

Uranium isotope composition changes with past climate changes

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Uranium series nuclides have unique chemical properties and have been widely used for determining the timing of the past climate changes (Edwards et al., 1988; Yokoyama and Esat, 2004; 2011). Rivers supply uranium to the oceans globally with excess ²³⁴U relative to secular equilibrium and ²³⁴U incorporated with coral skeletons can be used for dating. The ²³⁴U abundance in seawater, at the time the coral was growing, can also be measured independently. The reliability of Uranium series dates used in determining past sea-level variations is dependent on selecting pristine corals free from diagenetic alteration. A quantitative test for alteration assumes invariant ²³⁴U abundances in the oceans for at least the past ca. 500 kyrs and results from samples outside of a narrow range in modern ocean ²³⁴U abundance are excluded from data sets. It has been known that this can be constant and thus is able to use rigorous tests for diagenesis of corals. We combined data obtained from uplifted coral terraces in Papua New Guinea with previously reported values. A systematic trend emerges indicating shifts in the ²³⁴U/²³⁸U ratio at times of major glacial?interglacial transitions that involve large variations in sea-levels (Esat and Yokoyama, 2008; 2010). From last glacial to Holocene, the rate of change in ²³⁴U/²³⁸U is approximately 1 permil per thousand years. In this presentation, we introduce potential mechanism to explain these variations, which is closely linked to the sea-level changes and coastal environmental changes.

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Keywords: Paleoclimate, Paleoceanography, Uranium series isotopes, geochemistry, dating, sea level

Reconstructing paleoenvironmental changes around the Last Glacial Maximum in Bonaparte Gulf

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Timing and magnitude of the last glacial maximum (LGM: around 20,000 years ago) is a key to understand the climate systems. Global surface temperature was lower more than 2 degreeC and global ice volume was much larger than that for today (Yokoyama et al., 2000; Clark et al., 2009). Hence the observations during the LGM can be used for testing climate and glacial models under the naturally forcing condition. The maximum drop of the sea-level during the LGM was as much as ca. 135 m ice volume equivalent sea-level (Yokoyama et al., 2001; Lambeck et al., 2002; Mitrovica, 2003) according to the direct sea-level data from far-field sites, away from former ice sheet regions. Here we report paleoenvironmental reconstruction based on recently re-sampled sediment cores from Bonaparte gulf, North Western Australia.

More than 29 cores were obtained during the KH-11-1 cruise in January-February 2011. Detailed sedimentological analyses including CT scanning, major elements geochemistry using X-ray core scanners and color reflectance were conducted with over 40 radiocarbon dating in cores from 90-140 m water depth. Organic carbon and nitrogen isotopes variations were in accord with core descriptions and sedimentological descriptions. Timing of these changes is clearly related to the sea-level changes occurred around LGM. The results then were compared paleotidal model to further interpret paleoenvironments in the regions. In the presentation, we focus on the results obtained from cores taken from 120 m and 140 m water depth to see the relations to sea-level changes.

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Keywords: Sea Level, Last Glacial Maximum

Sea-level and environmental changes of Holocene using the archives of the submarine cave with the air-filled chamber

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In this study, speleothem (S0) was obtained at the surface of the cave pool in the air-filled chamber of Ginama submarine cave (shallower than 15 m water depth), which was occurred in the Permian limestone at northernmost part of Okinawa main land, Japan. In addition, drowned speleothems and sessile marine organisms were collected in the cave. The result of 14C dating presents that the outermost layer of S0 contains 102.44% percent Modern Carbon (pMC), indicating that the speleothem is forming at the present conditions. Based on the relative pMC value, its dead carbon fraction is estimated to be 7%. Using this value, it is likely that the formation of S0 occurred from about cal 5,745 yr BP to present. Such stalactite is first discovered except the Mediterranean and its forming duration is the world's longest. Given that the speleothem marks the sea level at the time of formation and the instrumental observed subsidence rate (0.037mm/yr) has continued during the last 5,745 years, it is estimated that the sea level at 5,745 years ago is 27-130 cm higher than the present sea-level. All 14C ages of the drowned speleothems were 1,000 years older than the timing of submersion under water.

The 14C ages and the altitudes of sessile marine organisms indicate that the brackish water lens in the cave had become thick after 3,150 cal. years BP. This suggests that the permeability of the limestone had increased after 3,150 cal. years BP. In addition, brackish water lens may have been temporarily thinner from 540 to 360 cal. years BP. This may be explained by reduction of summer monsoon during Little Ice Age.

Keywords: air dome, submarine cave, Holocene, sea-level changes, environmental changes, Okinawa

Distribution of recent benthic foraminifera around the Okinawa Island

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Benthic foraminifera have been regarded as reliable indicators not only of bottom environment but also of food supply from the ocean surface, and thus provide fundamental information on paleoenvironment for paleoceanography and geology. In this study, the distribution patterns of recent benthic foraminifera are examined around Okinawa Island, where is the direct source area of the Tsushima Warm Current as well as the warm Kuroshio Current.

Surface sediments for this study were taken by K-grab sampler during the GH cruises of 2008-2010 by National Institute of Advanced Industrial Science and Technology (AIST) in the east and west sides of Okinawa Island. The surface sediments were treated by the rose Bengal staining for recognized living foraminifera, and were screened on a 0.063 mm sieve.

Fifty six stations around the Okinawa Island were selected for this study. The east side of the island consists of rather simple slopes to the Ryukyu Trench. In the west side, on the other hand, the main current of warm Kuroshio flows, and is gently deepening toward the Okinawa Trough with complicated topography by small islands and banks.

Every sample were split into smaller aliquot, and about 200 individuals of benthic foraminifera were picked. 103 species of 38 benthic foraminiferal genera have been identified. Based on faunal composition, four assemblages, Assemblages A to D, are recognized. Characteristic species of each assemblage are, as follows:

Assemblage A: *Amphistegina* spp. and porcellaneous foraminifera

Assemblage B: *Globocassidulina subglobosa*, *Pullenia bulloides* and *Pseudoparrella exigua* and *Oridorsalis umbonatus*

Assemblage C: *Bolivina robusta* and *Uvigerina proboscidea*

Assemblage D: *Cibicides* spp.

Assemblage A, B and C are almost corresponded to water mass but Assemblage D implies substrata. In additional point, *Amphistegina* spp. live in shallow depth such as coral area, but come out in deeper sediment in this area, especially, until 1000m in west side of Okinawa Island. This evidence shows sediments move deeper and the movement of influence is smaller in east side. Thus, these benthic foraminiferal distributions can be explained by water mass, topography or substrata.

A coral polyp model with a carbon stable isotope module for clarifying vital effect in coral skeletal records

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Carbon stable isotope ratio ($d^{13}C$) recorded in coral skeletons exhibits annual variations and is considered to be controlled by the $d^{13}C$ of the dissolved inorganic carbon (DIC) in the ambient seawater and by metabolic activities such as photosynthesis and feeding (Weber et al. 1976; Erez 1978; Fairbanks and Dodge 1979; McConnaughey 1989; Felis et al. 1998; Reynaud-Vaganay et al. 2001). However, because of the complexity of the internal processes, the mechanism of the internal isotope effect (called the "vital effect") has been less understood, and the extraction of useful paleoenvironmental proxy from $d^{13}C$ data has been less successful compared with $d^{18}O$ as a temperature and salinity proxy.

Recently, we developed a coral polyp-scale numerical simulation model (Nakamura et al. under review), which is constructed with three components (ambient seawater, coelenteron and calcifying fluid), and incorporates photosynthesis, respiration and calcification processes with transcellular ion transport by Ca-ATPase activity, and passive transmembrane CO_2 transport and diffusion. The model calculates dissolved inorganic carbon (DIC) and total alkalinity (TA) in the ambient seawater, coelenteron and calcifying fluid, dissolved oxygen (DO) in the seawater and coelenteron and stored organic carbon (CH_2O). To reconstruct drastic variation between light and dark respiration, respiration rate dependency on DO in coelenteron is incorporated. Calcification rate depends on aragonite saturation state in calcifying fluid. The aragonite saturation state increases due to Ca-ATPase driven by the energy generated by the respiration. Our simulation result well reconstructed the "light-enhanced calcification", the basic responses of internal CO_2 system and DO, and calcification rate responses to the ambient aragonite saturation state. This model describes an internal DIC pass and mass balance inside the polyp. Therefore, considering the isotopic fractionation of each path, the ^{13}C mass balance module may be easily incorporated into the polyp model. The aims of this study are to develop a carbon stable isotope module for the coral polyp model to shed light on the "vital effect", and to verify its applicability as paleoenvironmental proxy.

There are two primary factors to explain the "vital effect" of carbon stable isotope; (1) kinetic isotope effect through the CO_2 hydration and hydroxylation in the calcifying fluid (e.g. McConnaughey et al. 1997), and (2) influx of lighter CO_2 into the calcifying fluid by respiration (e.g. Goreau 1977). To evaluate the efficiency of the kinetic isotope effect, the model was examined for two hypothetical cases: (1) all CO_2 system is equilibrium and (2) CO_2 hydration and hydroxylation is nonequilibrium; and to evaluate the efficiency of CO_2 passage by respiration to calcifying fluid, some different rates of the CO_2 flux were tested.

The results of the simulations showed that the kinetic isotope effect was not enough to decrease coral skeletal $d^{13}C$. On the other hand, the CO_2 flux by the respiration decreased the skeletal $d^{13}C$ and the simulated $d^{13}C$ reached to a measured level. Therefore, it is considered that the CO_2 flux by the respiration is the most important process for the "vital effect" of coral skeletal $d^{13}C$. Our model reconstructed clear seasonal variations of skeletal $d^{13}C$. In this result, $d^{13}C$ in the summer is lighter than that in the winter. Some coral records show similar trends with our simulation, but some ones indicate opposite trends. In this simulation, because the $d^{13}C$ of DIC in the ambient seawater and temperature are assumed to be constant, the simulated seasonal change is caused only by the seasonal light intensity change. However $d^{13}C$ of DIC in the ambient seawater and temperature must have seasonal change, and the skeletal $d^{13}C$ must be affected by these factors directly or indirectly. Therefore, to reconstruct the coral skeletal $d^{13}C$, these factors also need to be considered.

