Delayed Asian monsoon onset during the Medieval Warm Period: PMIP3 multi model study

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The Asian monsoon develops over tropical-to-subtropical South and East Asia and is characterized by salient seasonal variation in atmospheric circulation between land and ocean. Long term integrations of climate models on hundred or thousand year timescale reveal that the past variation in seasonal and latitudinal distributions of solar radiation due to orbital parameters forces long-term Asian monsoon variability. Enhanced summertime insolation at the top of the atmosphere (TOA) and resultant warmer Eurasian Continent during the Medieval Warm Period (MWP; 950-1250 A.D.) compared to the Little Ice Age (LIA; 1400-1700 A.D.) reinforces the Asian summer monsoon. The last millennium simulations conducted under the Paleoclimate Modeling Intercomparison Project phase 3 (PMIP3) reveal that the enhanced land-sea thermal contrast and monsoon during the MWP are largely consistent among models. The TOA radiation as a driving factor for the Asian monsoon has its peak anomaly (MWP minus LIA) during July to September (JAS) over the Northern Hemisphere mid and high latitudes. In contrast, the TOA radiation between boreal winter and pre-monsoon period (April to June; AMJ) shows negative anomaly (less insolation during the MWP compared to the LIA). The seasonally asymmetric radiative forcing can result in early/delayed onset of summer monsoon (e.g. Ueda et al. 2011). The current study examines physical relationship between timing of monsoon onset and variation of insolation during the MWP by using results of PMIP3 multi-model archive and idealized sensitivity simulations in a coupled climate model.
PMIP3 multi-model ensemble-mean shows warmer Eurasian Continent and enhanced Asian summer monsoon in JAS but inversely shows cooler Eurasian Continent in AMJ and delayed monsoon onset. Land-sea contrast in tropospheric temperature (between 200 and 500 hPa) can be used as an index for monsoon intensity. Sensitivity experiments performed by MRI atmosphere-ocean coupled general circulation model prescribed with orbital forcing during the two periods can reproduce the above regional anomalies including monsoon. The results of this study indicate that the delayed monsoon onset during the MWP is primarily forced by the orbital parameters and therefore robust feature among climate models.

Reference
Ueda, H., et al. 2011. Clim. Dyn., doi:10.1007/s00382-010-0975-z.

Keywords: Asian monsoon, Land-sea contrast, Medieval Warm Period, Little Ice Age

The cold periods before and after the warmest early Heian era –No existence of Medieval Warm Event in Japan –

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A continuous reconstruction of quantitative paleotemperatures in the Holocene was conducted by using alkenone sea surface temperature (SST) measurements from coastal sedimentary cores because of the strong correlation of SST with atmospheric temperature (AT) in the coastal bay area. Especially during the last three thousand years, the SSTs (ATs) fluctuated by 2.1 degree, with a maximum in 820AD (24.3 degree, 25.9 degree). In addition, the large minimum SSTs (ATs) wa observed at 990 AD (22.4 degree, 24.0 degree). Low temperature was also observed in 560-620AD. The Medieval Warm Period (MWP) in 950-1250 AD (sometimes 1000-1400 AD) is a period of warming by a few degrees that was primarily confined to Europe and North America. The period and affected areas are, however, still open to debate. The IPCC Assessment Reports (2001, 2007) and Mann et al. (2009) discussed the “MWP around 1000 AD”, which may have been local or regional. Bradley et al. (2003) reviewed the evidence and concluded that the warmest medieval ATs were not synchronous around the globe. The MWP was not identified in western Japan because a cold climate prevailed in 990–1150 AD. Particularly low temperatures around 1000–1100 AD can be verified by historical documents from in and around the ancient capital city of Kyoto (Ishii, 2002). It is also confirmed by the evidence that large decrease of SSTs(ATs) was reconstructed in Uchiura (Funka) Bay in northern Japan. Therefore Japanese islands did not experience MWP although MWP has been reported from Europe, USA, and China. Although it is difficult to exactly specify the causes, one plausible mechanism is ENSO. It is suggested that the equatorial Pacific was predominantly in an El Niño phase in 900–1200 AD. Actually, the Southern Oscillation Index (SOI), a proxy for an ENSO event, with negative values corresponded to an El Niño episode. At the modern condition, the Pacific high is weakened, with reduced atmospheric pressure in the western North Pacific in the vicinity of Japan. This results in an enhanced Okhotsk high, which tends to be accompanied by a cold and cloudy/rainy summer in Japan (Meteorological Agency of Japan, 2014).

Keywords: Sea surface temperatures, Atmospheric temperatures, Climatic change, Medieval Warm Period, Japan

Late Holocene flooding history reconstructed from GDGTs in Beppu Bay sediments

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Reconstruction of flooding events is a recent issue of paleoclimatology. We developed the use of GDGT compositions to identify flooding sediments in marine cores and generated a 2900-year long record of flooding in Beppu Bay area, northern Kyushu, Japan by analysing 457 sediments (2-cm interval) of core BP09-3 retrieved in Beppu Bay basin. We also analysed 74 soils in the watershed areas of Oita and Ohno Rivers and 35 estuary sediments for comparison.
Branched GDGTs in soils have less methyl group (higher MBT) and less cyclic structures (higher CBT) than estuary and basin GDGTs. Soil and estuary sediments have more branched GDGTs (higher BIT) than basin sediments. GDGT compositions are, thus, useful to identify the provenance of sediments in Beppu Bay cores.
In core BP09-3, 18 thick and 55 thin event layers were recognized by visual, soft X ray and CT-scan descriptions, and the sediment ages were determined by 42 radiocarbon dates of molluscan shells (Kuwae et al., 2011). Most of major event layers showed higher BIT than hemipelagites. Some of them have high MBT and CBT values which correspond to those of soils. We interpret that they originated directly from the surface soils via Oita and Ohno Rivers, most likely by typhoon-induced flooding. Historical records support this interpretation.
U^{K}_{37}' in the study core showed decadal-scale variation in temperature (PDO). More than two third of flooding events occurred when temperature was rising (transition from positive to negative PDO). These results suggest that the spatial pattern of North Pacific sea surface temperature is a key factor controlling typhoon activity.

Keywords: typhoon, flooding, PDO

Formative Process of varve sediments and recent cyclic change in the Lake Hiruga, Fukusima Prefecture, central Japan

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Lake Hiruga, is one of the Five Lakes of Mikata, is a small lake of less than 1 km^2, which is located in the Japan Sea side of central Japan. This lake is in contact with the Japan Sea by Hiruga channel, and with Lake Suigetsu by artificial Saga Tunnel. Although the salinity of lake water is close to the seawater, the bottom water shows the low water temperature (about 10˚C) in the summer season, and shows the constantly anoxic environments, because the water depth of lake basin is deep (about 38m).
In order to clarify the history of paleoenvironmental change at the Lake Hiruga, the coring was carried out around the center of lake. In this time, we discuss about the formative process of distinct lamina in core top of 50cm, and report to cyclic change.
15HG-2C and 3C cores consist of mud sediments with the lamination at the integrated core length of 251cm. AMS^{14}C dating is carried out in 11 horizons. Based on the results, the age of core bottom is about 3300 years ago. Lake Hiruga was a freshwater lake until AD150, and changed to oligohaline lake from that time. Around the 10th century, the bottom water of this lake became to mixoeuhaline water. Judging from the bottom water exhibits a euxinic environment, it might have had a distinct stratified structure in water column. From the 19th century, the lake basin shows high sedimentation rate, and distinct lamina sediments are formed. It is considered that this is caused by the construction of the Saga tunnel.
In distinct lamina sediments, a lamina with high soft X-ray absorption intensity shows gray color. This suggests that it is a lamina with high precipitation. According to the precipitation pattern in the Wakasa district, the peaks of precipitation are shown snowfall season in winter, and rainy and typhoon seasons in summer. In snowfall season (Dec. to Jan.), the precipitation is the highest. Although the drainage to the lake is large, the current velosity seems to be low, because it accumulates in the catchment area as a snowfield. It is considered that this period contributes to the supply of fine sediments, and forms a lamina with low soft X-ray absorption intensity. In rainy season (Jun. to Jul.) and typhoon season (Aug. to Sep.), heavy rainfall is likely to occur, and the current velosity in lake seems to be high. It is considered that these period contributes to the supply of coarse sediments, and forms a lamina with high soft X-ray absorption intensity. When both events occurred, a lamina with high intensity shows double layer. In this reason, a lamina set with high and low intensity seems to be interpreted as varve.
During the last 200 years, the fluctuation of 5 cycles in total organic carbon (TOC) contents, and the fluctuation of 10 cycles (about 20 years cycle) in total sulfur (TS) contents were recognized. It is considered that the cyclic fluctuation of TS contents is caused by different level of reduced environment due to differences in inflow of seawater with cyclic sea-level change. This cyclic fluctuation seems to be related to the Pacific Decadal Oscillation (PDO). We recognized about 35 years cycle in the TOC contents, and 75 years cycle in the sediment flux.

Keywords: Lake Hiruga, varve, Total sulfur contents, cyclic fluctuation, PDO

Relationship between sedimentary environment and change in type/magnitude/frequency of paleo-hazard history recorded in the sediment of Lake Suigetsu during the late Holocene

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Occurrences of floods and earthquakes could cause the inflow of enormous material to sedimentary basin and consequent deposit of “event deposits (event layers)”. Event deposits could be the recorder of hazard events in the geological past, exceeding the limit of observation and historical record. However it is not easy to distinguish the cause of deposition of event layers and magnitude of each event. In addition, it is also necessary to consider the change of sedimentary environment which could affect the boundary conditions of deposition and scale of event layers. In this study, we tried to reconstruct the record of heavy precipitation and flood events on the last 7000 years using sediment of Lake Suigetsu (SG12 core) based on correlation of observational record and sediment. As a result, depositional processes for recording the occurrence of heavy precipitation and flood events are revealed as below;
1) Flux of detrital material from drainage area increases with the frequency of heavy precipitation (>50mm/day).
2) Light gray event layer is deposited with the occurrence of flood event and its thickness represents the total amount of precipitation in the flood event.
In addition to this result, we reconstructed the flux of sediment components including detrital material from different sources and correlated the result with other environmental record obtained from the sediment of Lake Suigetsu. As a result, local environmental changes described below are revealed.
1) Flux of detrital material would increase and keeps high level in ~100 year time scale occasionally after the deposition of event layers. This could be caused by the increase of erosion rate triggered by slope failures.
2) After the deposition of event layers which are correlated with historically recorded earthquakes, flux of detrital material would increase and keep high level in ~1000 year time scale. This could be the result of topographic change of drainage area caused by fault movements.
Related to this presentation, establishment of proxy for reconstructing heavy precipitation and flood event based on correlation of sediment and observation is presented in H-SC07 session, and correlation of the result of flood event in the late Holocene with regional climate change would be discussed in M-IS 06 session.

