of WJ axis over East Asia during the Holocene with decadal to annual resolution using the Lake Suigetsu sediments. Our previous studies proved aplicability of the provenance tracing method of eolian dust to the Lake Suigetsu sediments. Because the Lake Suigetsu sediments have annual lamination and extremely well-dated through the extensive studies under SG06 project (lead by Nakagawa), the sediments will provide us a rare opportunity to examine changes in eolian dust flux, grain size and provenance on annual time-scale. To accomplish this objective, we plan to drill Lake Suigetsu again in this summer.

The outline of the paired projects and preliminary result of YR-11 project will be presented at the meeting.

Keywords: East Asian Summer Monsoon, Westerly Jet, Yangtze River, Lake Suigetsu, sediments, eolian dust

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Holocene oxygen isotopic records of Itoigawa stalagmites and climate change

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A stalagmite is a valuable paleoclimatic proxy and it is known that its stable isotopes record temperature, rainfall amount and vegetation changes. Especially in tropical and monsoonal regions the oxygen isotope shows inverse correlation with rainfall amount. Previous studies suggested that oxygen isotopic records from caves in south China reflected the intensity of Asian Summer Monsoon (ASM).

We examined stalagmites (FG01 and FG02) collected from a cave in Itoigawa, Niigata Prefecture. They have transparent appearance and relatively straight growth center. Stable isotope analysis was conducted by means of mass spectrograph (Finnigan Delta-plus) and the age was determined by U-Th isotopic compositions measured using MC-ICP-MS (Finnigan NEPTUNE). The dating results showed that the upper part of FG01 was deposited during Holocene and the lower part of FG01 and FG02 were during the Late Pleistocene (mainly 21-30 ka).

The oxygen isotopic record in FG01 is considered to reflect rainfall amount, meaning that heavier rain has lower oxygen isotopic ratio. This was supported by oxygen isotope of rainwater in Toyama and the rainfall record over the past 90 years in Takada, SW Niigata Prefecture. With the relatively stable value from Hendy Test, it can be considered that the isotopic equilibrium has been maintained between the cave drip-water and precipitated calcite.

Two factors are considered to have affected oxygen isotope of FG01. First is the Asian Winter Monsoon (AWM). The isotopic trend of FG01 is different from that of the stalagmite collected in Dongge Cave, SW China. This is because of the difference in dominant moisture source. Rainfall in Southern China is mainly brought by the ASM, of which intensity is recorded in the stalagmite oxygen isotope. On the other hand, climate in Niigata is largely influenced by the AWM leading heavy snowfall, so the stable isotope of the Itoigawa stalagmites probably reflects its strength. The isotopic profiles of FG01 show an inverse correlation with that of Dongge Cave between 4500 and 1000 year B.P. This suggests that the two monsoons worked inversely with each other during the period. However, the inversed trend was not observed in the older period that includes the Holocene Climate Optimum. Moreover, isotopic value of FG01 tends to decrease during this warm period. This is opposite to the general expectation in the warming climate: AWM and winter snowfall likely decreased and stalagmite oxygen isotope increased. Therefore, the second factor, the Tsusima Warm Current (TWC), may affect the stalagmite oxygen isotope in Fukugahuchi by providing moisture to cold-dry air of AWM. Indeed, the abundance of Dictyocoryne spp, dominant species in TWC, in the Holocene core sediment from offshore of Oki Island is well correlated with the isotopic curve of FG01. This indicates that the intensified inflow of Tsushima Current in early Holocene increased winter rain and snowfall in the Japan Sea side.

Keywords: stalagmite, Holocene, climate change

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Millennial-scale surface water property change in the southern Japan Sea during the Marine Isotope Stage 3

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The deep sea environment in the glacial Japan Sea was more sensitive to surface climate change than today because of semi-closed situation due to sea-level low stands. The hemipelagic sediments in the sea are characterized by alternations of bioturbated, organic-poor light layers and finely laminated, organic-rich thin dark layers during the Marine Isotope Stage (MIS) 3. Such sedimentological evidence indicates drastic changes in bottom oxygen level during MIS3. Two possible mechanisms that explain depleted oxygen in bottom water are suggested. First, the dissolved oxygen consumption in bottom water was increased by high productivity due to upwelling. Second, the supply of dissolved oxygen to bottom water was decreased due to enhanced density stratification. These should be quite different situations in terms of surface water density structure. However, there are a few surface water property records at this time.

Here we conducted d18O and Mg/Ca analyses of planktonic foraminifera for a radiocarbon-dated sediment core KR07-12 PC3, which is taken from intermediate depth (329 m) of the southern Japan Sea. Sea surface temperature (SST) and d18O of seawater (d18Osw), which is a proxy of salinity, were reconstructed to reveal variations of surface water property during the MIS3. Results clearly showed millennial-scale surface environmental change. Reconstructed SST ranges from 4 to 9 degreeC which is much lower than modern SST (seasonal range: 11 to 26 degreeC) at the core site. Variations of SST and d18Osw were positively correlated (r = 0.78).

This positive correlation can be regarded as a mixing of two distinct water masses of high SST, d18Osw and low SST, d18Osw. The only one current of warm and saline water flows into the Japan Sea today is the Tsushima Warm Current (TWC). Therefore, the alternation of high SST, d18Osw and low SST, d18Osw during MIS 3 is explained by periodic changes in the strength of TWC inflow. This is consistent with planktonic foraminiferal assemblage in the East China Sea (ECS), which indicates the alternation of two water masses, Kuroshio-related water and coastal water. The millennial-scale variation of the TWC inflow into ECS and Japan Sea played an important role in determining surface water density.