Keywords: Coral polyp model, carbon stable isotope ratio, vital effect, numerical simulation

Last deglacial paleoceanography in equatorial Pacific reconstructed from boron isotopes of Tahitian fossil corals

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Antarctic ice cores have revealed close relations between surface temperature and atmospheric pCO₂ in the past in accord with glacial and interglacial cycles for the last 800 kyrs. The deep ocean is thought as responsible for approximately 80-100 ppm changes in its magnitude since it is the largest carbon reservoir on surface of the Earth. Several attempts have been made to identify exact locations of those carbon pools and routes during the orbital and millennial scale climate change in the ocean though the outcomes are still inconclusive. Pacific ocean is the one of the main candidates for this path of CO₂ purge during the deglaciation because there is the largest CO₂ source in the world ocean at present in the equatorial Pacific, and Tahiti locates in the margin of the equatorial upwelling (cold tongue) region as is sensitive to its past changes. In this study, we measured boron isotopes to reconstruct paleo pH on Tahitian fossil corals (*Porites* spp.) recovered during the Integrated Ocean Drilling Program (IODP) expedition 310 (Tahiti Sea level). U-series dated corals precisely can provide the timing of changes as is able to compare the record directly with ice core pCO₂. Local marine radiocarbon reservoir ages are also calculated using previously published datasets in the region. The result shows large pH depletions in surface of equatorial Pacific associated with much older water intrusions during the last deglaciation, in particular during HS1 and YD. This is consistent with previous pH reconstructions using boron isotopes of marine carbonates in Marquesas Island (coral) and off Papua New Guinea (planktonic foraminifera). Thus low pH and radiocarbon depleted surface water distribution during the millennial scale climate event was persisted not only in Tahiti but other surface equatorial Pacific. This suggests close relations Pacific oceanography with global climate via ocean circulation as is recorded as either stronger upwelling or subsurface water chemical characteristic changes in wider region of equatorial Pacific has been occurred associated with HS1 and YD.

Keywords: boron isotope, porites spp., Integrated Ocean Drilling Program, Tahiti, equatorial Pacific, the last deglaciation

Stable C and O isotope ranges of African land snail shell reflect different ecosystems

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The geochemistry of land snail shell can be a good indicator of paleoenvironmental conditions, because it responds to seasonal environmental variation encountered by the animal and fossil land snails can be found in many continental sections. We present variation in the stable C and O isotope ratios of modern land snail shell from various ecosystems in the African continent and discuss the relationships between ranges of isotope ratios, genus, climate, and diet.

Sequential powdered samples from shells are drilled parallel to growth lines through multiple years of shell growth. Results are summarized as follows:

d13C: Variation within one specimen is small. The values probably respond to differences in diet, i.e. C3 plants, C4 plants, and the ingestion of carbonates from detritus, bedrock or soil.

d18O: (1) The ranges in oxygen isotope ratio from tropical forest, upland forest, desert, semi-desert are small, with the values of the former two generally lower than desert or semi-desert. (2) Regions with pronounced dry and wet seasonality (savanna, and some Mediterranean) show large seasonal variation in d18O. Within one climate class, snails of different genus sometimes have similar ranges, and sometimes different ranges. Habitat climate has a stronger control on shell chemistry than taxonomy. For example, oxygen isotope ratios of *Achatina* from savannah woodland, Pakasi, Kenya are +5.4 to -5.4 per mil, while *Achatina* from a Tropical forest, Pemba Island, Tanzania are +0.1 to -2.8 per mil.

We conclude that the d13C and d18O ranges of land snail shells reflect ecosystems, diet, and perhaps micro-habitat preference, and that land snail fossils are good indicators for paleoenvironment and palaeoclimate based on a combination of faunal analysis and C and O stable isotope geochemistry.

[Tropical forest] *Leptocala* (Lastourville, Gabon) d13C: -11.28 ~ -13.28; d18O: -0.97 ~ -3.29; *Trochnanina* (Lastouvilla, Gabon) d13C: -14.20 ~ -15.56; d18O: +0.39 ~ -1.74; *Thapsia* (Lastouvilla, Gabon) d13C: -11.80 ~ -13.35; d18O: -1.37 ~ -3.55; *Limicolaria* (Mabira forest, Uganda) d13C: -12.68 ~ -15.36; d18O: +1.01 ~ -3.85; *Achatina* (Pemba Island, Tanzania) d13C: -8.45 ~ -13.02; d18O: +0.13 ~ -2.83

[Upland forest] *Limicolaria* (Kipsaraman, Kenya) d13C: -9.37 ~ -11.41; d18O: +1.41 ~ -2.13; *Limicolaria* (Alekkilek, Uganda) d13C: -9.01 ~ -12.11; d18O: +2.61 ~ -0.82

[Upland woodland] *Limicolaria* (Napak, Uganda) d13C: -7.90 ~ -10.02; d18O: +3.45 ~ -0.07; *Trochnanina* (Napak, Uganda) d13C: -0.24 ~ -5.22; d18O: +1.63 ~ -1.25; *Limicolaria* (Koru, Kenya) d13C: -8.35 ~ -12.33; d18O: +2.03 ~ -2.23

[Savannah woodland] *Xeroceratus* (Aigamas, Namibia) d13C: -6.37 ~ -7.99; d18O: -2.31 ~ -7.76; *Achatina* (Pakasi, Kenya) d13C: -5.96 ~ -10.90; d18O: +5.38 ~ -5.42

[Mediterranean (winter rain fall)] *Helicopsis* (Agadir, Morocco) d13C: -3.19 ~ -4.62; d18O: +0.74 ~ -0.99; *Rumia* (Agadir, Morocco) d13C: -9.27 ~ -9.80; d18O: +5.76 ~ -1.08; *Kabylia* (Agadir, Morocco) d13C: -5.31 ~ -7.01; d18O: +3.48 ~ -0.07

[Semi-desert] *Dorcasia* (Remhoogte, Namibia) d13C: -5.91 ~ -8.58; d18O: +3.89 ~ -0.12; *Bloyetia* (Kogole, Uganda) d13C: -5.96 ~ -7.32; d18O: +2.79 ~ -1.21

[Desert] *Dorcasia* (Skilpadberg, Namibia) d13C: -0.18 ~ -1.03; d18O: +3.37 ~ 1.26; *Trigonephrus* (Bogenfels, Namibia) d13C: -0.20 ~ -2.75; d18O: +5.70 ~ 3.27

This work continues with future analysis of stable isotopes in land snails from following ecosystems; savannah woodland near Lake Albert; semi-arid woodland steppe, Uganda; savannah bushland, Kenya; coastal steppe, Oman; and desert, Namibia

Keywords: paleoenvironment, paleoclimate, land snail, carbon isotopes, oxygen isotopes, Africa

Glacial North Atlantic variability during the past 300,000 years.

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A combined record from Sites DSDP 609/IODP U1308 spans the last three glacial intervals. Hudson Strait (HS) Heinrich Events appear to slightly precede weak East Asian summer monsoon events, as indicated by the absolutely-dated Hulu and Sanbao speleothem records. While the Stage 8 interval exhibits similar variability as the last glaciation (i.e., HS Heinrich Events and well-defined IRD cycles), North Atlantic conditions during the penultimate glaciation suggest an anomalously stable Laurentide Ice Sheet (LIS). No large ice rafting events are detected in multiple locations across the North Atlantic, and the flux of IRD during "H11" (not sourced from the HS) is an order of magnitude lower than the average for those of the last glaciation. In the absence of significant millennial events, orbital solar insolation appears to have been the primary driver of climate variability. The Site U1308 record of Icelandic volcanic glass indicates sea ice expansion corresponding to low precession and a weakened East Asian Monsoon. If the Eurasian Ice Sheet was significantly larger during the penultimate glaciation, but total ice volume was similar to the last glaciation, glacial stability during Stage 6 could have been the result of a small LIS that was less prone to surging and large freshwater release.

Magneto-, and climate stratigraphy of abnormal interglacial MIS 19

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Marine oxygen isotope stage (MIS) 19 is an abnormal interglacial, having a thermal maximum about 5 kyr delayed the highest sea-level highstand. In addition, it includes the Matuyama-Brunhes magnetic polarity boundary, a candidate for the early-middle Pleistocene boundary. Thus, precise understanding of the climate, environment, and magneto- stratigraphy for the stage is important. In this study, we revise the age model of the marine layer correlated with MIS 19 in an Osaka Bay core to reevaluate the magneto-, and climate stratigraphy for MIS 19. The previous linear age model was replaced by that of using a sea-level proxy curve of diatom fossil data tuned to marine oxygen isotope stack LR04. The new age model reveals that the sedimentation rate is almost uniform throughout the MIS 19, except a short period in the earliest stage when the rate decreases by half. The model revises ages of the following events. 1) The first highstand, correlated with isotope event 19.3, spans from 784 ka to 778 ka, during which it has a brief sea-level drop at about 783 ka, and the highest sea-level at 780 ka. 2) The postglacial warming in the early MIS 19 was disrupted by the temporary cooling from 783 ka to 778 ka, followed by a rapid warming with the thermal maximum spanning from 776 ka to 774 ka. 3) The second highstand, correlated with isotope event 19.1, occurred at a period from 770 ka to 762 ka. 4) The magnetic polarity reversal has the low paleointensity interval spans from 784 ka to 776 ka, during which a brief paleointensity recovery and multiple polarity swings occur. The beginning of the low paleointensity interval is consistent in age with those observed in many deep-sea cores from different oceans. But for the termination, data from some deep-sea cores show several thousand year younger ages.