Keywords: Lake Suigetsu, varved sediment, flood, earthquake, Holocene

Variation factors of the coastal lagoon environment and ecosystem since the modern period in Hokkaido, Japan

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Although both human activity and natural climate change affect the aquatic environment and ecosystem of lagoon, most previous researches on lagoon eutrophication only discussed the effects of human-induced eutrophication. The effects of climate and sea-level changes have been comparatively less discussed. Thus, we reconstructed the environment and ecosystem changes since the mid 19 centuries in a seasonally frozen lagoon Mokoto-ko locates along the Okhotsk Sea coast in Hokkaido, northern Japan based on multi proxy analyses (CNS, XRF, and diatom) of sediment samples, to discover the impact of eutrophication and climate change on the lagoon ecosystem.
Mokoto-ko is seasonally ice-covered small lagoon, however, has a large 167 times catchment area. At present, Mokoto-ko is an eutrophic lagoon, and anoxic bottom water mass was observed. In January 2009, 1.8 m long sediment cores (09Mk-1C) was obtained from the northern part of basin using a push-in piston corer. There is the clear lamina layer throughout this core. Based on the sediment core analysis, eutrophication of lagoon Mokoto-ko started in late 1950s by phosphorus input, which is probably related with the development of dairy farming in the catchment area. On the other hand, lagoon environment and ecosystem showed drastic fluctuation. A sudden eutrophication and fresh water input of this lagoon has a strong relationship with heavy precipitation in its catchment. In this area, frequency of the heavy precipitation has good correlation with the phase of the Arctic Oscillation, meaning that Arctic Oscillation partially controlled the lagoon environment and ecosystem. In this presentation, impact of climate change on the lagoon ecosystem is discussed based on this periodical environmental change in addition to the impact of human activity.

Keywords: lagoon, Paleoenvironment, Diatom, Anthropogenic effect

Challenges for Millennium Reanalysis

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Our systematic instrumental measurement for meteorological quantities only lasts 100 years at most, so they are too short to analyze recent big climate changes, like Little Ice Age or Medieval Warming Period. In our research group, we have made an offline data assimilation system for stable water isotopes and showed our success to reproduce ENSO changes during 19th to 21st century (Okazaki and Yoshimura, submitted). On the other hand, we have made data assimilation of weather information from old diaries (Toride et al., submitted). Thus, by combining those two data assimilation methods, we are trying to make 1000-year length atmospheric reanalysis product or "Millennium Reanalysis". At the presentation, I'd like to introduce these two new methods and current status of Millennium Reanalysis project.

Keywords: Millennium Reanalysis, data assimilation, stable water isotope

Responses of Antarctic and the Southern Ocean temperatures to changes in annual-mean insolation over the past 700,000 years

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Antarctic temperature record, based on isotope composition of water (δ D), shows close correlation between temperature and atmospheric CO_2. Many studies suggest that a central role of the temperature variation of the Southern Ocean region for global carbon cycle. Deuterium-excess (d-excess = δ D $-8\,\delta^{18}$ O) provides the information on the ocean surface conditions in the moisture source for polar precipitation. We show a new d-excess record from the 3,035m-depth Dome Fuji ice core (DF2), which was obtained at the Dome Fuji station. The new part of DF2 core (2400m to 3034m depth) extends back to 700 ky BP with high time-resolution. We reconstructed Antarctic air temperature (T_{site}) and temperature at moisture source region (T_{source}) using the new d-excess data. Relationship between T_{site}, T_{source}, and annual mean insolation will be discussed.

Keywords: ice core, d-excess, glacial interglacial cycle

High-resolution reconstruction of climates under the three great famines in the Edo period based on intra-ring oxygen isotope ratio of tree rings and historical daily weather record

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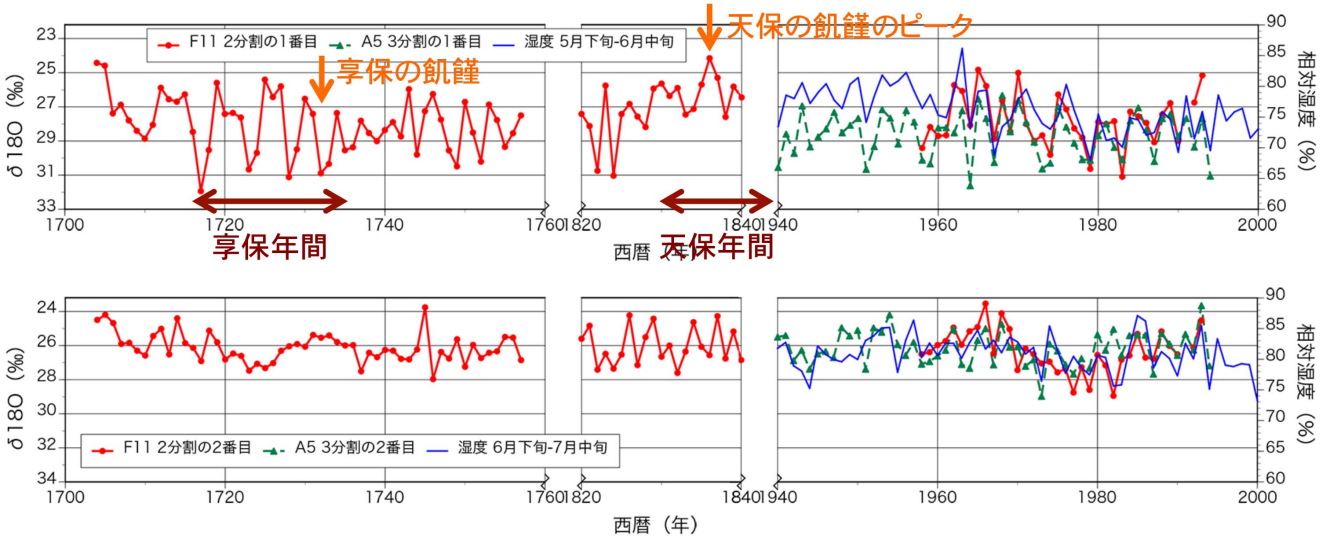
Stable oxygen isotope ratio ($\delta^{18}O$) of tree-ring cellulose is known to reflect well relative humidity at the time of ring formation. In this study we attempt high-resolution reconstruction of climates under the three great famines (Kyoho, Tenmei, Tempo) in the Edo period (1603-1867) by analyzing intra-ring data of oxygen isotope ratio of tree-rings. Tree-ring samples used in this study were taken from two hinoki (*Chamaecyparis obtusa*) trees growing at the Mt.Tanakami site, Shiga Prefecture, central Japan. We extracted cellulose from the wood samples by the “cross-section” method and divided into 12 (or 2, 6, 24, depending on the ring width) segments for each ring using a scalpel. Isotopic measurement was carried out using a continuous flow system with a pyrolysis-type elemental analyzer and an isotope ratio mass spectrometer (TCEA-Delta V Advantage). By comparing measured intra-ring data of cellulose $\delta^{18}O$ and observational data of relative humidity at the adjacent meteorological station for the mid- to late 20th century, intra-ring $\delta^{18}O$ was found to reflect variation of humidity at sub-seasonal (monthly or finer) temporal resolution in the growth season of the tree (May-Jul. or May-Sep. for our samples). According to this result, we reconstructed variations of humidity for the pre- to early Baiu rainy season (May-Jun.) and the mid- to late Baiu season (Jun.-Jul) using $\delta^{18}O$ chronologies of early part and middle or late part of each ring (Figure). For the pre- to early Baiu season, highly variable $\delta^{18}O$ was found in the Kyoho period (1716-1736), implying periodical occurrence of dry early summer caused by delayed onset of the Baiu season. We can also recognize significant decrease in $\delta^{18}O$ (increase in humidity) in the Tempo period (1831-1845), probably due to abnormally early onset of the Baiu season. Contrarily, variability of $\delta^{18}O$ is relatively small for the mid- to late Baiu season.

Keywords: Tree-ring cellulose, Stable oxygen isotope ratio, Intra-ring fluctuation, Relative humidity, The three great famines in the Edo period, Historical daily weather record



初夏～梅雨季前期(上)と梅雨季中～後期(下)に対応する年層内セグメントの年輪酸素同位体比と相対湿度の経年変動

Climate variations in northern Japan as reconstructed from tree ring cellulose $\delta^{18}O$

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Tree-ring cellulose $\delta^{18}O$ is known to be a promising proxy for reconstructing hydroclimate variations in monsoon Asia because the $\delta^{18}O$ is not controlled by ecological factors but by two climatic parameters (i.e., relative humidity and $\delta^{18}O$ of precipitation). In this study, two tree-ring $\delta^{18}O$ series were developed by measuring two individual trees (*Cryptomeria japonica*) growing in Miyagi, northern Japan. Climatic response analyses reveal that the relationship between tree-ring $\delta^{18}O$ and relative humidity is not temporally stable. Also, the tree-ring $\delta^{18}O$ from Miyagi shows complex correlations with other tree-ring $\delta^{18}O$ from Japan, indicating that tree-ring $\delta^{18}O$ in northern Japan is not simply controlled by local hydroclimate. Continued effort toward the development of a dense tree-ring network will shed more light on variability of climate in Japan.