Keywords: sea surface temperature, marine isotope stage 3, Japan Sea, planktonic foraminifera, Mg/Ca thermometry

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Indian monsoon variations obtained from Lonar crater lake in the Deccan Plateau, India

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Indian monsoon is an important component of the Earth's climate system to understand regional and global climate dynamics. Various geological archives including marine sediment records from Indian Ocean reveal evolutions of the monsoon (e.g. Clemens and Prell, 2003) yet, few reconstructions are available from the Indian sub-continent. Therefore, we study geology of Lake Lonar in the Deccan Plateau, India. Lonar crater is one of the best-preserved impact structures on Earth and there is a saline lake with depth of 6 m in the center of the crater (Maloof et al., 2010). The crater cavity is filled with breccia overlain by 30 to 100 m of unconsolidated sediment (Fudali et al., 1980). 40Ar/39Ar step heating experiments of the Lonar crater melt rocks yielded a precise and statistically robust combined isochron age of 570 +/- 47 ka (Jourdan et al., 2011). This suggests that Lake Lonar sediment can possibly provide the records of Indian monsoon for the last 500,000 years or more.

Keywords: Lake Lonar, Indian monsoon, crater

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Climate simulation of the last millennium: some notes on comparison with proxy-based reconstructions

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Coordinated simulations of the last millennium climate are being organized in the WCRP-CMIP5/PMIP3 framework for coupled atmosphere-ocean general circulation models and in a community-based framework for earth system models of intermediate complexity. The authors participate in both, and carried out several experiments. An increasing number of model output becomes available widely to the community. While the direct comparison between reconstructions and model simulations is tempting immediately after the data become available, there are several issues that have to be considered. Difficulties arise from the relatively weak forcing and consequent small ratio between externally-forced climate change and unforced (time-invariant forcing) internal variability. We argue that useful comparisons can be made by 1) first distinguishing externally-forced ”signal” and internally-generated ”noise” using both forced and unforced simulations; 2) extracting the ”signal” with ensemble simulation; and 3) running the model separately with individual forcings. Examples will be presented for variations in the Northern Hemisphere and Greenland temperature.

Keywords: last millennium, simulation, PMIP

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Construction of tree-ring cellulose oxygen isotope chronology in central Japan during last millennium

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<<Introduction>> So far, most of high-resolution paleoclimate reconstructions in Japan have been restricted after 17th century and climate changes in Middle Age of Japan (11-16th centuries) have not been clarified well although numerous famines and warfare occurred at that time. Because tree ring samples can be recovered even from the Middle Age as old architectural wood and excavated archaeological wood, we may create millennium scale of tree-ring chronologies including the Middle Age. In this study, we focus on the tree-ring cellulose oxygen isotope ratios which demonstrate similar inter-annual variations among different species and individuals, reflecting summer hydroclimate. We construct nearly millennium length of its chronology in central Japan and discuss its chronological, climatological and historical significances.

<<Material and Methods>> In this study, we analyzed three wood samples. (1) Cypress tree cut in 1960s at Nakatsugawa, Gifu (810 rings, Nagoya University Museum), (2) Cedar tree collapsed in October, 2009 at Ise, Mie (481 rings, Ise-Jingu Shrine), (3) Cypress old architectural wood at Okuwa, Nagano (351 rings, Chiko-Ji Temple). Each wood sample was cut into 1mm thickness of thin plates and directly applied for chemical treatments for cellulose extraction. After separation of each year ring under binocular microscope using a design knife, the cellulose fragment was wrapped by Ag foil in duplicate for each year ring and applied for oxygen isotope measurement using TCEA/IRMS (Xu et al., 2011). Among the three samples analyzed, the radiocarbon measurements of sample (3) have revealed that it was living during 11-14th centuries. Although we have known the felling years of sample (1) and (2), those samples were applied for cross dating together with sample (3) by comparison of their tree-ring cellulose oxygen isotope time-series with those of a cedar tree at Uda, Nara and two cypress trees at Agematsu, Nagano whose calendar years have been fixed by traditional dendrochronological methods as 1611-1756 AD (Yamaguchi et al., 2010) and 1730-2005 (Nakatsuka, 2010), respectively.

<<Results and Discussions>> First, we compared the data from sample (1) with those of cedar at Uda, Nara and cypress at Agematsu, Nagano and found very good matching periods (r=0.62 ($p=9.98\times10^{-12}$) and r=0.57($p=7.22\times10^{-14}$)), indicating that sample (1) corresponds to the period from 1121 to 1930 AD. Second, we made the isotopic time-series of sample (2) overlap those of sample (1) and cedar at Uda, Nara, resulting in highly matching periods (r=0.44 ($p=1.23\times10^{-10}$) and r=0.57 ($p=7.89\times10^{-11}$)), and confirmed that the innermost ring of sample (2) corresponds to 1529 AD. Third, the living period of sample (3) was determined by comparison of its oxygen isotope time-series with those of sample (1) (r=0.66 ($p=3.14\times10^{-22}$), so that it covers from 1034 to 1384 AD which coincides with the 14C age. The high correlations of tree-ring oxygen isotope time-series among all different species and locations not only suggest that the time-series reflect past summer hydroclimate but also indicate an fact that the time-series of tree-ring oxygen isotope ratios from 11th to 20th centuries can be applied for annually resolved dating of any wood samples of any species from last millennium in central Japan.

The time-series of tree-ring oxygen isotope ratios of sample (1) shows large variability with 50-120 yrs periodicities during 12-16th centuries, suggesting the potential linkage between climate changes and social upheaval during the Middle Age in Japan. The multi-decadal variations during 13-14th centuries coincide well with those of oxygen isotope time-series of stalagmite in China and India (Zhang et al., 2008; Berkelhammer et al., 2010), indicating that the large variability of tree-ring oxygen isotope ratios in central Japan reflects the variations of summer monsoon activity, covering all over Asia including Japan, China and India.