Keywords: paleoclimate, interglacial, stage 19, Matuyama-Brunhes polarity boundary, early-middle Pleistocene boundary, climate stratigraphy

Pliocene anisotropy of magnetic susceptibility (AMS) from the Wilkes Land margin

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During IODP Expedition 318, Site U1361 was drilled offshore from the Wilkes subglacial basin on the continental rise to reconstruct the stability of the East Antarctic Ice Sheet (EAIS) during Neogene warm periods, such as the late Miocene and the early Pliocene. As the drilled core has a complex story of compaction, erosion (thus hiatuses), unconformities, and possibly artificial disturbance, identifying these is important for reconstructing paleoenvironments. An unconformity, WL-U8, was found at ~100 mbsf during the cruise; this is considered as a result of the transition from a dynamic to a persistent ice sheet. Anisotropy of magnetic susceptibility (AMS) is sensitive to lithological changes and differential compaction. At Site U1361, highly anisotropic layers correspond with lithologic boundaries and hiatuses. During the Pliocene, the degree of anisotropy was controlled by the presence or absence of diatoms as opposed to in the late Miocene. Here we present a detailed study of the relationships between sediment compaction based on AMS fabric and variations in diatom taxa and magnetic mineralogy to identify the remarkable ice retreat and the geological response to the transition of dynamic to persistent ice sheet. There is a clear correlation between degree of anisotropy and moisture content. Where moisture content is high, the layer is more isotropic, and vice versa. Moreover, layers with the most abundant diatom valve concentration are characterized by more isotropic AMS fabrics. There are also strong rock magnetic indications for changes in the sources of the magnetic minerals above and below the interval of WL-U8 and Miocene to Pliocene transition. We will describe our AMS and rock magnetic stratigraphy to 1) characterize sediment compaction as a function of diatom taxa variation and 2) detect the sources of magnetic mineralogy throughout Miocene to Pliocene.

Keywords: Wilkes Land, Anisotropy of magnetic susceptibility, Pliocene, Miocene

NW-SE Kerama rift valley formed at 3 to 2 Ma and inflow of the Kuroshio warm current, prior to the 1.5 Ma main rifting o

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The basement of Kume-jima is the Aradake Formation, consisting of altered andesite, which represents 1.7 Ma terrestrial eruption at volcanic arc. Eroded surface of the andesite is unconformably covered by the lower part of the Maja Formation, consisting of 7 Ma silty sandstone and talus conglomerate, which represents embayment of sea toward Kume-jima. The upper Maja Formation, 3 Ma, consists of giant cross stratified sandstone, derived from the southeast, probably under effect of the branch of the Kuroshio warm current. The rounded chert gravels in the uppermost conglomerate were derived from southeastern accretionary terrain. The 2 Ma Uegusukudake Formation consisting of the lower unaltered basalt and upper andesite lava formed plateau like volcanic accumulations, indicating NW-SE rifting and sea floor spreading. The 1.5 Ma tectonic event is the NE-SW rifting and opening of the Okinawa trough, and affected Kume-jima to tilt northwestward as a consequence of NE-SW normal faulting, and subsidence as an island. The Kitahara Formation, a member of the so called the Ryukyu limestone, deposited filling this depressions. The base is conglomerate and sandstone, and the main part is calcareous algae limestone. Flat coral limestone of the Dosaki Formation abuts these older strata. The structure of Kume-jima is simple and only tilting of older strata, although some minor active faults cutting the Dosaki Formation are observed. The sea barrier to form endemic species like *Luciola owadai* is expected in 7 Ma embayment event, especially followed by 1.5 Ma isolation to form an island.

Keywords: Kume-jima, 7 and 3 Ma Shimajiri Group, giant cross stratification toward NW, Kuroshio, 2 Ma Plateau basalt, NW-SE rifting and sea floor spreading, prior to 1.5 Ma rifting of NE-SW Okinawa Trough

Stratigraphy and paleoceanography for the Plio-Pleistocene marine sequence distributed in the southern most part of the

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Based on magnetostratigraphy and oxygen isotopic stratigraphy using benthic foraminifers, an integrated chronostratigraphy has been reconstructed for middle part of the Chikura Group including the Plio-Pleistocene boundary distributed on the southernmost part of the Boso Peninsula, central Japan. The results indicate that, the studied sequence is correlated with from the middle Gauss chronozone to the Olduvai subchronozone, and the LR04 (Lisiecki and Rymo, 2005, *Paleoceanography*, 20) marine isotope stages (MIS) from MG4 through 61.

The Matuyama/Gauss boundary detected at the sequence is situated on MIS 103, not on MIS 104 that is described in the LR04 time scale. This interpretation is consistent with the boundary position reported at the Mediterranean sapropel stratigraphy.

Planktonic foraminifera assemblage has analyzed for the sequence between 3.2 to 2.4 Ma, and the results demonstrated that the mixed water (between the Kuroshio and Oyashio waters) dwelling species dominate for most of the sequence. However, the ratio of the Kuroshio dwelling species against the total of the Kuroshio and Oyashio dwelling species (except for the mixed water one) indicates that Kuroshio has been quite strong stably before 2.7 Ma and Oyashio has just started to influence after that time at around the Boso Peninsula. A record of biogenic opal shows a cyclic variability might be associated with glacial-interglacial changes. This variability seems to decrease slightly, but does not show any drastic drop at around the Plio-Pleistocene boundary observed in the Northern Pacific (eg. Haug et al., 1999, *Nature*, 401). On the other hand, a nitrogen isotopic ratio of organic matter progressively increases through the whole sequence. These results suggest that nutrient uptake has gradually but never drastically decreased across the Plio-Pleistocene boundary at around the Boso Peninsula.

Keywords: Plio-Pleistocene boundary, oxygen isotopic stratigraphy, magnetostratigraphy, planktonic foraminifera, Kuroshio current

Variation in marine primary production recorded by biomarker in northeastern edge of paleo-Japan Sea during the Miocene

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The objective of this study is to reconstruct of marine primary production in shallow marine environment of northeastern edge of the paleo-Japan Sea during the middle to late Miocene. It has been known that diatom production increased in the North Pacific and paleo-Japan Sea during middle to late Miocene. In particular, shallow marine environment is thought to be one of the highest productivity area due to efficient supply of nutrient into the sea surface by terrestrial input and coastal upwelling. In the present, we analyze diatom-derived biomarkers in sedimentary rock samples from turbiditic sequences to evaluate depositional system and to reconstruct paleoproduction in shallow marine environment of the northeastern edge of Japan Sea during the middle to late Miocene.

Miocene (23Ma- 5.3Ma) is known to be a transition epoch in global climate that changed from warm to cold conditions since the mid-Miocene Climatic Optimum (MMCO; 15Ma). At the same time, expansion of the Antarctica ice sheet and intensification of Asia monsoon started (Zachos et al., 2001). Also, diatom productivity dramatically increased in the North Pacific and paleo-Japan Sea (Barron, 1998; Yamamoto et al., 1999). Moreover, it was suggested that C₄ plant expansion caused increasing diatom productivity by efficient transport of biogenic opal from land to ocean (Falkowski et al., 2004).

Opening of the Japan Sea was known to have started from the early Miocene. Biogenic silica and biomarker analyses inferred that diatom was a major primary producer in the paleo-Japan Sea during this epoch (Tada, 1994; Yamamoto et al., 1999). In addition, source rocks including the Onnagawa Formation were formed as a result of high diatom productivity and well preservation of organic matter under anoxic bottom environment. Thus, we performed biomarker analysis for the Miocene Kawabata Formation in Yubari area, central Hokkaido to understand long term paleoceanography and biogeochemical processes in interface between land and ocean. The Kawabata Formation is mainly composed by turbiditic sequences that filled Ishikari basin. F-T analysis for interbedded tuff layer and diatom biostratigraphy showed that the Kawabata Formation was formed during middle to late Miocene (Kawakami et al., 2002).

In mudstone samples of the Kawabata Formation, the ratio of C₂₇ to C₂₉ steranes, which indicate the relative abundance of eukaryotic alga to terrestrial plant, are almost similar to those of shallow marine sediment as reported previously (Sawada, 2006). The ratio of pristane to phytane (Pr/Ph) was generally used as a redox indicator, and suggests that anoxic bottom environment was distributed in the Ishikari basin during the Miocene. We detect 24-norcholestane and higher branched isoprenoid (HBI) alkane/thiophene. It is reported that 24-norcholestane and HBI alkane/thiophene are originated from *Thalassiosira* and *Rizoseolenia*, respectively (Rampen et al., 2006; Sinninghe Damste et al., 2004). The relative abundances of these diatom-derived biomarkers to total organic carbon (TOC) are closely related to those of sterane to TOC in sedimentary rock samples. These results suggest that the diatom was the major producer in the Ishikari basin. Interestingly, the decreasing spikes of Pr/Ph values correspond to the increasing peaks of the amounts of diatom-derived biomarkers in the Kawabata Formation. From these results, we interpret that high diatom productivity in the sea surface resulted in occurrence of anoxic waters in bottom of the Ishikari basin. Furthermore, the amounts of diatom biomarkers increased in the late Miocene sediment layer, which agree with the previous results from the Onnagawa Formation and the North Pacific sediment core (Barron, 1998; Yamamoto et al., 1999).

Keywords: Miocene, Japan Sea, paleoceanography, biomarker, diatom, turbidite

Sediment supply to the Shikoku Basin by the Kuroshio Current during the latest Cenozoic era

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Sr-Nd-Pb isotope ratios of detrital mud of the late Cenozoic hemipelagic succession cored from the IODP site C0011 in the Shikoku Basin suggest that the Kuroshio Current had initiated at 5 Ma and gradually increased its strength toward 3Ma around this site. The combination of $^{87}\text{Sr}/^{86}\text{Sr}$, $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$, and $^{208}\text{Pb}/^{204}\text{Pb}$ of detrital mud in the period between 4.2 and 5 Ma at this site is fairly close to that of the Okinawa Trough sediments, and that of $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ resembles that of the Yangtze River sediment. Although $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ in this period are also close to sediments in inland China, where the Asian dust originates, $^{208}\text{Pb}/^{204}\text{Pb}$ of C0011 samples are significantly higher than those of inland China in relation to $^{206}\text{Pb}/^{204}\text{Pb}$. Isotopic values from 5 to 0 Ma of C0011 samples can be explained by the mixing of those sediments around the East China Sea (ECS) and the sediments derived from the Honshu Island. Sediments should have been transported from the continental shelf of the ECS to the Shikoku Basin as suspension of the Kuroshio Current. Transportation by underflows or gravitational flows is unlike because the Kyushu Palau Ridge should have obstructed their accession to the Shikoku Basin.