Keywords: Tree-ring cellulose δ18O, Japan

Correlation between two tree-ring d18O chronologies from coastal areas of Pacific and Japan Sea in Hokkaido, North Japan

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We analyzed the tree-ring oxygen isotope ratios (d18O) during last one hundred years for four trees of Picea glehunii in each of North (Teshio) and East (Onnebetsu) Hokkido, Japan. In each of the two sites, there are very good correlations of the tree-ring d18O variations among different tree individuals. However, there is no good correlation between averaged tree-ring d18O variations of Teshio and Onnebetsu, suggesting that the main meteorological factors to determine the tree ring d18O are different between Teshio and Onnebetsu.
We investigated the relationship between the tree-ring d18O and local meteorological parameters. We found that the tree-ring d18O in Teshio has positive correlation with spring temperature and negative correlation with summer precipitation and relative humidity, showing that it can become a good summer precipitation proxy because there is especially large negative correlation with summer precipitation. In contrast, we could not find any significant correlations between the tree-ring d18O in Onnebetsu facing on Pacific Ocean and summer meteorological factors. Because summer hydro-climate in Pacific Ocean side of North Japan is more complex than that in Japan Sea side reflecting the inter-annually varying effects of cold marine fog, we are obliged to conclude that it is difficult to reconstruct paleoclimate using the tree-ring d18O solely in Pacific Ocean side of Hokkaido. However, we found that there are predominant 20-years periodicity in the 11 years sliding correlation between the tree-ring d18O in Teshio and Onnebetsu, which is coincident well with the 11 year running mean of air temperature in Hokkaido. So, the tree-ring d18O in Pacific Ocean side of North Japan can be used as a novel temperature proxy by investigating its correlation with the tree-ring d18O in distant area rather than treating it solely.

Keywords: tree-ring d18O, Hokkaido, Picea glehunii

Climate response of oxygen isotopic compositions in tree-ring cellulose from Java, Indonesia: consideration based on proxy system model

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Oxygen isotopic composition in tree-ring cellulose has been used as paleoclimate proxy. Although Indonesian region plays a key role in global climate system, there are only a few dendroclimatic research using oxygen isotopic composition in tree-ring cellulose. In this study, we investigated climate response of oxygen isotopic compositions in tree-ring cellulose from Java, Indonesia. We checked correlation coefficient between oxygen isotopic compositions in tree-ring cellulose and climate parameter (temperature, precipitation, etc.). In addition, we investigated the dominant factor of oxygen isotopic compositions in tree-ring cellulose from Java by means of tree-ring cellulose oxygen isotope model (proxy system model) in order to improve the interpretation of oxygen isotopic compositions in tree-ring cellulose as proxy.

Teak (*Tectona Grandis*) was used for tree-ring sample in this study. Teak has clear annual ring related to seasonal precipitation change (rainy season and dry season). As for Indonesia, teak is an only species that cross dated tree-ring chronology was established. We collected ten teak disk samples from four plantation area in Java. We measured ring width and cellulose oxygen isotopic composition. All samples were dated by cross dating using ring width and cellulose oxygen isotopic composition.

Oxygen isotopic compositions in tree-ring cellulose have similar inter-annual variation all over Java. This indicate that common climate signals preserved in teak tree-ring cellulose oxygen isotope in Java. Oxygen isotopic compositions in tree-ring cellulose shows positive correlation with precipitation and relative humidity in the last dry season and negative correlation with precipitation in rainy season (growing season). Next, we did analysis using proxy system model. According to the model, oxygen isotopic compositions in tree-ring cellulose is controlled by isotopic composition of source water (the water taken up by roots), relative humidity and isotopic composition of atmospheric water vapor. Our result shows dominant factor of oxygen isotopic compositions in tree-ring cellulose is isotopic composition of source water. In addition, comparison of source water oxygen isotopic composition and rainfall oxygen isotopic composition indicates source water consists of rainfall not only during growing season but also during the several months before growing season.

Keywords: tree-ring, proxy system model, oxygen isotope

An 11.5 Ma paleoclimate record from travertine deposits at Barrancas Blancas in the eastern Atacama Desert, Chile

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Here we survey the potential of spring-related, surface and sub-surface carbonates as an archive of paleoenvironmental change at Barrancas Blancas, located in the broadest and driest sector of the Atacama at 24˚S in Chile. From these deposits we present a new stable isotopic record of paleoenvironmental conditions over portions of the past ~11.5 Ma. U-Pb dates from the carbonates, both surface and sub-surface, demonstrate that springs have discharged at this location over much of the last 11.5 Ma, attesting to the exceptional geomorphic stability of the central Atacama. Many of the sampled vein systems line vertical fissures, and formed within the aquifer before ground water discharged at the surface. Carbonates in such circumstances should not undergo off-gassing and kinetic fractionation prior to formation, simplifying the interpretation of their isotopic composition. Oxygen isotopic compositions of carbonates are genrally high (>-1‰VPDB), and using paleospring water temperatures reconstructed from clumped isotopes, point to strongly (up to 20-30%) evaporated water oxygen isotope values, like those associated with hyperarid conditions in recharge areas today. Carbon isotopic compositions are also high (+3‰ PDB) reflecting a recharge area essentially devoid of plants and dominated by volcanic CO_2, as is the case today. Our isotopic results are very similar to those from the Calama Basin to the north, suggesting that the western face of the Andes between 21-25˚S has been highly evaporative and plantless for much of the last 11.5 Ma. The spring carbonates at Barrancas Blancas strongly resemble those found at Devils Hole and Furnace Creek in Death Valley, USA, and as such warrant further exploration as potential archives of climate change.

Keywords: Atacama Desert, oxygen isotopes, carbon isotopes, travertine, paleoclimate

Preservation processes of paleoflood in stalagmite –case study of Inazumi Underwater Cave, Oita, NE Kyushu,Japan –

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Detrital sediments and mud trapped in stalagmite have been used for reconstruction of frequency of past extreme rainfall events associated with hurricane and cyclone (e.g., Dasgupta et al., 2010 EPSL; Frappier et al., 2014 AGU; Finné et al., 2014 Quat. Res.), yet more efforts should be put in for better understanding of the formation mechanism of so-called “flood layer”. This research presents the features and formation processes of the flood layer using microscopic observation (stereomicroscope, polarized microscope and fluorescence microscope) of the stalagmite’s thin section (SUI-1 and SUI-2) sampled from Inazumi Underwater Cave, Oita, Japan, where experiences episodic cave flooding during summer due to the East Asian Summer Monsoon.

Both of SUI-1 and SUI-2 showed (1) the presence of troughs filled by mud and rock-forming minerals such as augite, magnetite and quartz on the stalagmite’s flank; (2) the presence of numerous microcrystalline $CaCO_3$ on the flood layers; (3) alternating couplets of thick and porous layers on upper part of the stalagmite, which the porous layers were frequently filled by mud, and; (4) that no fluorescence layers were observed.

The (1) indicates that large size suspended solids carried during cave flooding induce physical weathering on the stalagmite’s surface, resulting in formation of the troughs and fill-up by small size suspended mud in the troughs while water level of cave river is decreasing. The large size minerals are considered to be washed away toward the stalagmite’s flank by dripping water. The (2) indicates that the $CaCO_3$ growth was temporarily ceased by the coverage of the suspended solids on the stalagmite’s surface, and that the numerous microcrystalline $CaCO_3$ are the evidence of nucleation and growth competition of newly precipitated $CaCO_3$ from dripping water. The (3) infers that the period of forming the porous layers corresponds to the one of the cave flooding (summer and autumn), and hence seasonality. The (4) indicates that either the concentration of humic substance in the dripping water was too low to provide the fluorescence layers or the humic substance contained in the mud trapped in the stalagmite should be incorporated in the crystal lattice of $CaCO_3$ for the fluorescence.

Keywords: stalagmite, paleoflood, paleoclimate, humic substance, sedimentology

Temperature change since the latest Pleistocene deglaciation stage recorded in carbonate clumped isotopes of a stalagmite collected in Hiroshima Prefecture, Japan

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Stalagmite Hiro-1 from northeastern Hiroshima Prefecture is a valuable material for terrestrial paleoclimate in Japan (Shen *et al*. 2010; Hori *et al*. 2013). However, it is not always easy to separate the temperature and the moisture signals from the stalagmite oxygen isotopic profile. A possible solution for this problem is carbonate clumped isotopes that is independent on isotopic value of water (Ghosh *et al*. 2006) and has been applied to some stalagmites (Affek *et al*. 2014). Carbonate clumped isotopes means the concentration anomaly of mass-47 carbon dioxide generated from the reaction of calcium carbonate and phosphoric acid, and is generally in inverse proportion to the square of the absolute temperature. Here we measured the clumped isotopes for 40 horizons of Hiro-1 stalagmite reacted with phosphoric acid at 70˚C.

The generated carbon dioxide was carefully purified in column cooled at -10˚C, and measured by MAT 253 with applying the baseline correction of He *et al*. (2012). Each value was adjusted on the absolute reference frame of Dennis *et al*. (2011). A typical measuring error was within 0.015 permil (1s) that corresponds to 3˚C in the temperature range of Hiro-1. We applied the temperature equation based on our own measurements of synthesized calcites of known temperatures, which is very similar to the theoretical equation of Guo *et al*. (2009).

After eliminating obvious offsets, the temperatures based on the clumped isotope of Hiro-1 was in 29.7–20.7˚C (24.8˚C in average) during Holocene (11–4 ka), and in 22.4–14.3˚C (18.0˚C in average) during the latest Pleistocene (18–12 ka). These temperatures are likely higher than the real, by considering that the modern temperature of this cave is 10.7˚C. The temperature offset is common between several speleothem studies reflecting Kinetic Isotopic Effect associated with CO_2 degassing (e.g. Affek *et al*. 2014). Although our evaluation involves some uncertainties, we suggest that the temperature difference between Holocene and latest Pleistocene was 6–7˚C. This preliminary estimation is broadly consistent to the 1.5 permil difference in oxygen isotope between Holocene and Pleistocene observed in Hiro-1 (Shen *et al*. 2010).