Keywords: tree ring, cellulose, oxygen isotope, dating, central Japan, middle age

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Carbon and Oxygen Isotopic Variation over the Last 1000 Years of a Stalagmite from West Java, Indonesia

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Equatorial region are important because of driving global atmosphere circulation. Though climate changes during the past few millennia have been reconstructed using stalagmites and lake sediment recently, there are only a few high resolution (especially annual- to centennial-scale) paleoclimate records in equatorial region. Stalagmites provide continuous paleoclimate records in land and are dated accurately by U-Th dating. For that reason many studies use oxygen and carbon isotope ratios of stalagmites as paleoprecipitation proxies (e.g. Zhang et al., 2008; Jex et al., 2011).

This study aims to reconstruct variation of past precipitation in Asian equatorial region by analyzing carbon and oxygen isotope ratios (d13C, d18O) from the annually laminated stalagmite CIAW15a, which is obtained from Ciawitali Cave in West Java, Indonesia. Watanabe et al. (2010) reveals d13C and d18O of CIAW15a is affected by kinetic fractionation occurring in the cave and proposes the possible process that d13C and d18O of CIAW15a record variation in local precipitation amount through kinetic process in the cave. Based on the previous study, this study did the following things:

(1)d13C and d18O time series of CIAW15a are compared with instrumental precipitation data and evaluated as proxies to reconstruct past precipitation.

(2)Annual d13C and d18O are analyzed along the growth axis following Izutani (2010), and precipitation before instrumental observation is reconstructed.

d13C and d18O are dated using the average thickness of the uppermost 106 layers. We compared temporal variation between precipitation data and isotopic data of the stalagmite CIAW15a dated using the average thickness of 44.8 micrometer. There are significant negative correlations. Further analysis reveals that d13C and d18O of CIAW15a have high correlations with precipitation amount in rainy season (December-April).

SOI (Southern Oscillation Index), which is an index of ENSO (El Nino/Southern Oscillation), shows no significant correlation with d13C and d18O of CIAW15a. In this region ENSO has high correlation with precipitation in dry season (June-October), while d13C and d18O reflect precipitation amount in rainy season (December-April). Therefore, it supposes that ENSO was not recorded clearly in d13C and d18O variation.

Annual d13C and d18O of CIAW15a were analyzed over the last 1000 years. d13C and d18O are dated using U-Th age model. d13C and d18O variations are synchronous in 10-30 year order during the last 600 years, indicating that they reflect kinetic processes in the cave relating to variation of local precipitation amount. Higher d18O (d13C) of CIAW15a in AD 1425-1625 and 1760-1800 are consistent within age error with periods of droughts recorded in lake sediment from East Java (Rodysill et al., 2012; Crausbay et al., 2006).

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APE33-P13 Room:Convention Hall Time:May 24 17:15-18:30

Comparison of Stable Isotope Time Series of Stalagmite and Meteorological Data from East Java, Indonesia

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Speleothems continuously grow up and can be accurately dated by U-Th disequilibrium. Because of these characters, in recent years, speleothems attract attention of scientist as geological materials from which a paleoclimate is reconstructed.

Climatic phenomena of the Southeast Asia equatorial region affect climates all over the world (e.g. El Nino-Southern Oscillation). However, there are only a few paleoclimatological studies using speleothems in the region. These preceding studies have an agreement that precipitation is the factor of stable isotopic variations on stalagmites. However, they disagree about stable isotope fractionation and process controlling d18O and d13C values of stalagmites. Each stalagmite may have individual stable isotope fractionation and individual process controlling d18O and d13C values of the stalagmite.

In this study, firstly, we constructed a high-resolution age model by comparing the U-Th disequilibrium age with the counts of the bandings in the stalagmite BRI09a, which was collected in Bribin Cave, East Java, Indonesia. Secondly, we checked for equilibrium vs. kinetic fractionation on the stalagmite BRI10a, which was collected in Bribin Cave, East Java, Indonesia. Thirdly, we compared d18O and d13C values of the stalagmite BRI10a with instrumental precipitation data on Yogyakarta, Indonesia, in order to judge whether its d18O and d13C variation are proxies of paleo-precipitation.

We constructed a high-resolution age model by comparing the U-Th disequilibrium age with the counts of the bandings in the stalagmite BRI09a. U-Th disequilibrium age of the stalagmite BRI09a was 1038+/-52 yrs. The result of bands counting of the stalagmite BRI09a was 879+/-10 layers at the top of the dated section and 1018+/-38 layers at the base of the dated section. In the thin section of the stalagmite BRI09a, We did not observe hiatus and, when we collected the stalagmite BRI09a, it was growing. These results suggest that the growth layers of BRI09a are dominantly annual. However, the top edge of BRI09a in thin section may be chipped, because of difference between U-Th disequilibrium age and the result of bands counting.

For oxygen and carbon stable isotope time series determinations of the stalagmite BRI10a, in which we constructed a high-resolution age model (Fukunaga, 2010, graduation thesis), 70 samples collected along the growth axis on the stalagmite BRI10a was analyzed using a mass spectrometer. d18O and d13C variations of the stalagmite BRI10a have the good correlation ($R=0.75$, $p<0.01$). d18O and d13C values of the stalagmite BRI10a are higher than an estimated d18O and d13C values from the drip water on the supposition that equilibrium fractionation occurred on the stalagmite BRI10a. These results suggest kinetic fractionation with CO2 degassing.

d18O and d13C variations of the stalagmite BRI10a show the good correlation with precipitation in rainy season on Yogyakarta ($R=-0.59$, $p<0.01$, $R=-0.44$, $p<0.01$). Oxygen and carbon stable isotope time series of the stalagmite BRI10 were proxies of local precipitation. However, SOI and NINO-4, which are El Nino-Southern Oscillation index, do not show the good correlation with d18O and d13C variations of the stalagmite BRI10a because of the difference of the season in which precipitation show correlation with them. Accordingly, oxygen and carbon stable isotope time series of the stalagmite BRI10 were not good proxies of SOI and NINO-4.