Assuming the sediments from the Okinawa trough and those from the landward rises of the Nankai Trough as the end members, the ECS area supplied 60 to 100 % of siliciclastic mud deposited on the Site C0011 during the period from 5 to 4.2 Ma. Then, the proportion had gradually decreased to less than 40 % by 3Ma. Before 5 Ma, the proportion ranged from 30 to 70 %. After 3Ma, the proportion was no more than 50 %. Contribution from the ECS significantly decreased also in quantitative aspects after 3Ma judging from the sudden decrease of bulk sedimentation rate at this site from 6.7 to $2.8\text{g cm}^{-2}\text{ kyr}^{-1}$ at 3Ma.

The Late Cenozoic History of the Kuroshio Current around the site C0011 is inferred as below. *5-4.2Ma*: An ocean current that was strong enough to transport particles from the ECS to the Shikoku Basin is established. From *4.2-3Ma*: the ocean current had grown up, and the increasing capacity of the flow lowered the settling flux from the current. On the contrary, migration of the site C0011 toward the Honshu Island increased the terrigenous flux. *3Ma*: The strong, modern Kuroshio Current had established, and had prevented particle settling from the sea surface to the floor around C0011.

Keywords: the Kuroshio Current, hemipelagic mud, Sr-Nd-Pb isotope ratios, Shikoku Basin

Different oceanographic responses during last two deglaciation in the western subtropical Pacific

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Deglaciation process is one of the results that the tropical climate forcing impact on the global changes by its large heat capacity. The Okinawa region, where the Kuroshio Current and central water of the subtropical gyre are oscillated, provides the high-resolution paleoceanographic records of the tropical-subtropical Pacific during the late Quaternary. Two IMAGES cores collected from the Okinawa Trough under the Kuroshio Current (MD982196) and Ryukyu Trench under the influence of central water of the subtropical gyre (MD012398) covered the records back to Marine Isotope Stage (MIS) 7. Here, we demonstrate the environmental changes of the surface and intermediate waters during two glacial-interglacial shifts, MIS 6 to 5 and MIS 2 to 1, based on the comprehensive analyses of the oxygen isotopes, Mg/Ca ratios of two planktic foraminiferal faunas (surface and upper intermediate species), and faunal assemblages of planktic foraminifera.

The $d^{18}O$ and Mg/Ca paleo-temperature of surface water were changed according with the glacial-interglacial cycles in whole of the Okinawa region. During MIS 1/2, the paleo-temperature of upper intermediate water decreased in the Okinawa Trough, while it increased in the Ryukyu Trench. This temperature increased during MIS 5/6 at both the Okinawa Trough and Ryukyu Trench. Small temperature differences between surface and intermediate waters during MIS 5/6 suggest that the water-column was mixed well in the Okinawa region. Temperature difference during MIS 1/2 showed the strong stratification at the Okinawa Trough, whereas it was stable at the Ryukyu Trench.

The faunal compositions of planktic foraminifera provide further detailed changes of the four water masses represented the oceanic condition in the Okinawa region. Two warm water groups (subtropical gyre and Kuroshio groups) showed a negative correlation between the Okinawa Trough and Ryukyu Trench area during the interglacial periods. It suggests oscillation between the Kuroshio Current and subtropical gyre. Two cold-water groups (northern Pacific and upper intermediate groups) showed different fluctuations between two glacial periods. The northern Pacific group increased during MIS 2, whereas the upper intermediate group of the subtropical gyre was dominant during MIS 6. Moreover, the upwelling species drastically increased at the deglaciation of MIS 5/6 in the Okinawa Trough. Straightforward implication for this phenomenon is expansion of intermediate water to the subtropical gyre during MIS 6 causing mixture of water-column in MIS 5/6.

Our multidisciplinary analyses successfully inferred two different glacial mechanisms of MIS 2 and 6 leading unique oceanographic response to the deglacial processes. When the effect of the Kuroshio Current was weakened in the NW subtropical Pacific, the cold-water came down during MIS 2 due to southward shift of the subtropical gyre front. During MIS 6, the intermediate water of the subtropical gyre extended westward because of weak subtropical gyre and/or development of intermediate water itself.

Keywords: West Pacific, Glacial oceanographic condition, Water column structure

High-resolution climatic signal over the last glacial-interglacial from magnetic nanoparticles in Chinese loess-paleosol

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Measurement of bulk magnetic susceptibility (MS) has been applied routinely in environmental research: for example, MS variations in Chinese loess-paleosol successions are well known for their correlation with marine oxygen-isotope records, which leads to interpretation of past Asian monsoon intensity variations in the context of global climatic change (An et al., 1997). However, MS is theoretically a function of various factors such as the concentration, grain-size and other magnetic properties inherent in magnetic particles present in a sample. In this study, we present high-resolution (millennial-scale) records of past climatic variability obtained from a loess-paleosol succession in Luochuan, central China, which have been reconstructed by applying a new method that measures MS over broadband frequencies (Kodama, 2013). This method is capable of estimating the concentration and volume fraction distribution of ultrafine magnetic particles, so-called superparamagnetic (SP) particles with volumes ranging in 10^{-24} to 10^{-25} m³. We have investigated an upper loess-paleosol section, a profile that records climatic changes over the last glacial-interglacial cycle (An & Porter, 1997). The studied section is 13-m-thick and consists of two paleosol (S0 and S1, in Chinese loess sequence nomenclature) and two loess units (L1 and L2); the 7-m-thick L1 unit and 3-m-thick S1 unit are subdivided into subunits that are intercalated by weakly developed soil (weak paleosol) layers. Chronology for this section has been provided, based on the correlation of bulk MS values variation with marine oxygen isotope stages and linear interpolation using the control ages: 71 kyr for the L1/S1 boundary and 129 kyr for the S1/L2 boundary. An additional control age is provided for a layer within the L1 unit, which corresponds to the Laschamp geomagnetic excursion at 41 kyr (Xian et al., 2012). A total of 143 samples were collected in 10 cm intervals from the top of S0 unit to the upper part of L2 unit.

We have analyzed profiles of a series of magnetic parameters that represent the abundance of SP particles and the proportion of finer particles in their narrow distributions. Results show that high-resolution signals can be decoded from these profiles, but in a manner different from previous studies. There is no considerably enhanced signal for the paleosol units, but instead the paleosol and weak paleosol units are identical in terms of the relative abundance of SP particles. Profiles of the indices representing the proportion of finer SP particles show a common pattern that is well correlatable with the loess-paleosol stratigraphy: the weak paleosol (mostly L1SS) show high-frequency and small-amplitude fluctuations, whereas the loess units (L1LL2 and L2) are associated with large-amplitude oscillations. The high-frequency oscillations later than 70 kyr are quite similar to the D-O oscillations. Below the 70 kyr boundary, the curve tends to fluctuate at lower frequency (a few millennia scale), which resembles the contemporaneous GISP2 pattern. The close similarities between variations of these profiles and other climatic proxy variations over the last glacial-interglacial cycle demonstrates that the method in this study can be a substitution of other methods using stable isotopes, and that Chinese loess-paleosol sequences have a potential as high-resolution, millennium-scale archives of both global and local climate changes.

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Keywords: magnetic susceptibility, paleosol, loess, climatic change, Luochuan

Palaeoclimate analysis for 300 ka based on the organic carbon contents of MD01-2407 core from the Oki Ridge, Japan Sea

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We analyzed total organic carbon (TOC) and total nitrogen (TN) contents at 2 cm interval for a long sediment core named MD01-2407 (932 m depth, 55.28 m length) taken from the Oki ridge in the southern part of the Japan Sea. We made an age-depth relation for the MD01-2407 core, using age-control data such as 5 marker tephra layers, 7 ¹⁴C ages, 3 TL boundaries, and nine delta ¹⁸O events (after Kido et al., 2007; Yokoyama et al., 2007). This analysis was performed for the core sample from 25.50 m to 0.18 m in depth, and corresponds for the past 300 ka in age.

TOC content is generally high in MIS 7, 5, 3 and 1, and low in MIS 8, 6, 4 and 2. Fluctuation of TN content is similar to that of TOC. In MIS 8, TOC content is constantly low, around 1.0 to 1.8 %. In MIS 7, TOC content is high, varying from 1.2 to 4.3 % with periodic fluctuation. In MIS 6, TOC content is constantly low in the range of 0.5 to 1.8 %. In MIS 5, TOC content is high and fluctuates from 1.0 to 5.0 % with periodicity of a few thousand years. In MIS 4, TOC content is constantly low around 1.2 %. In MIS 3, TOC content is a slightly high, varying from 1.5 to 3.8 % frequently with short periodicity of several to tens hundreds years. In MIS 2, TOC content is in the lowest level, around 0.3 to 2.0 %. In MIS 1, TOC content varies from 2.0 to 5.0 % with distinctly fluctuation. TOC content in the sediment core reflects biological productivity in the Japan Sea (Oba and Akasaka, 1990). Therefore, high TOC content means high productivity, and vice versa.

Temporal fluctuation of TOC content in MIS 3 shows many peaks, changing drastically in short periodicities like a D-O cycle. On the other hand, TOC content fluctuates in longer periodicity than D-O cycles in MIS 7 and 5. TOC content is high at 290 ka and 262 ka in MIS 8 and at 160 ka in MIS 6, which is regarded as cold periods. According to these characteristics of TOC fluctuation, surface productivity of Japan Sea might be controlled by not only global cold-warm climate changes but also other different factors such as regional climate system or water circulation of the Japan Sea.