Keywords: stalagmite, clumped isotopes, temperature change, last glacial period, Holocene

Geochemical analyses of shells of *Gafrarium tumidum* and seawater collected from Tongatapu Island and their application for paleoenvironment and archaeology during the Holocene

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South Pacific Convergence Zone (SPCZ) fluctuation largely affects the climate in South Pacific islands. Current climate models have difficulties in a representation of the SPCZ movement, thus paleoclimate records are crucial to understand SPCZ' s variability. Meanwhile, it is suggested that human migration over the South Pacific islands during the Holocene was influenced by sea level and climate changes, however, they are not evidenced from the quantitative geochemical records. The aim of this study is to reconstruct paleoenvironment of Tongatapu Island, Tonga using geochemical analyses of shells of *Gafrarium tumidum* and seawater. The climate in Tonga is under the influence of SPCZ and this island was a base of South Pacific human migration during the Holocene, thus it is suitable for studying past variability of SPCZ and its relation to human migration. Fossil *G. tumidum* is often excavated from archaeological sites in South Pacific, thus this species is of archaeological importance, too. Bivalve shells which consist of calcium carbonate exhibiting growth lines like reef-building corals are ideal archives of paleoenvironment changes. However, few studies have evaluated potential of *G. tumidum* as paleoenvironmental recorder. Therefore, we assessed it from geochemical analyses of live-caught and fossil shells and seawater collected from Tonga. We measured $\delta^{18}O$ using IRMS (isotope ration mass spectrometry) and trace element/Ca ratio (e.g., Sr/Ca, Mg/Ca, and Ba/Ca) using LA-HR-ICPMS (laser ablation high resolution inductively coupled plasma mass spectrometry) along the maximum growth axis of the shell. Furthermore we calculated a local marine radiocarbon reservoir ages (ΔR) from ^{14}C-ages of fossil shells measured by using Single-Stage-Accelerator Mass Spectrometry (Single-Stage-AMS). We also monitored sea surface temperature (SST) *in situ* for four months, and measured sea surface salinity (SSS) using portable salinometer and $\delta^{18}O$ using Cavity Ring-Down Spectroscopy (CRDS). The results suggested: 1) $\delta^{18}O$ of *G. tumidum* shell can record about 3 yr SST variation in monthly timescales; 2) Sr/Ca of *G. tumidum* shell is controlled by a growth rate, neither by SST nor by SSS; 3) The lagoon of Tongatapu island was isolated from the open ocean between ~2.6 ka and ~1.2 ka; 4) the growth of *G. tumidum* is likely controlled by SSS, not by SST.

Keywords: Calcium carbonate, oxygen isotope, ΔR

Uranium in Corals provide the clue to solve the Quaternary chronology logjam

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Shallow water corals provide only direct way of determining the absolute timing and magnitude of Quaternary sea levels extending back over 600,000 years. Their uranium and thorium abundances and uranium isotope ratios when combined with coral reef elevations help determine sea-levels. Radiocarbon dating is also useful up to ca. 50,000 years but older than that relying on the U-series dating technique. It is relies on the following radioactive decay chain:

238U (4.5x10^9 yr) -> 234Th (24 days) -> 234U (2.5 x 10^5 yr) ->230Th (7.5x10^4 yr)

Deep-sea corals do not provide sea level information but appear to be responsive to ocean circulation changes and continental riverine and ice-sheet meltwater inputs to the oceans (Chen et al., 2016 Science).
In this presentation, we introduce recent debate with regards to uranium isotopes in ocean and discuss the reliable method to conduct U-series dating. Also consequence on the topic related to the phase relations of climate sub-systems are discussed.

Keywords: Quaternary chronology , Coral, Uranium series nuclides

New analytical method of triple combination: gene, morphology, and isotopes, for a single planktonic foraminifer

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Stable oxygen and carbon isotopes of planktonic foraminiferal shells are the most important proxies for paleoceanographic studies. This is because that each (morpho)species of planktonic foraminifers is distributed in a certain area/depth in the world oceans, and their shells are formed under an influence of ambient water condition (i.e., temperature). However, this commonly accepted theory needs improvement, according to the classification of genetically incompatible species (biological species). Molecular phylogeographic studies have revealed that multiple biological species found in a single morphospecies of planktonic foraminifers are differently distributed in the oceans. This improved species concept (biological species) encourage ecological study, and is able to provide novel environmental proxies combing with other basic methods (i.e., morphology and isotope). Although the foraminiferal shells can be preserved after DNA extraction by using the guanidium isothiocyanate buffer, no study has examined the impacts of the chemicals and incubation step with 65–70˚C on the shells. In this study, we carefully tested whether the process of DNA extraction physically and chemically damage to the shells of *Globigerinoides ruber*, one of the most useful planktonic foraminifers, or not. First, we checked the changes of the shell densities in pre- and post-DNA extraction by using the micro-focus X-ray CT (MXCT) scanning. The simultaneous measurement of a sample and the standard material enable us to calculate the accurate CT number, which indicates the density of the shell. As the result, the shell densities showed no significant differences. Second, we prepared three sample sets with: (a) no chemical and incubation as control, (b) incubation in the DNA extraction buffer at 65–70˚C for 40 minutes as standard way, and (c) incubation in the DNA extraction buffer at 65–70˚C for 120 minutes. Stable oxygen and carbon isotopes were measured one by one from these three samples sets by using the microscale isotopic analytical system (MICAL3c). Although the isotope values largely varied among specimens, there were no significant differences among the three sample sets. These data of MXCT scanning and isotopic measurements clearly certified that we define morphological and geochemical features from same specimens after genetic identification. Utilizing our developed method, we compared stable oxygen and carbon isotopes between two different genetic types of *G. ruber*, which were phylogenetically distant. All examined specimens were collected at the same place in the same season. We demonstrated that the isotopic signatures between biological species. Thus, our challenge provide future studies to establish the paleoceanographic proxies in higher-resolution based on the biological species of planktonic foraminifers.

Keywords: planktonic foraminifers, stable oxygen and carbon isotopes, CT scanning, micro-scale analysis

A preliminary result of paleowind variations in Hungary during MIS 19 from loess-paleosol deposits

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Marine Isotope Stage (MIS) 19 is a unique interglacial that occurs around the minimum amplitude insolation variation of eccentricity component at 65 deg N, and thus has been a target for a number of paleoclimate studies. In East Asia, numerous studies revealed detailed paleomonsoon variations for MIS 19 using loess-paleosol deposits in Chinese Loess Plateau (CLP), and discussed continental climate changes. Despite the well-studied CLP, the detailed paleoclimate reconstruction of MIS19 is missing in Europe. The similarities and differences between the characteristic of the East Asian monsoon and the European paleoclimate have not been revealed yet. We analyzed loess-paleosol deposits in the European Loess Belt (ELB) in order to reconstruct detailed inland climate changes in Europe during MIS 19, to evaluate its relation to the global paleoclimate.

Quasi-continuous sampling was elaborated at Paks brickyard, about 150-km south of Budapest (Hungary), where about 60-m thick loess paleosol sequence lies on the right bank of River Danube. The studied sequence is dated back to Early to Late Pleistocene. The Matuyama-Brunhes magnetic polarity transition was reported in various stratigraphic positions around the PD_1 and PD_2 paleosol complex. Oriented samples were collected at 2.5-cm depth intervals from an about 380 cm thick section, ranging from paleosol PD_1 to PD_2. We conducted magnetic and grain size analyses of the samples. Low field magnetic susceptibility (kLF) and frequency dependence of magnetic susceptibility (kFD) show consistent variations, having a large peak in each of paleosol PD_1 and PD_2, and a minimum at the loess horizon between them. We tentatively correlate the lower peak with MIS 19.3, the upper with MIS 19.1, and the minimum with MIS 19.2. The kLF gradually decreases upward from the lower peak, and has a temporal stagnation of decrease on the way at 208~256 cm in depth, that probably lies between MIS 19.3 and 19.2. The result of grain size analyses shows that the median size inversely correlates well with kLF and kFD, namely large kLF and kFD samples have small grain sizes, and vice versa. The relation is the same with the loess-paleosol deposits in CLP. However, we find that the content of fine grains ($< 8\ \mu m$) shows no vertical changes, namely almost constant, while coarse grains ($> 8\ \mu m$) show variations, consistent with median size. We interpret the results as surface winds, carrying coarse grain over short distances, weakened in the warm-moist periods, and strengthened in the cool-dry period, whereas, compare to that winds, the intensity of high altitude winds, carrying fine grain over long distances, such as the Westerlies, has no large variation.

The paleoclimate records from Hungary were compared to those from Lingtai in the CLP during MIS 19. The kLF and kFD of both sites show quite consistent variations. In addition, the characteristic temporal stagnant of kLF decrease observed in Paks is also confirmed in the Lingtai record. The grain size records of both sites show consistent changes that the grain size decreases in the pedogenic zones, and increases in the less pedogenic zone. This record reveals the similarities between the influence of various wind system in the ELB and in CLP: the surface wind (winter monsoon), probably weakened in the warm-moist periods, and strengthened in the cool-dry period. The similarities between the paleoenvironment in ELB and CLP reveal a possible link between Europa and East Asian inland climates during MIS 19.

Keywords: Loess-paleosol deposits, MIS 19, magnetic susceptibility, grain size analyses

High-resolution magneto-climatostratigraphy for MIS 19 loess-paleosol layer in Paks, Hungary

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Detailed paleomagnetic and rockmagnetic investigations of the Paks loess/paleosol succession in Hungary revised the stratigraphic position of the Matuyama Brunhes Transition (MBT).
The first deflections of the virtual geomagnetic pole (VGP) during the precursor phase of the MBT occurs in a well-developed soil horizon. The transit phase of MBT is situated in the upper and transient horizon of the soil mentioned above, and the overlaying loess layer. The transit period is followed by the rebound phase, characterized by instable magnetic field.
The new paleomagnetic results provided evidences for a new detailed terrestrial MIS19 chronostratigraphy in loess, including MIS19.3, 19.2 and 19.1 and revealed a possible link between various terrestrial and marine records from the Atlantic and Pacific area also.