We constructed a high-resolution age model in the stalagmite BRI09a and showed that d18O and d13C variations of the stalagmite BRI10a are useful proxies of local precipitation. We will be able to compare between d18O and d13C variations of two stalagmites, BRI09a and BRI10a which were collected from the same cave. After this study, a comparison between two stalagmites, BRI09a and BRI10a will advance our knowledge of stable isotope variations of stalagmites and relation between stable isotope variations of stalagmites and precipitation.

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Relationship between modern speleothem formation and surface weather in Southeast Asian equatorial cave

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To predict future climate change and prepare it is large scientific and social problem. For precise climate prediction, it is necessary to reconstruct high time and space resolution paleo-climate (especially past 2000 years) by paleo-climate proxies and reflect the result to climate model. Equatorial Southeast Asia, where include Indonesia, is well affected by El Nino Southern Oscillation (ENSO). ENSO do not only directly affect to precipitation in tropical Southeast Asia, but also significantly affect to middle and high latitude climate through heat transport (Hastenrath, 1991). However, continuous paleo-climate data in that area is few (IPCC, 2007), thus paleo-climate reconstruction is particular necessary.

Speleothems are useful as a pleo-climate proxy because they are grown continuously in cave (Fairchild et al., 2006). Watanabe et al. (2010) revealed that oxygen and carbon isotopic ratios in the stalagmite calcite are useful as an effective proxy of ancient precipitation, because annual precipitation amounts have negative correlation with delta ^{18}O and delta ^{13}C values in stalagmite sample. However, relationship between modern speleothem formation and surface weather (e. g. recording mechanism of precipitation in stalagmites, how large or in which season precipitation is recorded in) is not revealed clearly. Thus, cave monitoring studies (cave and surface climate, dripwater chemistry, modern speleothem growth experiment) are starting actively (e. g. Boch et al., 2011; Tremaine et al., 2011). But, few are studied in equatorial region.

Baldini et al. (2008) revealed that seasonal airflow direction change, which was driven by seasonal air temperature difference fluctuation between cave and surface, fluctuated cave air CO_2 concentration, and that might influence delta ^{13}C in stalagmite. Tremaine et al. (2011) revealed that seasonal cave air CO_2 concentration variation fluctuated CO_2 degassing rate from dripwater, and then produced seasonal variation of speleothem precipitation rate. However, these were studied in temperate region. In equatorial region, it is predicted that intra-daily variation of cave air CO_2 concentration is main cause which fluctuate growth rate and stable isotope composition, because it is considered that cave airflow direction is dominated by intra-daily surface air temperature fluctuation rather than seasonal.

Thus, in this study, cave monitoring, which included surface meteorological observation (air temperature, precipitation and delta ^{18}O), cave meteorological observation (air temperature, airflow direction and speed and CO_2 concentration), chemical analysis of dripwaters (pH, Ca^{2+} concentration, HCO_3^- concentration, partial pressure of CO_2 ,calcite saturation index, delta ^{13}C, and delta ^{18}O) and speleothem growth experiment (growth rate, delta ^{13}C, and delta ^{18}O), is started from October 2011 in Petruk Cave, Central Java, Indonesia. High time resolution monitoring (2 hour interval) is conducted in addition to 1 to 3 month interval monitoring which is generally conducted in temperate caves. Aim of this study is to reveal relationship between speleothem formation (growth rate and stable isotopic composition) and surface weather in equatorial cave through obtain time series monitoring data and compare them mutually.

Keywords: cave, stalagmite, carbon dioxide concentration, dripwater, equatorial region, Indonesia

Japan Geoscience Union Meeting 2012
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APE33-P15 Room:Convention Hall Time:May 24 17:15-18:30

Temporal variation of mineral composition in the drainage area of the Ohno River, Ohita, Japan

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The Ono River is located in the northeast Kyushu Island, which has the head water region at the Mt. Kuju and Mt. Aso, flows eastward combining some tributaries from the south, and then flows northward to the Beppu Bay. Surface geology of the drainage area is roughly divided into two as andosol in the northeast and brown forest soil in the south. Such contrasting detrital provenances could provide a variety of grain composition to the marine sediments deposited in the Beppu Bay. The No. 5 boring core was drilled at a landfill site on the mouth of the Ono River. The core continuously recovers 97 m length and consists of Holocene marine sediments. The variety of the sediment facies would give us a good opportunity to reconstruct the terrestrial environment of hinterland (the Ono River Basin) through the detailed analysis of the detrital mineral composition.

Detrtal fraction contained in marine sediments can be generally used as climate proxies because variations in provenance and mineralogy could be affected by the precipitation distribution and weathering intensity. Change in the surface soil composition could be observed if a well-preserved depositional soil sequence was found. In order to detect the change in provenances and interpret the terrestrial environment using detrital proxies in the marine sediments, it is necessary to know the variability or range of the mineral composition of a particular provenance during the targeted time periods. Fortunately, we found a suitable soil sequence on the foot of the Mt. Kuju at 850 m altitude, which covers the similar time interval as the No.5. The soil sequence consists of brown loam overlain by the alternation of tephra and andosol. We tried to compare the variations in mineral compositions both for this soil sequence and the No.5 core since about 8,000 yrs age.

We conducted a powder X-ray diffraction analysis (XRD) and color (visible light reflectance) measurement to determine the major mineral composition. Used samples were extraction residues by organic solvent, which were dried and powdered before XRD and color measurement. Major minerals were identified and evaluated semi-quantitatively using the height of their diagnostic peaks. The sediment color was examined through $L*$, $a*$, and $b*$ indices.