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

Late Quaternary climates of East Asia elucidated from the total organic carbon contents of cored sediments, Japan Sea

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Total organic carbon (TOC) and total nitrogen (TN) contents are analyzed with high temporal resolution (ca. 100 ka) for MD179-3304 and MD179-3312 cores taken from the Japan Sea off Joetsu City. The temporal changes in TOC and TN contents vary quasi-regularly in a similar pattern. The age models are formed on the basis of the relationship of the dates of ¹⁴C dating, marker tephra beds, TL layers, and marine isotope events with depth. TOC content is high in MIS 1 and 5, and is low in MIS 2 and 4. That in MIS 3 is a slightly elevated, with frequent fluctuations of short periodicity. This general trend is very similar to LR04 curve, except for the reduced dominance of TOC around the MIS 5.5 substage. As shown typically in MIS 3, there are many peaks of TOC in a short interval. The details of these TOC peaks can be correlated with the warm interstadials of the Greenland ice core. We can identify a sawtooth-like decreasing trend of TOC in MIS 3. In contrast, the decreasing trend of oxygen isotope ratios in the ice core corresponds to an increasing trend of TOC in MIS 5.

The synchronicity of temperature changes between East Asia and the North Atlantic is easily explained by oscillation of the Arctic polar front through time. The detailed correspondence of TOC contents of the Japan Sea sediments to other common paleoclimate proxies means that the TOC contents of these sediments is an excellent paleoclimate record in Far East Asia, although the genetic relationship between air temperature and biological productivity in the Japan Sea is as yet unknown.

Keywords: total organic carbon, climate change, Japan Sea sediment, high resolution, D-O cycle, Late Quaternary

Radiolarian assemblages in the Japan Sea and their origins related to the eustatic-sea-level changes

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Radiolarian assemblages in the Japan Sea during the past 640 kyr have been examined using sediment core MD01-2407 (56 m length). Totally 160 species or species group of radiolarians were encountered in this core, and number of species was high in interglacials and low in glacial times, which is associated with the eustatic glacial-interglacial cycles. Because high species numbers during the interglacials were characterized by predominance of warm water species, it is related with inflow of the Tsushima Current originated from southern strait. On the other hand, the glacial assemblage was characterized by cold water species. The Oyashio related species increased during the transitional periods from the glacial to interglacials.

Keywords: Pleistocene, Paleoceanography, Tsushima Warm Current, Oyashio Current

High-resolution SST reconstruction in the Japan Sea for the past 18 ka

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Ishiwatari et al. (2001) reconstructed sea-surface temperatures (SSTs) in the Japan Sea during the past 36 ka based on alkenone unsaturation ratio, but the low-saline conditions during the early deglacial periods make the accuracy of alkenone-based SST estimates uncertain (Harada et al., 2008; Fujine et al., 2006). By contrast, during the Holocene, timing of intrusion and pulses of Tsushima Current were well investigated by assemblages of diatom and foraminifera (e.g., Koizumi et al., 2006; Domistu and Oda, 2008), but high-resolution SST reconstruction has not yet been conducted. These situations limit our understanding of the SST evolution in the Japan Sea from the LGM to the Holocene and of the driving force that determines the SST evolution in the Japan Sea. Here, we present planktic foraminiferal Mg/Ca-derived SST record in the Sea of Japan.

The studied sediment core (YK10-7-PC09) was taken from 738 m water depth off Niigata. The thick lamina layer was observed in a section from 420 cm to 750 cm core depth, which corresponds to the sediments during Heinrich 1 and glacial periods. We have analyzed the sediment samples above 450 cm core depth (i.e., back to 18 ka). The age model for the core was based on 8 AMS ¹⁴C data of planktic foraminifera. We have used Marin09 and delta R of 0+/-100yr to convert the conventional ¹⁴C ages to the calibrated ages. delta-¹³C and delta-¹⁸O of benthic (*Uvigerina* spp.) and planktic foraminifera (*N.incompta*, *N.pachyderma*(s), *G.bulloides*) were measured by MAT 253 (CMCR, Kochi University), whereas trace metal/Ca ratio of planktic foraminifera were measured by Thermo Fisher Element II (Toyama University). Precision (1sigma) of Mg/Ca ratios obtained by the SF-ICP-MS in our laboratory was 0.69%.

The delta-¹⁸O records from planktic foraminifera were almost same as the records from L-3 core (Oba and Murayama, 1995), and one of striking features of the delta-¹⁸O records was a significant increase in delta-¹⁸O values from 0.6 per mil to 3.4 per mil during the early deglaciation (18 - 15 ka). Further, we found that the Mg/Ca-derived SSTs (from *G.bulloides*, Mashiotta et al., 1999) showed a slight increase from 5 to 8 degrees during 18 - 7 ka and presented an increase in ~3 degrees during the B/A period. Importantly, the SST evolution in the Japan Sea exhibited a close similarity with the SST variation reconstructed off Tokachi, which was under the influence of Oyashio Current (Sagawa and Ikehara, 2008), with ~1 degrees offset, corroborating that the Japan Sea was influenced by Oyashio Current at the time. During last 7 ka, Mg/Ca-derived SSTs (*N.incompta*, Anand et al., 2003) were correlated with delta-¹⁸O variations, indicating delta-¹⁸O variations primarily reflect changes in SSTs. The significant cooling of the SSTs were observed at ~2 ka and 4 - 5.8 ka, whereas the highest SSTs were observed during 2.5 - 3.4 ka. The SST evolution during the mid to the early Holocene was almost consistent with the relative abundance of *F.doliolus*, that is an indicative of Tsushima Current pulses (Koizumi et al., 2006) and the SST evolution off Kashima (Isono et al, 2009). The SST changes in the Japan Sea may have been related to intensification of Tsushima Current that might be associated with the East Asia winter monsoon system.

Keywords: Sea of Japan, Mg/Ca, Oxygen isotope, Holocene, Pulses of Tsushima Current

History of surface and intermediate depth environmental change in the Japan Sea, Scientific objectives in IODP Exp.346

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The Japan Sea is a semi-closed marginal sea that connected to North Pacific and other marginal seas by shallow straits. It has been experienced dramatic environmental change caused by glacio eustasy and monsoon variation. Today, the Tsushima Warm current (TWC), formed by mixing of subtropical water and coastal water in the East China Sea, flows into the Japan Sea and has sustained climate and ecosystem by supply of heat and salt. The past variations of the volume transport of TWC associated with sea level change induced surface water salinity change in the Japan Sea, resulting in dramatic change of the deep water oxygen level via ventilation. It is essential to reveal the onset timing and history of such environmental change for understanding the evolution of climate and ecosystems in the Japan Sea and Japanese islands. The millennial-scale change in the deep water ventilation during the last glacial period is attributed to the East Asian monsoon. The major cause is thought to be due to influence of the low salinity coastal water related to the summer monsoon. Given that the winter cooling plays a major role in modern ventilation, the winter monsoon should be more taken into consideration to the millennial-scale ventilation change. However, it is still obscure that the relationship of the winter monsoon variation to the ventilation. Further, the millennial-scale changes of the winter monsoon during the penultimate and much earlier glacial periods are rarely understood.

I propose the paleoenvironmental reconstruction of surface and intermediate depth of the Japan Sea using the chemical analysis of the benthic and planktonic foraminiferal shells at the YB-1 site (water depth 330 m), off Tottori in the southern Japan Sea. The proposed penetration depth at this site is 500 m, which is equivalent to the last 2 Myr sediments. Owing to shallow water depth, the continuous occurrence of carbonate microfossil is expected. It is expected that the history of TWC and the relationship between the millennial-scale winter monsoon variability and ventilation will be revealed by oxygen isotope stratigraphy and temperature reconstructions for surface and intermediate depth. I will introduce the research progress of ongoing project and scientific objectives in IODP Exp.346.

Keywords: IODP Exp. 346, Japan Sea, East Asian monsoon, Tsushima Warm Current, intermediate water circulation, winter monsoon

Reconstruction of long-term fluctuation of East Asian winter monsoon using the Japan Sea sediments

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East Asian winter monsoon (EAWM) is characterized by cold, dry northwesterlies from the Siberian high that blow over the Japan Sea. Recent studies indicate that EAWM fluctuation recorded as fluctuations in the occurrence of ice-rafted debris (IRD) and sea-surface temperature (SST) of NE Japan Sea. Records of IRD and SST showed a close relation with oxygen isotope records of Chinese stalagmites. For example, the co-occurrence of maxima in the abundance of IRD and minima in SST during MIS 3-5 indicates that the intensity of the EAWM was enhanced during periods of low summer insolation and high oxygen isotope ratios in Chinese stalagmites. SST in the SW Japan Sea had larger influence on the surface water properties flowed into the Japan Sea through the Tsushima Strait than that in the NE Japan Sea. On the other hand, the occurrence of IRD was influenced by the location of southern margin of sea-ice expansion. Because cooling of surface water by the EAWM promotes the formation of deep water in the northern Japan Sea, microfossil assemblages also have been influenced by the EAWM intensity. Combination of IRD-SST-microfossil results might be useful to understand the EAWM fluctuations. Reconstruction of long-term fluctuation of the EAWM and its relation to global climate changes is an interesting topic on the IODP Japan Sea expedition.

Keywords: East Asian winter monsoon, ice-rafted debris, sea surface temperature, IODP, Japan Sea

Millennial to orbital-scale variabilities of East Asian Monsoon, its evolution, and the linkage with the HTP uplift and

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It is well-established that millennial-scale variability of East Asian monsoon (EAM) is closely linked with climatic changes in high-latitude North Atlantic and Greenland. However, how they are linked and when such linkage started is still unknown. It is also hypothesized that EAM climate emerged and intensified through Neogene due to the uplift of Himalaya and Tibetan Plateau (HTP) based on the result of climatic simulations, although recent studies suggest possible influence of the emergence and expansion of the northern hemisphere ice sheets on EAM evolution. However, when and how EAM evolved on orbital- to millennial-scales and how its evolution process was influenced by the uplift of HTP and/or the buildup of the northern hemisphere ice sheets are poorly understood.

To approach this long lasting paleoclimatological question, IODP Exp. 346 is scheduled from July 29 to September 28 this year. The cruise focuses on orbital to millennial-scale variabilities of EAM and their evolution during the last 10 My. Especially, our group will focus on orbital to millennial-scale variability of East Asian summer monsoon (EASM) precipitation in South China, millennial-scale changes in westerly jet (WJ) path over Japan, their temporal changes through Plio-Pleistocene, and potential linkage between EASM precipitation and WJ path.