Keywords: Matuyama Brunhes Transition, magneto-climatostratigraphy, pan-European loess

Paleoceanographic change in the western North Pacific during MIS 20-18 based on Mg/Ca-temperature, oxygen and carbon isotope records from Chiba composite section deposited in Boso Peninsula, southeastern part of Japanese islands

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Marine Isotope Stage (MIS) 19 is one of the analogues for the present interglacial period in terms of orbital parameter: low-amplitude precessional insolation variability modulated by the 413-kyr eccentricity cycle. Thus, knowledge of natural climate variability during the time period between MIS 20 to 18 helps to understand the future climate change.
The Kuroshio Current, a western boundary current in the North Pacific, transports warm saline waters from low- to high-latitude and thus plays a crucial role in heat transport in East Asia. Previous studies revealed high SST variability during the last 144 ky off central Japan, with peak SSTs during early MIS 1 and the MIS 5a/4, 5c/5b and 5e/5d transitions, primarily caused by the latitudinal shift of the Kuroshio–Oyashio Currents.
Here, we present Mg/Ca-based temperature, and oxygen and carbon isotope ($\delta^{18}O$, $\delta^{13}C$) records of planktic foraminifers *Globigerina bulloides* and *Globorotalia inflata* in Chiba composite section and reconstruct gradients of surface and intermediate water temperature (ΔT) and vertical $\delta^{13}C$ ($\Delta\delta^{13}C$). Compared to Oyashio water, the Kursohio is characterized by more oligotrophic, stratified with warm surface water. Therefore, the high $\Delta\delta^{13}C$ and ΔT with warm surface water suggest the increase in the Kuroshio influence. The results indicate that both $\Delta\delta^{13}C$ and ΔT increased during the transition from MIS 20 to 19, which suggests the increase in influence of the Kuroshio water. The $\delta^{18}O$ of *G. bulloides* shows low values with high amplitude still in the late MIS 19, suggesting the warm surface water. This further suggests the strong influence of the Kuroshio water, which is also supported by relatively high $\Delta\delta^{13}C$, ΔT and microfossil assemblage. A recent study based on grain size analyses from Loess- palaeosol sequence in northern China suggest weak East Asian winter monsoon and Siberian High during late MIS 19, triggered by a very weak precessional insolation minimum leading to warm summer conditions unfavorable to Northern Hemisphere ice-sheet build-up at the inception of each of MIS 20, MIS 18. This study suggests that the strong Kuroshio Current during late MIS 19 might have played a crucial role in enhancement of poleward heat transport that helped to warm up the middle to high latitude and suppress the development of Siberian High.

Keywords: Chiba composite section, Kuroshio, East Asian winter monsoon

Paleoceanographic change through the Marine Isotope Stage 19 in the Kuroshio-Oyashio subarctic boundary, the northwestern Pacific, based on benthic and planktic foraminiferal oxygen and carbon isotope records

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Orbital configuration during the Marine Isotope Stage (MIS) 19 are characterized by weak eccentricity-precession forcing and the obliquity maximum, and they have occurred at around the precession minimum as well as MIS 1, the present interglacial period, although the both absolute values of obliquity are different (Tzedakis, 2010; Tzedakis et al., 2012). Thus, MIS 19c, the one of sub-stages during MIS 19, is assumed as the close analogue for the present interglacial and will suggest the timing of the next glacial inception in the future excluded anthropogenic influences.
Here, we report foraminiferal stable oxygen and carbon isotopic records from the Chiba composite section, and the Higashinagata Formation, Toyofusa Group in the Boso Peninsula, and the CHOSHI-1 core drilled through the Yokone Formation, Inubo Group, at Choshi city, northestern part of Chiba. The Chiba composite section is one of the candidates for the middle Pleistocene GSSP (Global boundary Stratotype Sections and Points). We carried out stable oxygen and carbon isotopic analyses by using benthic foraminifers, *Bolivinita quadrilatera*, *Cibicides* spp. and *Uvigerina* spp., and planktic foraminifers, *Globigerina bulloides*, *Globigerinoides ruber* and *Globorotalia inflata*. Stable isotope measurements were performed by a Finnigan-MAT253 Isotope mass spectrometer coupled with a Kiel IV carbonate preparation device installed at the Department of Geology and Paleontology, National Museum of Nature and Science. In order to develop age models, the resultant $\delta^{18}O_{benthic}$ curves were correlated to the sea level equivalent curve (Elderfield et al., 2012).
$\delta^{18}O_{planktic}$ and $\delta^{18}O_{benthic}$ curves basically represent synchronized changes in the glacial-interglacial cycle scale. Especially, $\delta^{18}O_{G.\ bulloides}$ curves show millennial scale oscillations from the peak of the MIS 19 to MIS 18 superimposed on the glacial-interglacial cycles in both of the Chiba composite section and the CHOSHI-1 core. However, the $\delta^{18}O_{G.\ ruber}$ curve from the Higashinagata Formation, in which the isotope data yielded only through the late MIS 19, exhibits a slight oscillation in contrast to those of the Chiba composite section and the CHOSHI-1 core during the same interval. This implies that since the Kuroshio front facing to the Kuroshio-Oyashio subarctic boundary was placed at near the latitude of the present Choshi region, the Chiba composite section and the CHOSHI-1 core were commonly affected by sea surface temperature (SST) changes associated with a latitudinal shift of the Kuroshio front during the MIS 19 –MIS 18 transition. In contrast, the Higashinagata Formation was less affected by the SST changes since the Kuroshio front have not reached down to the southernmost part of the Boso Peninsula during the interval.

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Keywords: Marine Isotope Stage 19, Foraminifera, Oxygen isotope, Carbon isotope, Kuroshio front

Pliocene planktonic foraminiferal assemblages of IODP Site U1338 in the equatorial Pacific: implication to the closure of the Central American Seaway

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Modern oceanographic settings of the equatorial Pacific is characterized by an East-West asymmetric structure of thermocline caused by the closure of the Central American Seaway in Pliocene. IODP Site U1338 was placed in the eastern part of the equatorial zone from Miocene to Pliocene. Therefore, this site is suitable to examine paleoenvironmental changes related to the closure of the seaway. In this study, we investigates planktonic foraminiferal assemblages from 5.5 to 2.2 Ma at Site U1338.
As a result, 79 species belonging to 19 genus of planktonic foraminifera were detected from 42 samples of this interval. The planktonic foraminiferal fauna is dominated by tropical to subtropical species such as *Globorotalia tumida*, *Globigerinita glutinata* and *Menardella menardii*. According to a Q-mode factor analysis of the samples, planktonic foraminiferal assemblages can be divided into three zones, namely, Zone A (5.5--4.5 Ma), Zone B (4.5--3.1 Ma) and Zone C (3.1--2.2 Ma). Zone A is characterized by cyclic changes of subtropical subsurface components, tropical subsurface components and surface components. In turn, Zone B is characterized by alternative changes between subsurface and surface tropical components. Zone C is dominated by tropical subsurface components. These faunal changes suggest that the shoaling of thermocline in the eastern equatorial Pacific might start at approximately 4.5 Ma followed by stepwise weakening of the western Pacific oligotrophic water.

Keywords: planktonic foraminifera, Pliocene, eastern equatorial Pacific, IODP

History of the equatorial Pacific thermocline during the early to middle Miocene

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The evolution of the equatorial thermocline is essential in understanding climate changes in the tropical Pacific. Multispecies analyses of planktic foraminifera provide a way to examine temperature distribution thus equatorial thermocline. Although the secular development of the thermocline can date back up to the late Miocene, the early to middle Miocene interval has been rarely examined. In addition, causal relationships with dynamic Antarctic ice sheet and closing low latitude gateways remain unclear. Here we investigate vertical thermal gradient at Integrated Ocean Drilling Program Site U1337 in the eastern equatorial Pacific (EEP) throughout the early to middle Miocene. The gradient increased (surface water warmed) over the Miocene Climatic Optimum (16.9 to 14.7 Ma), whereas it decreased (surface water cooled) across the East Antarctic Ice Sheet Expansion (EAIE: ~13.9 Ma). Comparison of the EEP record with the western equatorial Pacific (WEP) counterpart (Corfield and Cartlidge, 1993) suggested that changes in sea surface temperature were relatively stable in the WEP than in the EEP through the early to middle Miocene (18.8 to 11.9 Ma). We further estimated thermocline depth and tilt from the two diagonal gradients between the EEP and the WEP records: shoaling of thermocline from 16.7 to 15.7 Ma and weakened thermocline tilt between 16.5 and 13.8 Ma. Closures of low latitude gateways (the Indonesian Throughflow and the Central American Seaway) (~17 to 15 Ma) might trigger thermocline shoaling, and the reduced Antarctic ice sheet volume (16.4~13.9 Ma) would affect thermocline tilt. Thermocline depth from 18.8 to 11.9 Ma was likely much deeper compared to the Pliocene to modern condition.

Keywords: eastern equatorial Pacific, Miocene, thermocline, planktic foraminifera, oxygen isotope ratio

Stratigraphy and paleo-environmental study of Paleogene sequences in Hokkaido, Japan

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Paleogene period is characterized by the transitional interval from warm greenhouse period to cool icehouse period in the climate history of earth. Although detailed stratigraphic and paleo-environmental studies of Paleogene sequences have been carried out in the Atlantic, Indian oceans and Tethys Sea, while little is known about the paleo-environmental change in the northwest Pacific Ocean.
Thick Paleogene sequences are exposed in the central and eastern Hokkaido, Japan. These sequences were accumulated in the fore-arc and/or intra-arc basins in the northwestern Pacific Ocean. In this study, we analyzed U-Pb ages of tuff beds and carbon isotope, benthic foraminifera and dinoflagellate cyst fossils of the Paleogene sequences of the Nemuro, Poronai, Urahoro and Onbetsu groups. Based on our U-Pb ages and carbon isotope stratigraphy and previous work of calcareous nannofossil biostratigraphy, the middle-upper parts of the Nemuro, Poronai, Urahoro and Onbetsu groups are correlated with Danian to Ypresian, Lutetian to Rupelian, Bartonian to Rupelian and lower to middle part of Rupelian, respectively. Four major environmental events are identified in the studied sequences as below.
(1) Danian-Selandian: This period is characterized by eutrophication of surface ocean, represented by prominent increase in P/G ratio of dinoflagellate in the Nemuro Group. This interval corresponds to the warm-climate period of early Paleocene.
(2) PETM: No significant faunal change is identified around this period in the Nemuro Group. Since exposure around this horizon is quite poor, there is a possibility that exact PETM horizon is not exposed in this studied section.
(3) Middle Eocene Climatic Optimum (MECO): This interval is correlated with the basal part of the Poronai Formaiton. On set of deposition of the Poronai Formation might reflect the sea level rise in this period although tectonic subsidence might have been the major contribution of the Poronai basin formation.
(4) Bartonian cooling: In the middle part of Poronai Formation is marked by occurrences of glendnite. This interval yields abundant benthic foraminifera of *Bullimina*. These evidences suggest that cooling and increased primary productivity occurred in this region.
(5) Eocene/Oligocene boundary: Prominent sedimentary facies change from hemipelagic mudstone to shallow-marine sandstone occurred across the boundary between the Poronai and Momijiyama formations. These facies change may reflect sea-level fall around the Oi-1 glaciation. The same horizon is identified in the upper part of the Urahoro Group.