The No. 5 core mainly consists of smectite, illite, chlorite (or kaolinite), amphiboles, quartz, feldspars, and amorphous materials with minor calcite. Amorphous material is supposed to mainly consists biogenic opal. Amorphous material is higher during 7000 to 3500 yrs BP which suggests the decrease in detrital input due to the Jomon transgression. All the detrital minerals show opposite variation. The detrital mineral composition such as quartz / feldspars ratio is higher during 0 ? 2000 yrs BP and before 7000 yrs BP which suggests a change in terrestrial condition. On the other hand, The Mt. Kuju soil sequence (KSS) mainly consists of smectite, illite, chlorite (or kaolinite), amphiboles, quartz, felspars, and amorphous materials assoiated with gibbsite. Amorphous material is supposed to mainly consists volcanic glass. Crystalline minerals such as smectite, illite, chlorite, and quartz are higher in loam (up to 7000 yrs BP), and quartz increases at the top andosol of the KSS (after 3000 yrs BP). Volcanic glass began to increase just before quartz decreased at about 7000 yrs BP when feldspars increased alternatively. Quartz / feldspars ratio both in terrestrial soil and marine sediment, which show lower value between 3000 and 7000 yrs BP, suggests that the change in surface soil composition could affect the mineral composition of the marine sediments.

Keywords: Ohno River, Mt. Kuju, Beppu Bay, Soil, Mineral composition

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APE33-P16 Room:Convention Hall Time:May 24 17:15-18:30

Last 100ka biogenic silica content variation in Lake Biwa, Japan and its factors

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Biogenic silica content (BSC) variation during the last 100ka has been clarified by using molybdenum-yellow method. Samples analyzed were taken at Off-Takashima Drilling Site of Northern Lake Biwa and the time resolution was less than 100 years.

Biogenic silica is one of the main components of diatom frustules and its content variation is regarded as to reflect primary production changes in lakes. Production rate of diatoms is influenced by temperature and precipitation during blooms. Consequently, BSC is used as one of good indicators of climate change at Lake Baikal and Lake Malawi, for example.

Result of frequency spectrum analysis shows good correlation of BSC variation to that of Milankovitch precession cycle and obliquity cycle and the result of shorter term frequency spectrum analysis showed that of ocean circulation and solar activity.

BSC of Lake Biwa also shows short term variation lasting decades to centuries. These variations can be correlated to those of Chinese Interstadials and Greenland Interstadials.

Keywords: Lake Biwa, biogenic silica, interstadials, molybdenum-yellow method

Japan Geoscience Union Meeting 2012
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APE33-P17 Room:Convention Hall Time:May 24 17:15-18:30

Last 120ka to 250ka climate changes as deduced from the biogenic silica content of Lake Biwa, central Japan

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The aim of this study is to clarify historical variation of primary production rate through measurement of biogenic silica content (BSC) in lake sediment using molybdenum-yellow method. Samples analyzed were taken at Off-Takashima Drilling Site in 1986. As a part of our research aiming at clarifying variation of primary production history during the last 250ka, BSC analysis was carried out regarding the last 120ka to 250ka, which corresponds to MIS 6 to 8, with a time resolution ca. 400 years.

The result shows good peak correlation to those of delta O18 at Sanbao/Hulu stalagmite record, which mean Chinese Interstadial Number (CIS) B1 to B24. Result of frequency spectrum analysis using SPECTRUM shows good correlation of BSC variation to that of Milankovitch precession cycle of 23kyr and 19kyr which are also recognized during the last 140ka. Short term frequency spectrum analysis using REDFIT 3.8e was applied to BSC variation of kilo year cycles, which recognized 5 cycles, namely, 3.4, 2.3, 1.5, 1.2 and 1.0kyr cycles with more than 95 % confidence level. These periodicities have also been confirmed in the Off-Takashima drilling sample during the last 120ka which mean that those periodicities have affected climatic changes of central Japan during the last two glacial cycles.

Keywords: Lake Biwa, Biogenic silica content, climate change, sediments, periodicity

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APE33-P18 Room:Convention Hall Time:May 24 17:15-18:30

Lake-level change history estimated by acoustic record and their factors during the last 45,000 years in lake Nojiri

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Acoustic stratigraphic analysis of acoustic records obtained by Uniboom revealed that lake-level change repeated eight times in lake Nojiri, central Japan, during the past 45,000 years. Comparison of the lake-level record with a profile of pollen composition, TOC concentration changes both in lake Nojiri, oxygen isotope record of NGRIP and those of Sanbao/Hulu caves, show the lake level rose during cold stages and the lake level fell during warm stages. Especially, high lake levels correspond with the global cooling events such as Younger Dryas, Heinrich events and Bond events. The factors for the lake-level rise during cold stages are, decreased evaporation due to cooling and increased snowfall due to enhanced winter monsoon. The factors for the lake-level fall during warm stages are, increased evaporation due to warming and decreased snowfall due to weakened winter monsoon. Grain-size profile of loesses from Loess Plateau corresponds well with that of intensity of winter monsoon deduced from lake-level record.

Keywords: Lake Nojiri, lake-level fluctuation, acoustic record, cold event, snowfall, winter monsoon

Japan Geoscience Union Meeting 2012
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A 28-kyr record of environmental change in NE Japan inferred from the Lake Ichi-no-Megata sediments

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Continuous geochemical data of 37-m thin laminated sediment core from Lake Ichi-no-Megata (maar), northeast Japan provides a 28,000-year history of the response of the lake and its surroundings to global climate change in the northeastern Japan. Principle component (PC) analysis of 17 major and trace elements in the bulk sediment samples indicated that PC-1 score (explain 46.1% of all chemical variables) may reflect the paleo lake productivity and detritus inputs from the surrounding area caused by monsoonal-climate change. We interrupt this correlation that warm and humid climate leads to the high stand of lake productivity and the low input of detritus minerals when the PC-1 score is low (negative), and the vice versa.

On the other hands, seventy four AMS 14C dates enabled us to establish the detailed chronology agreed well with tephrostratigraphy. The event-free composite depth versus calendar plots indicates a stable deposition environment since after 28,000 cal yr BP.

In the last glacial after 28,000 cal yr BP, the PC-1 score has fluctuated with millennial scale and temporally increased at the periods of 27, 25-24, 22-21, 19-18, and 16 cal kyrs BP. These climate cool/dry events could be compared with the stadials in the North Atlantic region such as the Heinrich events.