We speculate the amplitude and frequency of the millennial-scale variability of EASM is modulated by the ice volume based on our preliminary analysis of gray scale profile of the Japan Sea sediments. To test this hypothesis, comparison of EASM precipitation record from the northern East China Sea, WJ positional record from the Japan Sea, high resolution gray-scale record of the Japan Sea sediments, with ice volume record is necessary.

Keywords: Asian Monsoon, Tectonics, Climatic change

Formation of the global monsoon - A comparison between the past and future -

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In this presentation, the comparison will be made between past warm climate such as mid-Pliocene (3Ma) /mid-Holocene (6k) and projected CO₂ rich climate. The past cold climate so-called last glacial maxima (21k; LGM) or last millennium (LM) historical archive are also important topics in the monsoon studies which are expected to provide another insight for the climate dynamics. Keeping these in mind, the speaker seeks a conjunction point between the climate modeling groups and paleo-proxy investigator.

The Asian monsoon is a planetary-scale phenomenon driven by differential response to seasonal variations of solar radiation between the Asian Continent and surrounding oceans due to their difference in heat and moisture capacity (Halley 1686). This concept, so-called macro land-sea breeze, is elegant in its simplicity and has been accepted in the monsoon community. In addition to the conventional idea, recent progress of the climate dynamics enable us to discuss heat by integrating temperature with time, which opened new door for interpretation of the monsoon in terms of various time-scales including future projection and paleoclimate. The heat in the monsoon system can be decomposed by diabatic heating over and around the elevated Tibetan Plateau and adiabatic heating anchored with the enhanced rainfall in the tropics.

Trenberth et al. (2000) proposed a concept of global monsoon (GM), in which the seasonally varying overturning circulation in the tropics plays a crucial role for the connections among various kinds of regionally different monsoons. Recently, Wang et al. (2012) clearly deduced the GM domain based on the annual varying rainfall and suggested that various monsoons in the globe are closely connected with adjacent semi-arid climate through the dynamical heat-induced response to the intensified condensation heating caused by the monsoon rainfall. The GM concept allows us to understand consistently the formation and variation of wet and dry climate. The other merit of this system is that we can combine spatially distributed various climatic elements such as local proxy-data into the GM, creating an opportunity to discuss different science community.

Keywords: global monsoon, mid-Pliocene, mid-Holocene, Last Glacial Maximum, Global warming, Millenium experiment

Development and prospective of stalagmite paleoclimatology

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Stalagmites are forefront archives of terrestrial paleoclimates during late Pleistocene and Holocene, which have advantages in precise dating by U-series methods and lamina counting. Oxygen isotopic age-profiles from the caves in south China have provided the standard paleoclimatic records that reveal the change in intensity of the summer Asian Monsoon. Stalagmite studies in Japan have just started recently. Our research group, for instance, has revealed that 1) oxygen isotopic profile in Hiroshima Prefecture conforms the Chinese profile in the deglaciation period, and that 2) the Holocene oxygen isotopic profile in Niigata Prefecture may indicate intensity of East Asian winter Monsoon. Such case studies have been published from around the world. While, studies on interpretation of geochemical proxies are still ongoing. The stalagmite records cannot quantitatively evaluate temperature and rainfall changes because a complex of processes in the atmosphere, the soil layer, and the cave controls stable isotope values and trace element contents in a stalagmite. The stalagmite oxygen isotope value changes with rainfall intensity, rainfall seasonality, temperature, and evaporation of water, whereas the carbon isotope value reflects drip rate of the water on a stalagmite, vegetation types, and soil moisture. Another important effect is prior calcite precipitation, a degree of calcite precipitation from the water before dripping on a stalagmite, which largely influences to the carbon isotope value and the trace element contents. Despite of complexity of the processes, the prominent synchronicity appears among the stalagmite records from different regions. This was found for some climatic events and supported the climatic teleconnection in the Northern Hemisphere. The age-profile of the isotopic and chemical proxies certainly involves paleoclimatic information. Novel techniques in the stalagmite paleoclimatology will be developed to separate the effects from temperature and from rainfall amount to the oxygen isotope value.

Keywords: stalagmite, carbonate, Holocene

Oxygen isotope of stalagmites in Itoigawa, Niigata Prefecture and intensity of East Asian winter Monsoon

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Stalagmite oxygen stable isotopic records from Chinese and Japanese caves have demonstrated the intensity of East Asian summer monsoon (EASM) in late Quaternary. In our study, we analyzed a stalagmite collected from Itoigawa on the Japan Sea side of Japan to reconstruct East Asian winter monsoon (EAWM) intensity during Holocene (from 9.8 ka). Climate of the locality is characteristic in wet winter and nearly 60 percent of the annual precipitation occurs from November to March when EAWM brings moisture from the Japan Sea warmed by the Tsushima Warm Current. Rainwater oxygen isotope values reveal a negative correlation with precipitation amounts at Toyama; indicating the amount effect. The oxygen isotope profile of the stalagmite showed the similar trend to the high-resolution records of eolian fraction from China, and to winter precipitation observed near the cave since 1924, supporting that oxygen isotope record of our stalagmite reflects the EAWM intensity. Comparison of our profile with EASM record from Chinese stalagmite, the inverse correlation was recognized only in early Holocene (9.8-5.3 ka), and apparent positive correlation was in the following interval (5.3-4.5 ka). We suggest that the former was caused by the southward migration of intertropical convergence zone, and the latter was likely due to reduced seasonality in insolation, which could weaken both EASM and EAWM. Late Holocene oxygen isotope profile after a period of mild winter of ~4.5-3.0 ka exhibits high-amplitude changes that could not be observed in the Chinese stalagmites, and two pulses around 1.0 and 2.5 ka were associated with short-lived intensification of NAWM and/or Tsushima Warm Current.

The average oxygen isotope value in 21-30 ka are higher than that in Holocene by about 1.0 permil. To explain this low oxygen isotope during the ice age, we need to consider decline in oxygen isotope values of Japan Sea surface water, the main source of moisture. Japan Sea was isolated from outer ocean due to fall of sea level during this period, and low density freshwater from the Russian Far East and the Japanese Islands is considered to have been stratified from high density deep water. Stalagmite record from Itoigawa supports this oceanographic reconstruction and suggests that the low salinity surface water of the Japan Sea was developed at least in 30 ka and accelerated in 23 ka.

Keywords: stalagmite, oxygen isotope, EAWM, Holocene

Decadal- to centennial-scale fluctuations of East Asian winter monsoon intensity over the last millennium recorded in co

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The southern coast of Japan Sea exhibits many dune fields formed by winter northwesterly wind, which is driven by East Asian winter monsoon that blows from the Siberian High developed around Mongolia and Lake Baikal to western Pacific. The coast is almost perpendicular to the northwesterly, causing longitudinal and transverse dune ridges to develop nearshore. These dune fields have been activated intermittently with some inactive periods marked by organic sand layers during the Holocene. We applied a detailed stratigraphic analysis that combines ground-penetrating radar (GPR) and optically-stimulated luminescence (OSL) dating to two transverse dune ridges on the Tottori coast, southern central Japan Sea. This combination allowed us to establish a thorough chronostratigraphy of dune deposits as optical dating is applied to subsurface sediment sampled in accordance with continuous GPR profiles, and we found patterns of aeolian process affected by decadal- to centennial-scale fluctuations in winter monsoon intensity over the last 1000 years. OSL dating showed concordant results with radar stratigraphy and topographic changes since AD 1932 revealed by maps, suggesting it works well for the Tottori dune sand. Two OSL ages showed that the dune deposition occurred in the 11th century AD, but no age was obtained from the 12th to late 15th centuries, suggesting the dune was inactive during this period. Remarkable reactivation of the dune occurred in the late 15th century, and has periodically continued until present. The dune is generally dominated by landward migration, but the outer dune ridge shows a clear seaward accretion during the 18th century. This seaward migration reflects a decrease in wind capacity, which restricted sand transport nearshore. The 18th century showed a decline in winter monsoon revealed by Chinese historical documents, which is associated with higher winter temperature and lower frequency of thunder and aeolian dust fall. In contrast, two remarkable events of landward dune sand accretion occurred in AD 1580?1640 and around AD 1840, respectively, corresponding to periods of increased dust fall in China, which suggest enhanced winter monsoon. These suggest that the Tottori dune has evolved in relation to the winter monsoon intensity. The dune reactivation over the last several centuries is generally correlated with intensified winter monsoon, and is probably related to the beginning of the Little Ice Age, during which many European coastal and inland dune fields were activated due to increased storminess. The dune reactivation and associated increased aeolian sand transport were reported from historical documents and sediment record for other coastal dune fields along Japan Sea, and thus are considered as widespread phenomena, which led to the need for coastal afforestation since the 17th century.

Summer monsoon precipitation in the Himalaya reconstructed from a tree-ring network of oxygen isotope chronologies

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Though over the last couple of decades researchers have reconstructed past climate variations for the western Himalaya using tree-ring-width records, climate reconstructions for the central and eastern Himalaya are rather few, due at least partly to reduced climate sensitivity resulting from relatively abundant rainfall. Here we developed a tree-ring network across the Himalaya by measuring oxygen isotope ratios. Sampling was carried out at one site in Bhutan, three sites in Nepal, and one site in India. A total of 10-30 individual tree samples were collected at each site. Collected cores were visually cross-dated using standard methodology, resulting in the absolute assignment of calendar years to every growth ring. We selected 2-4 trees for each site for isotopic analysis. Then cellulose was extracted directly from a wood plate (transverse section) with a thickness of 1.0 mm, rather than from individual rings usually conducted in previous studies, allowing us to process thousands of rings simultaneously. Oxygen isotope ratios of tree rings were individually determined for each core over the last 50-250 years using an isotope ratio mass spectrometer.