Keywords: Paleogene, stratigraphy, dinoflagellate

Utility of apatite trace-element for tephrochronology

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Apatite is a common accessory mineral in intermediate and felsic igneous rocks. Because apatite has a wide range of trace-element compositions as well as strong resistance to diagenetic alteration, the trace-element composition of apatite has been used for tracing petrogenetic processes of plutonic bodies as well as the tephrochronology of Paleozoic tephras. We studied apatite trace-element compositions of representative Quaternary ignimbrites and their corresponding co-ignimbrite ashes in Japan. The results demonstrated following three points.
1. Trace-element compositions of apatite phenocrysts are useful for discriminating and correlating tephras and ignimbrites. Even different tephra deposits and ignimbrites derived from the same caldera can be distinguished.
2. Trace-element compositions of apatite phenocrysts are not affected by welding, making them valid for correlations between densely welded and non-welded tuffs.
3. In successive ejecta of each eruption cycle, the Cl, Mg, Mn, Y, and Ce contents of apatite phenocrysts generally are constant throughout successions except for the uppermost parts, whereas Fe contents vary from horizon to horizon. This compositional stratigraphy makes it feasible to identify the eruptive stage at which co-ignimbrite ash was ejected by correlating apatite trace-element compositions between ignimbrite successions and co-ignimbrite ashes.
Given the resistance of apatite to diagenetic alteration, this correlation method is a promising tool for correlating pre-Quaternary volcanic and volcaniclastic rocks and identifying their source volcanoes. In order to apply this method to tephrochronology of pre-Quaternary tephra, we examine Miocene and Cretaceous tuffs in Japan (Kinone Formation in Chiba and the Yezo Group in Hokkaido). Our result demonstrated that pre-Quaternary tuffs can also be used for wide-correlation of tephra as well as identification of source caldera.

Keywords: apatite, tephrochronology, caldera

Dramatic oceanic sulfur-isotopic shift event at the Early Eocene

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Oceanic sulfate is a huge reservoir of sulfur on the earth surface with its residence time as long as >10 myr. Paytan et al. (1998: Science) showed temporal variation of sulfur isotope value ($\delta^{34}S$) of oceanic sulfate that was summarized based on the analytical results of pelagic barite from deep sea sediments. They revealed conspicuous positive $\delta^{34}S$ shift (17 to 22‰) within a short period of time (~1 myr) across 50 Ma.
Ogawa et al. (2009: EPSL, 285) reported continuous deposition of pyrite-rich sediments through 55 to 45 Ma from ACEX core (IODP EXP. 302) and suggested deposition of vast quantity of pyrite on the sea floor of Arctic Ocean during Eocene that could explain 3‰ of positive $\delta^{34}S$ shift of entire ocean. However, it was still inconsistent with the enigmatic positive shift mentioned above from the standpoint of its duration and size. The temporal variation of oceanic sulfate is also required to be verified through this interval.
The objective of this research is to clarify the global temporal variation of $\delta^{34}S$ of oceanic sulfate through Early-Middle Eocene and discuss the inconsistency between duration and magnitude of positive $\delta^{34}S$ shift between $\delta^{34}S$ fluctuation shown by Paytan et al. (1998) and that expected from ACEX data.
Continuous $\delta^{34}S$ record of pelagic calcareous ooze or micritic carbonate collected by ODP, IODP is obtained from analyses of CAS (carbonate-associated sulfate). We tried to acquire $\delta^{34}S$ values of both barite and CAS from identical sample but it could be achieved only from single sample of equatorial Pacific. Enough CAS data have been obtained from ODP Sites 1258, 1259 (Equatorial Atlantic) and Sites 1262, 1263, 1265, 1267 (South Atlantic) to draw a temporal variation of $\delta^{34}S$ with CAS for Early-Middle Eocene. The fluctuation exhibited considerable decoupling with that of Paytan et al. (1998) showing gradual shift over >5 myr with the magnitude smaller than 5‰ instead of abrupt change as large as 5‰. The time interval for $\delta^{34}S$ shift is concordant with that for pyrite deposition on Arctic seafloor and well explained by outflow water from Arctic discussed by Ogawa et al. (2009). Abrupt $\delta^{34}S$ shift at 50 Ma shown in Paytan et al. (1998) could reflect local heterogeneity of sulfur isotopic composition of oceanic sulfate around eastern equatorial Atlantic during this period.

Keywords: sulfur isotope, Eocene, sulfur, sulfate ion, barite

Characterization of Carboniferous sulfate mineral deposits in central Thailand

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We present petrographic and geochemical data of sulfate mineral deposits in northeast Nakhon Sawan, central Thailand, and provide new constraints on their age and depositional environments. The deposits are made up of a layered anhydrite in the lower part, and strongly deformed nodular and massive gypsum in the upper part. They are intruded by andesitic dikes that contain Middle Triassic zircons (ca 240 Ma). These dikes are probably part of the regional magmatic activity of the Sukhothai Arc during the Early to Middle Triassic. Sulfur ($\delta^{34}S$) and strontium ($^{87}Sr/^{86}Sr$) isotopic compositions of the sulfates range from 15.86‰ to 16.26‰ and from 0.70810 to 0.70817, respectively. Comparisons with the Phanerozoic seawater isotopic evolution curve indicate that those values are best explained by precipitation from seawater during the Serpukhovian (ca 326 Ma) in the Late Mississippian epoch of the Carboniferous period (Kuroda *et al.*, 2017). This is consistent with previous studies of calcareous fossils in the limestones that crop out around this site (Ueno and Charoentitirat, 2011). Our interpretation is that evaporitic gypsum was originally precipitated from hypersaline seawater on a shallow lagoon or shelf on the Khao Khwang Platform during the Serpukhovian, and that this gypsum changed to anhydrite during early burial. The anhydrite was then cut by andesitic dikes during the Middle Triassic, and more recently the upper part of which was rehydrated during exhumation to form secondary gypsum near the surface. In the presentation we will also discuss the relationship of this sulfate mineral deposits with that in the northeastern Thailand (Surakotra *et al.*, 2017).

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Keywords: Carboniferous, sulfate evaporite, strontium isotope, sulfur isotope

Implications for paleo-oceanographic oxygen conditions during the Cretaceous OAEs: Results from laboratory culture experiments

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The oceanic redox state is a critical determinant of the evolutionary history of life on Earth, and “anoxic events” have been proposed as one of the causal mechanisms for mass extinctions. During the mid-Cretaceous, oceanic anoxic events (OAEs) occurred several times with substantial turnover of planktonic foraminiferal species. However, the direct effects of the anoxic condition on planktonic foraminifera remain obscure. In this study, we cultured 6 species (n = 31) in all at three treatments: ~2 mg hydrogen sulfide (H_2S) L^{-1} (H1 treatments), ~9 mg H_2S L^{-1} (H2 treatments), and control (without H_2S). All planktonic foraminifera could not survive more than 48 hours. Furthermore, gametogenesis ratio of each H_2S treatments showed considerable low value (8% and 17%), and time to gametogenesis was also very short (less than one day) under H_2S occurrence. It revealed that foraminiferal biological response of anoxic with the presence of H_2S should be fundamentally different from that of the dysoxic (i.e., low dissolved oxygen; ~0.7 mg O_2 L^{-1} or ~22 μmol O_2 L^{-1}). Our results also proposed the species-specific tolerance for H_2S and that if harmful influence of H_2S restricted in relatively short time (i.e., less than 24 hours) such as tidal cycle, some foraminifera (e.g., *Neogloboquadrina dutertrei*) might have the potential to survive even under the episodic/temporary occurrence of H_2S. Complete disappearance of planktonic foraminifera at Cretaceous OAE2 could result from the photic-zone euxinia (free H_2S), and presence/absence record of planktonic foraminifera could contribute to examine the detailed oceanic redox state in the photic zone around anoxic events.

Keywords: oceanic anoxic events, hydrogen sulfide, Planktonic foraminifera

Behaviors of marine primary producers during ocean anoxic events

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At the Ocean Anoxic Events (OAEs) during the Phanerozoic, biomarkers of cyanobacteria and green sulfur bacteria have been found, which suggests depletion of nitrogen and euxinic water condition in the euphotic zone (so-called "euphotic euxinia"), respectively. However, conditions to cause the depletion of nitrogen and the euphotic euxinia have not been known yet. We do not know well the behaviors of primary producers in the surface ocean when the ocean becomes anoxic. Here we investigated marine biogeochemical cycles of C, P, N, and S to understand these conditions and behaviors of primary producers quantitatively with a surface ocean biogeochemical cycle model. The results showed that nitrogen tends to deplete in the euphotic zone owing to net denitrification when the climate is much warmer than it is today. Under such conditions, cyanobacteria become dominant as a primary producer. When the upwelling rate is high in addition to the warmer climate condition, euxinic water upwells to the euphotic zone, hence green sulfur bacteria becomes dominant as a primary producer. We also found conditions for coexistence of eukaryotic algae, cyanobacteria, and green sulfur bacteria together within the euphotic zone, which could have been caused at coastal upwelling areas during the OAEs in the past.