During the last glacial-interglacial transition (the LGIT, 15-9 ka), the PC-1 score began to became negative gradually at 14,500 cal yr BP, that means the onset of the B/A warming interstadial. After that, the score temporally increased between 12,100 and 11,200 cal yr BP. This temporal climate deterioration seems to be the Younger Dryas (YD) stadial. However, the YD term is not simultaneous compared with the records in the North Atlantic region as well as the affected area of Asian monsoon activities and the Westerlies as China and Japan. It needs to discuss more about it.

In the Holocene, one large change of the PC-1 score was occurred at 1,100 cal yr BP. Compared with the pollen data on the same core, this change may be caused by the human impacts to the lake surrounding area that are forest tree cutting to make buildings. Except this, the score has fluctuated with millennial scale, suggested that Holocene climates in the northeastern may have fluctuated caused by a solar activity.

Keywords: Major and trace elements, Principal component analysis, Lake Ichi-no-Megata, LGIT, human impacts, monsoonal-climate change

Japan Geoscience Union Meeting 2012
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APE33-P20 Room:Convention Hall Time:May 24 17:15-18:30

Geomorphological evolution and environmental variation after a deglaciation in the highland of central Peru

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We attempt to reconstruct past environment after deglaciation by using a glacier lake on the central Peru. For this, we had undertaken field investigation as echo sounding and piston coring at Lake Yauriuiri, 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 bedrooks. 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 with multiple radiocarbon dating for the whole core section. Our preliminary results indicated two cyclic variations of $L*a*b*$ values, magnetic susceptibility, suggesting that past lake level fluctuation over the last 2,000 years caused by climate changes. These past environmental variations in Lake Yauriuiri may have the similar pattern with other records in inland area of Peru as well as off shore Peruvian marine records.

Keywords: Peru, glacier lake, climate change, echo sounding, Nazca

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Environmental history and flood events during the last 80 years in Lake Marunuma, Gunma Prefecture, Japan

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Lake sediments are, in general, regarded as to preserve environmental history of lakes and their surroundings. Recent studies clarified the existence of lake level change, climate change, floods, tsunamis and earthquake records in sediments. This study restores the existence of flood record, which occurred during the last 80 years, at lake Marunuma of Gunma prefecture.

Older Marunuma was a small lake formed after damming up by lava flows of Nikko-Shirane volcano and its initial diameter was ca. 600m. After the construction of artificial dam in 1930, lake level rose 28m higher.

In addition to the bottom surface sediments taken at all lake area, two short cores were taken at older lake bottom. Samples were described based on naked eye observation, soft-X ray photographs were taken, water content was measured at every 1cm in thickness and grain-size was measured using Mastersizer 2000 of Malvern Instruments Co. also at 1cm interval.

We distinguished flood sediments as to having coarser grain size, lower water content and lower transparency of soft-X ray photos. Statistically significant difference in grain size existed between normal sediment and flood sediments. Sedimentation rate was calculated as 0.2cm per year assuming that the sediment depth which shows minima of grain size and water content to be AD1930, when artificial dam was constructed. Time resolution of the record is ca.5 years based on sampling interval.

Comparison of meteorological events and ages of event sediment shows that five events of large flood can be correlated during the last 80 years. This means that sedimentary record of Lake Marunuma well correlates to those historical flood events at lower Tone River.

Keywords: Lake Marunuma, Event sediment, Flood events

Japan Geoscience Union Meeting 2012
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APE33-P22 Room:Convention Hall Time:May 24 17:15-18:30

Vegetation and paleoenviroment during the Last Glacial around the border of Musashino and Yodobashi Uplands, Tokyo

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Peaty deposits around the Last Glacial Maximum (LGM) were cropped out from Site A of Tachikawa terrace (the construction site of 9th building), in the College of Humanities and Sciences, Nihon University. The vegetation history of this outcrop around AT tephra was investigated on the basis of pollen analyses.

About 32,000 years ago, in the vicinity of the investigated area, swamp woods of Alnus were dominant, accompanying conifer and cool-temperate-subarctic deciduous broad-leaved trees in swampy land and upland. It became a little warmer at about 30,000 years ago, the conifer and the cool-temperate subarctic deciduous broad-leaved trees decreased, and temperate to cool-temperate deciduous broad-leaved trees increased instead. Then, the climate became colder toward LGM and the cool- temperate subarctic conifer increased. The commencement of cold climate was shortly before AT tephra fallout.

The pollen diagrams of this site and another site of neighboring Sakuragaoka High School, Nihon University show continuous vegetation change before and after AT tephra. Moreover, those were compared with those of the Nogawa peat, the Shimo-Oshima peat and Kashima IMAGES core, including AT tephra. At a result, the cool-temperate- subarctic conifer forest began to increase shortly before AT tephra, and those were strongly increased shortly after the deposition of AT tephra. This cold phase corresponds to LGM.

Another site B, boring core samples were taken from Musashino Upland in the College of Humanities and Sciences, Nihon University. In this site, the formations of Tachikawa Loam, Musashino Loam, and the uppermost part of Shimosueyoshi Loam are overlying gravel layer. Among these formations, some peaty horizons are included. Therefore pollen analysis for this core may be a good example for clarifying the vegetation history for the past 100,000 years, especially early to middle of the Last Glacial Period.

From the result of pollen analysis, Alnus was dominant in the depth of 6 m peaty deposit, but Cryptomeria japonica was dominated around the depth of 8 m. And also, Hemiptelea which existed in MIS5 and maybe before LGM in Japan was found at the depth of 5 m. The vegetation history of the site B is examined in more detail to clarify climatic and environmental change during the last 100,000 years in eastern part of Musashino Upland.