The variations in tree-ring $\delta^{18}\text{O}$ obtained from Bhutan are in good agreement not only among intra-species but also among three species ($r=0.78-0.89$, $n=50$). Overall, tree-ring $\delta^{18}\text{O}$ chronologies originating from different sites across the Himalaya showed significant negative correlations with local precipitation and relative humidity in the monsoon season, indicating that spatiotemporal variations in monsoon precipitation can be reconstructed using the tree-ring network. Though correlations of tree-ring $\delta^{18}\text{O}$ between different sites decrease with increase in distance of sampling sites, prominent drought years are recorded in all the 5 chronologies. As moisture in the Himalaya originates from the Bay of Bengal, the amount of precipitation usually decreases northwestward. Spatial patterns of precipitation recorded in tree-ring $\delta^{18}\text{O}$ are, therefore, of great use in investigating dynamics of monsoon circulation. The first principal component calculated using all the 5 chronologies for the past 50 years accounts for 49% of the total variance, with all positive PC loadings, reflecting mean precipitation across the Himalaya. On the other hand, the 2nd PC that accounts for 22% of the total variance shows a notable west-east contrast in PC loadings, i.e., positive (negative) for western (eastern) regions. In addition, long-term variations in tree-ring $\delta^{18}\text{O}$ chronologies over the past 200 years also show opposite phases between western and eastern regions. Although the mechanisms underlying the west-east contrast of monsoon precipitation still need to be fully analyzed, a previous study based on speleothem records from India points out that intra-seasonal variability characterized by active and break monsoon may produce a quasi west-east precipitation dipole.

Keywords: Tree ring, Oxygen isotope, The Himalaya, Monsoon

Summer monsoon destabilization at 400 years intervals recorded by tree-ring oxygen isotope ratios in central Japan

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[Introduction] So far, there have been few tree-ring based attempts in Japan to reconstruct past summer climate, because of its weak sensitivity. However, oxygen isotope ratios of tree-ring cellulose have been recently proven to reflect summer precipitation even in warm and humid region such as Japan, and promoted long-term high-resolution climate reconstructions all over Asia. Here, we have reconstructed past inter-annual variations in summer precipitation during last 2 millennia using the tree-ring oxygen isotope ratios of many Japanese cypress trees in central Japan and discovered many epoch-making facts on archaeology, history and climatology.

[Material and Method] We have analyzed many tree-ring samples of Japanese cypress (*Chamaecyparis obtusa*) from living trees, old architectural woods, archaeological remains and buried woods in central Japan covering more than last 2 millennia. After slicing of those woods into 1mm thickness of plate perpendicular to cellulose fibers, we have removed lignin, hemicellulose and resins by sequential chemical treatments and obtained plates consisting only of pure cellulose fibers. We have cut the cellulose ring one by one and measured the oxygen isotope ratio using TCEA-Delta V (Delta plus XL). Although some of tree-ring samples had not been dated by traditional dendrochronological method, we could determine ages of the samples with almost 100% accuracy by overlapping of the measured oxygen isotope time series with those of the predated samples. To combine the many time-series which show different mean oxygen isotope ratios between samples reflecting original growth altitude or physiological condition, we have shifted each time series up and down to make the averaged values equal in the overlapped period between the two different samples and finally completed continuous time-series of tree-ring oxygen isotope ratios during more than last 2 millennia.

[Result and Discussion] The time-series of tree-ring oxygen isotope ratios are correlated well with changes in summer precipitation estimated by various instrumental, historical and archaeological methods irrespective of the age. The similar pattern with variations in oxygen isotope ratios of Chinese and Indian stalagmites suggests that it is mainly controlled by changes in Asian summer monsoon. Moreover, the 2 millennia length of tree-ring oxygen isotope chronology provides us of many progresses in the studies of archaeology, history and climatology. In archaeology, this chronology makes us enable to date any wooden materials in Japan with annual time resolution since 2000 years ago because of its universal use independent from tree species in contrast to the case of tree-ring width. In history, we can propose a new hypothesis that many historical disturbances in Japan, such as civil wars and regime shifts, were caused by abrupt activation and destabilization of East Asia summer monsoon. In climatology, we can find two types of summer climate variability by comparison of the historical change in tree-ring oxygen isotope ratio with that of newly reconstructed East Asia summer temperature based on Asian wide tree-ring width database (Cook et al., 2012). One is the monsoon-type of variation where temperature and precipitation vary with positive correlations. The other is the variation with negative correlations between temperature and precipitation, found in the cases of volcanic eruptions and recent global warming. Especially, the monsoon-type variability shows predominant amplifications of multi-decadal components at exactly 400 years intervals, suggesting the existence of some astronomical pacemaker. Because of the fact that the destabilizations of summer monsoon activity often preceded the major historical disturbances in Japan and Asian countries and the next destabilization is predicted to occur in early 22nd century, it is very important to elucidate the mechanism underlying the 400 years periodicity.

Keywords: tree ring, cellulose, oxygen isotope ratio, East Asia, Japan, summer monsoon

Variation in the Yangtze River discharge during the Holocene based on sedimentological records from the East China Sea

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The Yangtze River is the largest river in the Eurasian Continent originated from the Tibetan Plateau and flows out to the East China Sea. The River plays an important role in marine sedimentation in the East Asian marginal seas. The relationship between the discharge and the flux of the Yangtze River-derived sediment is of great significance to understand the source-to-sink pattern of terrigenous materials into the East China Sea. The mud belt of East China Sea inner shelf is one of the major sinks of the Yangtze River-derived sediments, which provides important constraints on the sediment budget on the shelf as well as paleoenvironmental changes due to monsoon variability in the drainage basin during the Holocene.

IMAGES XIV 2006 Marco Polo II cruise recovered a high quality calypso core (MD06-3040, 27°43.3663'N, 121°46.8822E, 47m water depth, core length 19.36m) from mud belt of the East China Sea inner shelf. The age model of core MD06-3040 was constructed based on ¹⁴C dating that reveals the core covered the whole Holocene. The grain size distribution and the major element composition of the MD06-3040 core sediment have been determined in order to examine the relationship between the changing provenances of fine-grained sediments and East Asian Monsoon variation during the Holocene. The grain size shows a multi-modal distribution that consists of more than 3 modes centered at clay, silt, and sand sizes. The grain size of silt fraction is finer around 7 ka, which suggests the sea-level control on sand delivery. Co-variation of $(\text{Clay}+\text{Silt})/\text{Clay}$, Ti/Fe, and K/Al indicates a millennial-scale variability of suspension transport of the Yangtze River-derived fine sediments. Intervals of minimum grain size correspond to the low Yangtze River discharge events recorded in the northern East China Sea core and weak monsoon events recorded in some of stalagmite records within the Yangtze River drainage at millennial-scale, suggesting high discharge could transport the coarser materials as suspension load.

The contribution of each grain size mode and major elements ratio are significantly controlled by the Yangtze River discharge though the previous studies have suggested that the source rock compositions and chemical weathering intensities in the drainage basin account for the compositional variations of the River sediments. The extensive alongshore mud belt represents the southward transport of Yangtze-derived sediment. Most of this mud has been transported southward in the past 6.5-7ky BP after sea level reached its mid-Holocene highstand, which is the interaction among summer monsoon, winter monsoon, tide, current and river discharge at different timescale. The signal of monsoon climate registered in the fine-grained sediments must be more carefully interpreted considering the sediment transport process, and more attention to high-resolution and reliable provenance proxies for each grain size fraction is required.

Fossil coral sea-surface temperature reconstructed at Kume Island at the mid- to late Holocene boundary

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The relative warmth and stability of the Holocene was punctuated by several brief climate perturbations. There is evidence for a global late Quaternary climate anomaly at around 4.2 ka, and mechanisms of this event are not well understood. As one of the major climate events in the Holocene, 4.2 ka is proposed as the Middle-Late Holocene boundary (Walker et al., 2012). Although climate perturbations on a global scale are widely reported in this period, the lack of records from regions such as the East China Sea (ECS) results in an incomplete understanding of the underlying mechanism of Middle-Late Holocene climate change.

Here, we present a coral-based paleo-SST (Sea-Surface Temperature) reconstruction from the Kume Island, in the ECS, to reveal climate variability in mid- to late Holocene boundary. Coral (*Porites* sp.) exhibits annual bandings and a rapid growth rate that enables to reconstruct paleoclimate at seasonal time scales. Among the various chemical components in coral skeletons, Sr/Ca ratios are a reliable proxy for SST (e.g., Beck et al., 1992; Corregge, 2006). Two fossil corals were collected from the Kume Island, and radiocarbon dates were determined using AMS. The dating results of two fossil corals are 3.8 ka and 4.5 ka, respectively. We measured Sr/Ca ratio of two fossil coral skeletons and estimated paleo-SST (Sea-Surface Temperature) by applying the Sr/Ca vs. SST equation established from modern corals. Our new data confirm that both in summer and winter, cold conditions prevailed at 3.8 cal kyr BP, beginning after 4.5 cal kyr BP.

In the ECS, weak Kuroshio Western Boundary Current event, (*Pulleniatina* Minimum Event; PME, 4.5-3.0 ka) (e.g., Ujiie and Ujiie, 1999) has been reported around Middle-Late Holocene boundary. However, paleo-climate reconstruction of the PME has three problems. First, Some of the previously reported paleo-SST records shows decrease of SST during the PME, while others shows no change. Second, paleo-SST variability during the PME has not been reconstructed on a seasonal scale. Finally, the reported time range of the PME is highly variable. Therefore, a high-resolution, SST reconstruction is beneficial for understanding climate change during the PME.

While the PME has not been resolved seasonality, our high-resolution data clearly indicate sea-surface temperature decreased during both summer and winter. This result, combined with PME event reconstruction as the weak Kuroshio event, suggests that weak Kuroshio current caused SST decrease in the ECS both in summer and winter.

This result, combined with further Sr/Ca analysis using fossil corals collected and dated in this study, provides an important insight into the mechanism of the Middle-Late Holocene boundary in the ECS.

Keywords: Holocene, 4.2 ka, coral, Sr/Ca, SST, East China Sea

Toward quantitative reconstruction of precipitation during the latest Holocene using the sediment of Lake Suigetsu

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Lake Suigetsu in Fukui Prefecture, central Japan is characterized with deep depth relative to its small size and composition of accumulating sediment particles differs according to season. Because of these characteristics, Lake Suigetsu has annually laminated sediment (varve) continued since 70000yr B.P. In previous SG93 and SG06 projects, high resolution 14C datings of fossil leaves sampled from the sediment were conducted to construct extremely high quality age model. In SG 12 project, we drilled new sediment cores aiming to re-construct paleo-climatic changes such as precipitation and westerly jet path with high precision and high time resolution.