Keywords: Ocean anoxic events, euphotic euxinia, biomarkers, marine biogeochemical cycle modeling

Impact on planktic foraminiferal test (*G. bulloides*) calcification caused by sea-surface condition

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Discharged anthropogenic CO_2 gas has been accumulating in the oceans, lowering seawater pH (ocean acidification), and could reduce calcification rate of marine calcareous organism. In order to monitor and evaluate the impact on calcareous organisms by ocean acidification, several proxies of calcification intensity of planktic foraminifera based on test weight have been employed, whereas these proxies are controlled by several factors other than seawater carbonate chemistry. Here we employ 3-D physical measurement by X-ray micro CT scanner into living *Globigerina bulloides* (planktic foraminifera) test, evaluate test characteristics (wall thickness, density and calcification rate), and compared them with ambient seawater conditions for the first time. As a result, seawater carbonate saturation state (ΩCa) has the most significant correlation with test density, and seawater temperature has the most significant correlation with test wall thickness. Furthermore, traditional proxy of calcification intensity, based on the test weight measurement, is not controlled by test density but by calcification rate and wall thickness, indicating that these traditional proxies are not suitable to evaluate the impact on living *G. bulloides* calcification from ocean acidification, and 3-D physical measurement by X-ray micro CT must be a powerful tool replacing them.

Keywords: Planktic foraminifera, Ocean acidification, test density

Grain-scale stable carbon and oxygen isotopic variations of the international reference materials IAEA-603 (newly released) and NBS 19

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The international reference material IAEA-603 prepared from Carrara marble (calcite) was newly released on 2016 to replace the reference material NBS19 (exhausted). From the reference sheet of IAEA-603 (Fajgelj and Assonov, 2016), assigned carbon and oxygen isotopic ($\delta^{13}C$ and $\delta^{18}O$) values are +2.46± 0.01‰ and -2.37±0.04‰, respectively at a sample size of about 120 μg. For sub-microgram scale isotopic analysis, we examined the grain-scale stable carbon and oxygen isotopic variations of IAEA-603. The individual grains of IAEA-603 (grain size: 200 to 760 μm) were measured with an IsoPrime100 isotope ratio mass spectrometer with customized continuous-flow gas preparation system (MICAL3c, Ishimura et al., 2004, 2008) at National Institute of Technology, Ibaraki College, Japan, and the individual weight of each grain estimated from the reacted CO_2 gas volume was 4-90 μg. The standard deviations (1 σ uncertainties) of $\delta^{13}C$ and $\delta^{18}O$ of the individual grains of IAEA-603 are ±0.07‰ and ±0.16‰, respectively (N = 16), and the grain-scale analytical results also indicated homogeneous values as same as stable isotopes of the single grains of NBS19 (the standard deviation: ±0.10‰ in $\delta^{13}C$, ±0.16‰ in $\delta^{18}O$, N = 16, Ishimura et al., 2008). In IAEA-603, $\delta^{13}C$ and $\delta^{18}O$ ranged within 0.2‰ and 0.4‰, respectively. Both $\delta^{13}C$ and $\delta^{18}O$ of the individual grains showed non-significant grain-size dependencies. From the scanning electron microscope observations, the individual grains of IAEA-603 were dominantly polycrystalline with translucent grains composed of coarse crystals, and contained a certain amount of white opaque grains containing fine crystals. On the other hand, NBS19 showed single-crystal-like grains. Thus, as the reference sheet of IAEA-603 (Fajgelj and Assonov, 2016) mentioned, the storage in sealed ampules is important for avoiding exchange with atmospheric moisture and atmospheric CO_2, especially in polycrystalline IAEA-603.

Keywords: stable isotopes, international reference material, carbonate, IAEA-603, SEM

Isotopic re-equilibration of fluid inclusions in natural speleothem by artificial heating

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Isotopic compositions of inclusion water in speleothems are promising new climatic proxies. Oxygen isotope ratio of water ($\delta^{18}O$) may provide direct estimate for past temperature changes. Several studies, however, used hydrogen isotope ratio of water (δD) because the $\delta^{18}O$ may be affected by re-equilibration between water and host calcite. Thus, precise knowledge about magnitude and reaction rate of the re-equilibration is needed to evaluate paleoclimate records in speleothems.
To estimate the re-equilibration effect, we measured isotope composition of fluid inclusions in natural stalagmites, which had been heated in laboratory before isotope measurement. Several (3-5) subsamples were cut from the same depth of stalagmites. Then, each sub-sample was heated at different interval (0 –80 hours) under continuous evacuation using a turbomolecular pump. The experiments were conducted under different temperatures of 25 and 105˚C. The $\delta^{18}O$ and δD values of fluid inclusions in a sub-sample were measured using a semi-automated system, which was modified based on cavity ring-down spectroscopy technique (Uemura et al., 2016).
Under the 105˚C hating, the inclusion $\delta^{18}O$ values of a layer show a small increase from the initial value to ca.30 hours heating, and then after that it appears to stay flat. In contrast, the $\delta^{18}O$ value shows no trend under the room temperature. The δD value shows no trend at any experimental conditions, suggesting that loss of inclusion water during long-time evacuation does not cause the $\delta^{18}O$ enrichment. Preliminary data suggest ca. 5% of fluid inclusion water may re-equilibrated with surrounding host calcite at the 105˚C heating experiment. The results prove the existence of re-equilibration effect, but its magnitude is not significant for estimating glacial-interglacial temperature changes.

Keywords: speleothem, fluid inclusion, stable isotope, glacial interglacial cycle

Relationship between climate changes and solar activity in a mid-Holocene stalagmite from Minami Daito, Okinawa

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Correlations between atmospheric $\Delta^{14}C$ and oxygen isotope ($\delta^{18}O$) record of the stalagmites suggest that the variations of Indian and Asian monsoons are influenced by solar activity during the Holocene (Neff et al., 2001; Wang et al., 2005; Duan et al., 2014). To evaluate the influence of solar activity on a small oceanic island in East Asian monsoon region, we investigate multi-proxy records of a stalagmite from Okinawa, Japan. A stalagmite, HSN1, was collected in Hoshino cave in Minami Daito Island, Okinawa, Japan. The $\delta^{18}O$ of the calcite was measured using Gas-bench IRMS (Delta V advantage). The isotope compositions of the fluid-inclusion water were measured using a semi-automated version of our fluid inclusion analysis system described in Uemura et al. (2016). U-Th dates were measured at National Taiwan University. The HSN1 stalagmite grew from ca. 6,000 to 8,000 years before present with a high growth rate (ca. 130 μm/yr). The pattern of calcite $\delta^{18}O$ variation (e.g., 80-year periodicity) was similar to that of the atmospheric $\Delta^{14}C$.

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Keywords: stalagmite, isotope, solar activity

Paleoclimate records in stalagmites from Okinoerabu-jima, Ryukyu Islands, Japan

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Stalagmites can have continuous deposition of calcium carbonate over long periods of time and well-selected stalagmites are accurately datable with high-precision U-Th dating methods (e.g., Shen et al., 2002). Stable oxygen isotope signatures in stalagmites have been used as a paleoclimate proxy (e.g., McDermott, 2004) because the isotopic values can be controlled by oxygen isotopes of the drip water and the cave temperature (e.g., Hendy, 1971). Since 2000, stalagmite-derived oxygen isotope time series have been widely used to reconstruct hydroclimate variations in East Asian monsoon regions during the Quaternary (e.g., Wang et al., 2001).
Here, we present oxygen and carbon isotope time series of 17 stalagmites collected at 4 caves in Okinoerabu-jima, the Ryukyu Islands, Japan. The Hendy Test performed in this study suggests that the isotope profiles along the center of stalagmite growth appear to be primarily of environmental origin with little effects of kinetic fractionation. Since 2014, we have observed cave environments using loggers and collected water samples to establish relationship between oxygen isotope composition of drip waters and stalagmites. We generate a well-dated time series of the oxygen and carbon isotope ratios in stalagmites using a high-precision U-Th dating method to reconstruct hydroclimate changes around the Ryukyus during the Quaternary, especially Holocene. Coupled with previously published stalagmite records from China (e.g., Wang et al., 2001) and Japan (Shen et al., 2010; Sone et al., 2013; Uemura et al., 2016), our study can allow a better understanding of past spatial climate changes associated with the East Asian Monsoon.

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Keywords: stalagmite, paleoclimate, oxygen isotope composition, carbon isotope composition, Holocene, Ryukyu Islands

Mention of a speleothem collected at Iriomote Island –Observation of laminae and laminae counting–

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Reconstructing ancient climates can contribute to predicting the future climates, so that there are a lot of studies to reconstruct past climates all over the world using many proxies. Stalagmite is one of the powerful proxies to deduce ancient climates in land area. However, there are few studies where stalagmite is used for the reconstruction in Japan.
A stalagmite grows on the floor of the cave due to the accumulation of CaCO3 deposited from the drip water which comes from groundwater which dissolves the limestone of the host rock. Stalagmites have growth laminae and some of them are annual. In that case, they have annual climate data and we can obtain highly scale paleoclimate data. Moreover, we can obtain high time resolution information from one using U-Th dating method. This high resolution information is also useful to reconstruct past climates.
In this study, we used a stalagmite (TK04) as a sample, collected at Takana Cave in Iriomote Island, Okinawa, Japan, in order to reconstruct the ancient climate around there. As the first step of this study, we performed the observation of its laminae using a transmission microscope and a luminescent microscope, and counted the number of them.
As a result, two types of laminae (type a, b) and one type of structure (type c). Note that a lamina is composed of two parts: transparent part, and black part. In type a, a lamina is occupied by more black part than transparent part, and the width of the lamina is about 50 μm. In type b, a lamina is occupied by less black part than transparent part, and the width of the lamina is about 100 μm or over. In type C, the structure appears to be homogeneous and few laminae are observed. Whereas type a is observed only near the top portion of TK04, type b is observed almost all portions of it, and type c is observed around the hole of TK04.
Because type a is altered to type b clearly, it is assumed that the stalagmite’ s growth was stopped temporarily or the environment of the cave was changed. So we counted the number of laminae near the top portion, where type a is observed. As a result, we observed 15 to 18 laminae there.