Keywords: Musashino, Last Glacial Period, pollen, vegetation change, Japan

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APE33-P23 Room:Convention Hall Time:May 24 17:15-18:30

Depositional environment changes during the last 20000 years based on carbon and nitrogen around the Okinawa Island

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In order to reconstructing the depositional process after last glacial maximum (LGM), we collected two gravity cores located in the eastern (GH08-2004) and western (GH10-2013) area of Okinawa Island and analyzed Total organic carbon (TOC), Total nitrogen (TN), Total inorganic carbon (TIC), ratio of TOC and TN (C/N ratio). TOC and TN of GH08-2004 show increases toward 14000 cal BP from 26000 cal BP and then decreases toward 7000 cal BP. C/N ratio shows a decrease toward 7000 cal BP from 14000 cal BP. TIC decrease between 8000-12000 cal BP, and then rapidly increase toward 3000 cal BP. While, TOC and TN of GH10-2013 decrease toward 5000 cal BP from 14000 cal BP and then increases toward the present. C/N ratio decrease to 8 from 10 during 9000 to 11000 cal BP and after that, increase toward 9 with frequent variations between 8 and 10. TIC values increase to 5% from 3.5% between 4000 and 8000 cal BP.

Variations in TOC, TN, C/N ratio and TIC indicate that the supply of terrestrial organic matter increased during the sea-level lowstand of LGM and then amount of deposited in calcium carbonate from bioclasts increased accompanying with sea-level rise in a broad way. Increase in C/N ratio of GH10-2013 after 9000 cal BP implies that terrestrial organic matters frequently supplied from surrounding islands.

Keywords: Organic carbon, C/N ratio, Inorganic carbon, sediment, sea-level change, Okinawa

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APE33-P24 Room:Convention Hall Time:May 24 17:15-18:30

Paleoceanographic study of submarine cave with air-chamber

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A submarine cave named Ginama cave is located on the northwestern coast of Hedo Point, Okinawa Mainland, Japan. The entrance of the cave lies about 16 m deep. The cave is about 40 m long and ascends until it reaches sea level, thus forming a closed air-chamber at its farthest extension. We measured water temperature and salinity in the cave at 14 October 2011 and collected sessile fauna on the wall with a hammer and chisel. The humidity is almost 100 percent at the air-chamber, because we could see our breath. This implies that the formation of speleothems may be stopped within the air-chamber. Salinity increased from 11.7psu at water surface at the air-chamber to 32.9psu at 11m depth. Skeletal shells of cave-dwelling bivalve Pycnodonte tanighchii and coralline sponges Acanthochaetetes wells and Astrosclera willeyana were collected at the wall between 2 and 7 m depth. On the other hand, the living individuals of coralline sponges are observed at the cave wall below 11 m depth.

Keywords: submarine cave with air-chamber, sessile fauna, environmental changes, Okinawa

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Oxygen isotopic composition of the Bering Sea bottom water during the Last Glacial Maximum: constraints from pore water

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1.Introduction

North Pacific Intermediate Water (NPIW) is defined as the salinity minimum water at depths of 300-800 m in the North Pacific Ocean. Today, the main origin of NPIW is thought to be Okhotsk intermediate water, which is formed by brine rejection during the sea-ice formation on the continental shelf in the Okhotsk Sea in winter (Yasuda, 1997). Studies of microfossil assemblages such as foraminifera and radiolaria suggest that during the Last Glacial Maximum (LGM) NPIW was derived from the Bering Sea (Ohokushi et al., 2003; Tanaka and Takahashi, 2005). However to date, no quantitative evidence (for example, salinity, temperature, or isotopic composition data for water) directly indicates past changes in NPIW sources.

In this study, we reconstructed the distribution of oxygen isotopic compositions of bottom water between 1008 m and 3173 m water depth at the Bering Sea shelf break and Bowers Ridge during the LGM on the basis of the vertical profiles of oxygen isotopic composition in pore waters from International Ocean Drilling Program (IODP) Sites U1339, U1341, U1343, U1344, and U1345. We expect that the reconstructed distribution of oxygen isotopic compositions is a clue to discuss the past changes in NPIW sources.

2. Method

For oxygen isotopic composition measurements, pore water was analyzed by using a stable isotope ratio mass spectrometer (IRMS) (GV IsoPrime, UK) with an automated CO2-H2O equilibration system. Each analysis was performed on a 200-ml water sample. The results for each sample are averages of duplicate analyses.

3. Model

We used a model approach reported from that of Schrag and DePaolo (1993) and following studies (Schrag et al., 1996; 2002; Paul et al., 2001; Adkins et al., 2002; Malone et al., 2004) estimating the glacial-interglacial change in oxygen isotopic composition (delta value) by fitting the numerically simulated depth profile of pore water oxygen isotopic composition to the observed oxygen isotopic composition peak of pore water at 25-45 meters below the seafloor (mbsf), associated with the last deglaciation.

We modeled the oxygen isotopic composition of pore water profiles above 200 mbsf in 50-cm increments by using the one-dimensional diffusion/advection tracer equation. The absolute magnitude of changes in the oxygen isotopic composition of bottom water to input into the model is set as a function of the spliced the benthic foraminiferal oxygen isotopic composition records fixed relative to the magnitude of the oxygen isotopic composition since the LGM.

4. Results

The pore water profiles from all sites showed the expected pattern of isotopic peak left from the LGM bottom water. The oxygen isotopic compositions increased over the first 25-50 m below sea floor (mbsf), followed by a decrease. The oxygen isotopic compositions deeper than 150 mbsf from the Sites U1343 and U1344 increased with increasing depth. The increase of the oxygen isotopic compositions deeper than 150 mbsf may reflect the interaction with clay mineral or advection of fluid from deeper sedimentary column.