Lake Suigetsu has no direct feeder river. Fine suspended particles flow into Lake Suigetsu indirectly through Lake Mikata from Hasu River. Aeolian dust from the Asian Continent also contribute detrital supply to the sediment of Lake Suigetsu. There could be an additional source of detrital materials, which is supplied from the marginal part of the Lake by reworking due to earthquakes. However, the method to distinguish these clastic materials from different sources in the sediment cores are not yet established.

There are several previous researches to based on the lake Suigetsu sediments, such as pollen analysis and identification of flood events based on composition of clay minerals. However, quantitative reconstruction of precipitation has never been conducted.

In this study, we are going to quantitatively reconstruct the past precipitation of this region using the relationship between precipitation and flux of suspended matters in river water.

More specifically, we will re-construct temporal changes in the flux of suspended particles from Hasu River during the last 100 years or so. Then we compare the obtained detrital fluxes from Hasu River to Lake Suigetsu with observational precipitation record around the area to derive the relationship between the annual precipitation and the flux of suspended detrital particles from Hasu River.

Because there must be multi sources of detrital materials to the sediment in Lake Suigetsu, we will conduct end member analysis using mineral and elemental compositions of the sediment. Then we will compare the composition of these end members with those of possible sources such as aeolian dust, suspended particles from Hasu River, and sediments delivered from surrounding slopes of Lake Suigetsu.

Keywords: reconstruction of precipitation, annual laminated sediment (varve), suspended particles, lake Suigetsu, paleo-climate

Synchrony and asynchrony of climate changes derived from the SG06 varved sediment core from Lake Suigetsu, Japan

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

Keywords: Lake Suigetsu, SG06, Varved sediment, Climate change, Palynology, Radiocarbon

Paleoenvironment reconstruction from minor elements in sediment of Lake Biwa

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Climate changes during last Pleistocene to Holocene are characterized by Glacial-Interglacial Cycle, or more shortly, Dansgaard-Oeschger Cycle, and so on (Dansgaard et al., 1993). To reconstruct these millennial scale climate change, it is necessary to analyze high resolution geological records.

Lake sediment is one of geological records that can be analyzed high resolution because of their high accumulation rates. Thus, we can reconstruct paleoenvironments in high precision by analyzing lake sediments (Yancheva et al., 2007; Nakagawa et al., 2006).

In Asian region, climate is largely controlled by East Asian Monsoon (EAM). In summer, EASM (East Asian Summer Monsoon) brings moist and warm climate in the region, whereas EAWM (East Asian Winter Monsoon) is characterized as cold and relatively dry air originated from Siberian High, which intensified in boreal winter. According to paleoclimate archives, it has been said that EAM intensity are related to global climate change (Wang et al., 2001; Katsuta et al., 2007), thus it is important to reconstruct behavior of EAM.

As, Fe/Mn ratio, and Mass Accumulation Rate (MAR) in the sediment of lake Biwa show clear decrease of lake level in 30ka, which has lowest level in past 50kyrs. In same age, there is positive and negative peak in Sr and Nd isotope data respectively. These isotopic data indicates source materials and their contribution rates to sediment. The peak of isotopic data shows greater contribution of dusts from Taklimakan desert, which indicates either stronger Winter Monsoon, or southern shift of Westerly Jet. However, our data set requires higher resolution, so that we can separate source areas of sediment in detail. Furthermore we can reconstruct climate changes that occur in short time scale.

Keywords: Lake, sediment, Paleo-environment

Testing the accuracy of quantitative climate reconstruction using fossil pollen data of annually laminated sediment

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Quantitative climate reconstructions play an important role in understanding the global climate changes as well as regional climate changes. Pollen data allows us to reconstruct the terrestrial climate change quantitatively. Recently the research on the climate change at Lake Suigetsu and Lake Mikata in Fukui prefecture in Central Japan has been conducted by modern analogue method using the surface pollen data set in Japan and meteorological data. It is said that the reconstruction accuracy is quite high. However, there is no study to test the actual accuracy of it comparing reconstructed with meteorological data. The sediment from Fukami-ike lake in Nagano prefecture is annually laminated and the laminae are thick enough to separate annually. 11 cores were recovered from the lake and 2 cores, 10-6-1 and 10-3-1 cores were used to test the accuracy of reconstructed climate data from 1918 to 1980 from the 10-6-1 core and from 1920 to 1969 from 10-3-1 core comparing to the meteorological data close to the lake. Marker grains were added during the pretreatment of pollen and pollen analysis was conducted annually. Pollen flux of 5 years, 11 years, 21 years and 31 years was calculated based on the marker grains. Polygon 2.2.4 (<http://dendro.naruto-u.ac.jp/~nakagawa/>) were used to reconstruct the annual mean temperature, spring (March, April, May) mean temperature, summer (June, July, August) mean temperature, autumn (September, October, November) mean temperature, winter (December, January, February) mean temperature, warm index, cold index, annual, spring, summer, autumn and winter precipitations. Then, those were compared with the meteorological data from the Iida meteorological station which is the closest to the lake.

The averages of the reconstructed precipitations were closed to the observed meteorological data. However, the correlation coefficients were low and the reconstructed data did not reflect the change of precipitation. The reconstructed annual, autumn and winter temperatures, cold index were relatively reliable. The averages of these reconstructed values were close to those of observed temperatures. The correlation coefficients between the reconstructed values and observed values were highest at 11 years and 21 years of pollen flux. The difference between the averages of reconstructed spring and summer mean temperatures and those of observed ones were great. The correlation was not observed between reconstructed summer mean temperatures and observed ones. The correlation existed between reconstructed spring mean temperatures and observed ones, but the reliability was doubtful since great difference existed between the average of reconstructed spring mean temperature and that of observed one. Warm index was also doubtful in reliability. There were great difference between the averages of reconstructed one and observed one although the correlation was good.

Recently, high-resolution analyses have been conducted, but the analyses of very high resolution, like 1 year and 5 years are not suitable to pollen analyses based on this study. The analyses of 10 years or 20 years improve the correlation coefficient. However, the analyses of over 30 years loose reliability. The reconstruction of precipitation may be difficult in high precipitated region like Japan. In high precipitated region, the change of precipitation may not affect much in pollen production. It is also difficult to reconstruct spring and summer mean temperature, but the reconstruction of autumn and winter mean temperatures is possibly reliable. It may be caused by phenology of plants. It is hard to say that these can be applied to all regions in Japan. It is expected that we will observe different results at the region with great difference in flora, precipitation and temperature.

Keywords: Fukami-ike lake, pollen analysis, climate reconstruction

Effects of natural climate change and human activity on the lagoon ecosystem in the northeast Korea

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Although both human activity and natural climate change affect the aquatic environment and ecosystem of lagoon, the majority of previous researches on lagoon eutrophication discussed the effects of human-induced eutrophication. The effects of climate change have been comparatively less discussed. Thus, we reconstructed the environment and ecosystem changes since the little ice age in a seasonally frozen lagoon Hwajin-po locates along the northeastern coast in Korea, based on multi proxy analyses (CNS, XRF, grain size, diatom, foraminifera, ostracoda) of sediment samples, in order to discover the impact of eutrophication and climate change on the lagoon ecosystem.

Lagoon Hwajin-po locates along the northwestern coast in Korea, and is seasonally ice-covered. At present, Hwajin-po is eutrophic lagoon dominated by plankton. Although Hwajin-po is shallow as maximum depth is about 4 m, anoxic water mass was observed during summer time. In July 2012, two 2-m long sediment cores (Hw12-A and -B) were obtained from the outer lake of Lagoon Hwajin-po using a push-in piston corer; at that time the water depths were 3.85 and 3.92 m. Based on the sediment core analysis, eutrophication of lagoon Hwajin-po started in late 1970s by human activities. Before the 1970s, lagoon Hwajin-po was probably sea-grass dominating lagoon. Effect of human activity in itself was confirmed since the early 20th century. Volume of sediment inflow from the catchment area increased since then, and it changed the assemblages of benthic biota in the Lagoon Hwajin-po. On the other hand, lagoon environment and ecosystem showed the cyclic change before the 19th century. In this presentation, impact of climate change on the lagoon ecosystem is discussed based on this periodical environmental change between 15th and 19th centuries.

Keywords: Coastal Lagoon ecosystem, microfossil, chemical component, anthropogenic impact, climate change

Change of recent sedimentary environment recorded to the coastal Lagoon sediment in the Lake Ogawara , Aomori Prefecture

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To analyze paleoenvironment and paleoclimate, we must understand the feature of sediments as recorder and recent environment. In particular, the coastal lagoon is necessary to investigate before performing the paleoenvironmental study because of shows each characteristic lake environment. In this study, we performed a field study in the Lake Ogawara from November, 2012, to clarify a characteristic of sediments.

The Lake Ogawara, is located in east part of Aomori Prefecture, have a halocline around 20m for water depth throughout the year. The water column of Lake Ogawara divided into 3 water masses, as an epilimnion (0-10m), a metalimnion (10-18m), and a hypolimnion (deeper than 18m).

In this study, Og 20 , 33 , 64 , 84 , 95 and 97 in the 6 point short core samples.

As a result of grain size analysis, the frequency distribution of muddy sediment have a mode at 3.5, 5.5, and 7.5 phi. As a result of CNS element analysis of core samples, the total organic carbon (TOC) contents value of surface sediments is 9% decrease toward deep, and show very low value (around 2%) .The total sulfur (TS)contents value of surface sediments is 2.5% decreased towards a lower value 0.4%.

From the epilimnion of the current environment, the environment has changed and metalimnion and salinity in reductive of the current.

Characteristics of grain size composition is based on density flow from the Pacific Ocean, floating suspended solids, by the density flow and floating suspended solids by rivers.

Shows that by comparing the current and 2000 year, in the metalimnion into salinity in proceeded, has been an increase in the supply of coarse sediment by density currents from the Pacific Ocean.

Keywords: Coastal Lagoon, Lake Ogawara, TOC content, TS content, grain size analysis