Our fit to the data yields the delta values of 0.9-1.0 per mil at Site 1139 (water depth: 1868 m), 1.2-1.3 per mil at Site U1341 (water depth: 2140 m), 0.6-0.7 per mil at Site U1343 (water depth: 1953 m), 0.7-0.8 per mil at Site U1344 (3177 m), and 0.6-0.7 at Site U1345 (water depth: 1008). The globally averaged delta value due to ice volume change since the LGM was estimated as 1.0-1.2 per mil (e.g. Schrag et al., 1996; 2002; Clark and Mix, 2002). The small delta value in the Sites U1343, U1344, and U1345 from the Bering shelf break compared to the globally averaged delta value would reflect the locally decreased oxygen isotopic composition probably due to the low salinity bottom water at the shelf break during the LGM. Thus our result highly suggests that low salinity water sank into deeper depth at the shelf break during the LGM in the Bering Sea.

Keywords: Bering Sea, Last Glacial Maximum, NPIW, oxygen isotopic composition, pore water

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(May 20-25 2012 at Makuhari, Chiba, Japan)

APE33-P26 Room:Convention Hall Time:May 24 17:15-18:30

Paleoceanography of a piston core collected from north Emperor Seamount, northwestern Pacific

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Paleoceanography of a piston core collected from north Emperor Seamount, northwestern Pacific

Keywords: Emperor Seamount, marine core, oxygen isotopic stratigraphy, tephra, IRD

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An attempt to use current permafrost thickness to constrain the Last Glacial Maximum temperature in eastern Siberia

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The thickness of permafrost changes in responding to changing climate conditions. Since this process takes place as a result of thermal conduction from the surface, its response time becomes much longer for thick permafrost, compared with the timescale for climate change (Lachenbruch et al, 1982). The goal of the study is to constrain the ground temperature history using this characteristic of permafrost.

Genral circulation models (GCMs) has been used to calculate LGM climate, prescribing the reconstructed forcing conditions (i.e. orbital patameters, trace gases, topography, etc). Using temperature outputs from those experiments and assuming that the pattern of the climate history over last glacial cycle is basically follows the ice-core based temperature reconstruction, we ran a one-dimensional permafrost model to calculate the temperature profile variation for the north and central Siberia. Here, only spatially averaged characteristics of permafrost, such as permafrost thickness of the region or ground thermal properties, are discussed, to constrain the general temperature pattern over Siberia.

A series of 1-D experiments for ground temperature profiles are conducted to calculate temperature profile history in Siberia over last glacial cycle and to give the present (i.e. 0ka) value of permafrost thickness. The pattern of the climate history is assumed to be same, while the strength in LGM cooling is treated as a parameter for these experiments. Reflecting the long response time, the calculated 0ka permafrost thickness is strongly dependent of LGM temperature condition for such deep-permafrost area, varying from 200m to 600m for given conditions.

1-D ground temperature experiments suggest that strong cooling is required to explain the current deep permafrost thickness in eastern-central Siberia. Results from climate models, in which the difference in surface temperatures between LGM and present are larger in inland Siberia than arctic coast region, are consistent with the present permafrost thickness distribution.

Keywords: permafrost, last glacial maximum, ground temperature, numerical experiment, paleoclimate

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A negative feedback on pCO2 by shelf organic matters

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In the past 800 thousand years and before industrialization, the largest variations in atmospheric CO2 concentration (pCO2) occurred in connection with the glacial cycles that characterized Earth's climate over this period. The mechanisms responsible for the glacial-interglacial pCO2 changes have remained unresolved. One curious feature of at least the last four glacial-interglacial cycles is that atmospheric pCO2 reached about the same upper limit of 280 ppm during peak interglacial periods and about the same lower limit of 180 ppm during peak glacial periods. Here, we show using a numerical model of earth system that enhanced shelf sediment weathering during glacial sea-level low stand tends to raise pCO2 and thus stabilize it from further reduction. This is because not all nutrients from weathering will be utilized by biology but more importantly because the spatial distributions of carbon and phosphate from weathering become decoupled in such a way that carbon is preferentially stored in the upper ocean and phosphate in the deep ocean. This finding, combined with observations of preferential remineralization of phosphate in shelf sediment diagenesis, would predict enhancement of biological production during interglacial high stand and stabilization of pCO2 from further increase. The impact of sea level-driven continental shelf exposure and submersion on CO2 is therefore a negative feedback that may have contributed to limiting the variation of Pleistocene pCO2 to the observed 100 ppm range.

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Multiple steady states of Northern Hemisphere ice sheets and the timing of glacial cycles

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Multiple steady states of Northern Hemisphere ice sheets and the timing
of glacial cycles
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Wax and Wane of large Northern Hemisphere ice sheet occurred in the past few million years, characterized by a transition from a period of 40 thousand years cycle with small amplitude of ice sheet change to 100 thousand year cycle with a large amplitude, known as the Middle Pleistocene transition. Although the characteristics of the glacial cycle is well observed, the mechanism what determines the 100ka cycle and what controls the terminations are still under debate. Here we show that the pattern of the growth of the ice sheets during a glacial cycle follows the hysteresis (multiple steady states) structure of North American ice sheet versus insolation by modelling the three dimensional ice sheet. The 100 ka termination is punctuated by Northern American ice sheet responding basically to the precession cycle and summer insolation through its delayed bedrock depression and the large scale calving. Terminations occur when the summer insolation increases after a minimum eccentricity even under constant CO2 level. Obliquity modifies the role of precession and becomes important for a glacial cycle especially when the eccentricity is small. The North American ice sheet is slightly more favorable for faster growth than Eurasian ice sheet when the ice sheet expands over Labrador and Hudson Bay, and suppresses the growth of Eurasian ice sheet through the atmospheric planetary wave feedback. As a result, the North American ice sheet can have affected the hemispheric climate and punctuated the ice sheet change in Eurasia and in Antarctica through CO2 and sea level change. Furthur we show that a cooling due to, for example, the draw down of long term CO2 level of 20ppm or so at most from 240ppm to 220ppm is enough for a switch from 40 ka cycle response to 100 ka cycle response of Northern Hemisphere ice sheet.

Keywords: ice age cycle, paleoclimate, ice sheet