Keywords: Paleoclimatology, Stalagmite

Millennium-scale changes recorded in oxygen isotopes of two stalagmites from central Japan

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Stalagmite records from Japanese caves based on U-Th dating have demonstrate latest Pleistocen-Holocene change in East Asian summer and winter monsoons. Here, we present a new oxygen isotope record of well dated two stalagmites; KA03 collected from Kiriana cave in central Mie Prefecture and OT02 collected from Otaki cave in central Gifu Prefecture. Results of dating show that the stalagmite has been growing during the last 80 kyr almost continuously.
The oxygen isotopic profile of KA03 generally follows the records from the Chinese caves and Greenland ice-sheets in terms of 1) drastic decrease at the B/A warming, and 2) high isotopic intervals corresponding to the Heinrich events. However, KA03 lacks the millennium changes of Dansgaard-Oeschger cycles, which have been reported in a stalagmite from Gifu Prefecture. A distinct feature of KA03 oxygen isotope is a linear increase from 37 ka to the Last Glacial Maximum (LGM). Oxygen isotope of meteoric water collected near the cave shows a seasonal pattern (lower in summer) and an amount effect. Because the locality is generally dry in winter season, we can assume that the stalagmite oxygen isotope is a proxy of humidity in summer. The amount of rainfall had been decreasing gradually from 37 ka to LGM, and then sharply increased at the onset of B/A warming. During the Heinrich events, summer in central Mie Prefecture was relatively dry. The stalagmite KA03 is a novel and significant record of the East Asian summer monsoon.

Keywords: Stalagmite, Last glacial, Oxygen isotopes

Seasonal change recorded in carbonate clumped isotope of tufa deposits

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Clumped isotope of CO_2 generated by acid reaction of calcite is only dependent on temperature of mineral precipitation (Ghosh et al. 2006). However, this carbonate clumped isotope often offsets from the equilibrate value of an expected temperature likely due to kinetic effect. We applied the clumped isotope to tufa deposits that are generally equilibrate in conventional carbon and oxygen isotopes. Samples were collected at two tufa sites in Ehime and Okayama Prefecture, every month during a period from December 1999 to December 2000 (Kano et al., 2003; Kawai et al., 2006). The analyzed material was collected from the surface of each sample, which is 0.5 mm thick.
The generated carbon dioxide was carefully purified in column cooled at -10ºC, and measured by MAT 253 with applying the background correction of He et al. (2012). Each value was adjusted on the absolute reference frame of Dennis et al. (2011). A typical measuring error was 0.015 permil (1s) that corresponds to 3ºC in the temperature range of Hiro-1. We applied the temperature equation based on our own measurements of synthesized calcites of known temperatures, which is very similar to the theoretical equation of Guo et al. (2009).
The fufas from Ehime Prefecture indicated a clear seasonal changes of temperature ranging from 3.7 to 20.9ºC, which is consistent with measured temperature range of 5-19ºC. A similar consistent result from the Okayama tufa indicates that the carbonate clumped isotope of tufa can be used for a thermometer. CO_2 degassing was observed in these tufa sites, but did not resulted in a recognizable disequilibrium. We suspect that the kinetic effect was insignificant in a pH condition around 8.3 where the dominant carbonate species is bicarbonate.

Keywords: Clumped isotope, tufa, thermometer

A 300-year floating chronology of tree-ring oxygen isotope derived from teak log coffins in northwestern Thailand

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Oxygen isotope ratio of tree-ring cellulose is widely used to reconstruct hydroclimate variations in monsoon Asia. Long tree-ring chronologies are required for better understanding of monsoon dynamics. In this context, we developed a 300-year floating chronology of oxygen isotopes using teak log coffins collected at the Ban Rai Rockshelter in northwestern Thailand. Radiocarbon-based wiggle matching for log coffin indicates that the outermost ring was produced in 345-390 CE (2 σ). Spectral analyses reveal significant peaks in 27.0 and 9.3 years as well as 3.8 and 3.5 years, which fall within the range of ENSO variability. Because log coffin culture has long history in this region, a long chronology can be constructed by measuring other coffin samples. In addition, tree-ring data in collaboration with archeological findings will shed more light on the relationship between climate variability and human activities.

Keywords: dendroclimatology, oxygen isotope, radiocarbon dating

The Comparison of the method to measure tree-ring width in dendroclimatology using Teak annual rings in Indonesia

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Tree-ring width has been used to establish relationships between tree growth and climate (Fritts 1976). Teak (*Tectona grandis* Linn. f.) has been used for paleoclimate reconstruction in tropical region (e.g., D'Arrigo et al., 1994) because teak is the one of few trees that can make annual tree rings there. The tree ring of teak is, however, not growing in a concentric fashion and the width on the disk might have bias from place to place. Therefore, the discussion of the relationship between tree growth and climate might be influenced by the measurement method of tree-ring width.
In this study, we used three teak disk samples, which were collected in Cepu, East Java, Indonesia. We compared the way of tree-ring width measurement. Three different measuring approaches were developed: "method of back calculation based on area (Method 1)", "method of curve traverse lines (Method 2)", and "method of straight traverse lines (Method 3)". Method 1 is the way as follows: consider two circles, which have the same areas closed in internal and external circumference of a tree ring, and define the difference in the lengths of radius as the tree-ring width. Method 2 is the way of measuring along a pith line (growth line), and Method 3 is the way of measuring along a straight line drown from the center to outside.
First, with Method 1, we calculated tree-ring width, and defined each tree-ring's age by cross dating. Next, we measured along 16 lines for each teak disk with Method 2, and developed tree-ring width index. Here we made two types tree-ring width index: one is to choose one line for each teak disk and to average them (16^3 patterns in all; below is called "One Line"), and the other is to choose two lines for each teak disk and to average them ($({}_{16}C_2)^3$ patterns in all; below is called "Two Lines"). Method 3 can be described alike. In previous research, Poussart et al. (2004) used one core for each 2 teak disk to measure tree-ring width, so in this study, it corresponds "One Line" in "Method 3". Schollaen et al. (2013) used two cores for each 16, so in this study, it corresponds "Two Lines" in "Method 3".
Tree-ring width set with "Method 1" is calculated by the two-dimensional growth, and with "Method 2" and "Method 3" represent the one-dimensional growth directly, so the former mirrors the amount of teak's growth more than the latter does. Thus, we analyzed the correlation between each tree-ring width index and climate data, and ascertained how close the consequence of the latter to the former. We also compared the consequences with previous studies (e.g., Schollaen et al. 2013)
This study showed positive correlation ($p<0.001$) between teak's tree-ring width index and previous year's precipitation in dry season with Method 1, which is consistent with Jacoby and D'Arrigo (1990). With Method 2, the ratio of positive correlation ($p<0.05$) was 96.3% in all cases of "One Line", and 99.9% in all cases of "Two Lines". With Method 3, the ratio of positive correlation ($p<0.05$) was only 44.0% in all cases of "One Line", and 57.8% in all cases of "Two Lines".
Besides, this study ascertained negative correlation ($p<0.01$) between teak's tree-ring width index and previous year's DMI in dry season with Method 1. With Method 2, the ratio of negative correlation ($p<0.05$) was 84.8% in all cases of "One Line", and 95.5% in all cases of "Two Lines". With Method 3, however, the ratio of negative correlation ($p<0.05$) was merely 13.0% in all cases of "One Line", and 10.2% in all cases of "Two Lines".
As described above, tree-ring width with "One Line" and "Two Lines" in "Method 3" might not have

information enough to reconstruct paleoclimate. In addition, “Method 1” seems to be the most effective to reconstruct paleoclimate of the three, and the information of tree-ring width with “Method 2” seems to be more credible than the one with “Method 3”.

Keywords: tree ring, paleoclimate, dendroclimatology, dendrochronology

Measurement of sungkai tree-ring width from Jogjakarta, Indonesia

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Because equatorial monsoon and ENSO strongly influence on the climate of Indonesia, Indonesia is important place to understand these climate systems. However, modern meteorological observation in Indonesia lacks long-term data and observation stations. Therefore, it is necessary to reconstruct long-term climate changes by using some proxies. In the proxy such as stalagmite and ice core, tree-ring have an advantage that it records climate data with high time resolution.

Paleoclimatological researches using tree-ring have been conducted in Indonesia. Although almost trees in the tropics don’t make tree-rings, teak and sungkai make tree-rings exceptionally. Teak has been studied so far, but there are only small number of studies about sungkai. Understanding differences between responses of teak and sungkai to the climate makes it possible to compare the two species, and that is useful in reconstructing paleoclimate.

In this study, we observed three sungkai disk samples (samiga1, samiga2, samiga3) from Jogjakarta, Indonesia, and measured tree-ring widths in order to increase numbers of studies about sungkai. We confirmed that outermost tree-ring formed in 2014. Because of tree-ring widths and shapes, we presumed that samiga2 and samiga3 was sampled from the same tree. A false ring wasn’t observed in samiga1. Samiga2 had some doubtful rings. By comparing samiga2 with samiga1 and sungkaiNAN7 (Tamura, 2008), we concluded that samiga2 has two false rings. Thus, we concluded that samiga1 has 28 tree-rings, and samiga2 has 37 tree-rings.

However, it is a problem that the number of samples for comparison is small, and sungkaiNAN7 sampled at Serang. To compare sungkai with teak, it is need to analyze more samples from the same area.

Keywords: tree-ring, ring width, paleoclimate

Cellulose oxygen isotopes in Sphagumun from the Bekanbeushi mire, eastern Hokkaido and its application to paleoclimate reconstruction during the last 2000 years

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The oxygen isotopic composition of rainfall water has climate signals such as temperature and precipitation. Therefore, we can use the $\delta^{18}O$ values of plant cellulose which preserves the $\delta^{18}O$ values of rainfall water for paleoclimate reconstruction. At the Hani peat mire in northeastern China, paleoclimate reconstruction was attempted using the $\delta^{18}O$ values of cellulose in the peat core, and the variation of the $\delta^{18}O$ values in bulk samples was interpreted that it reflects the variation of temperature (Hong et al., 2009). On the other hands, the analysis of $\delta^{18}O$ in different plant tissues in the same sample from the Rhishiri Minamihama high mire showed that the $\delta^{18}O$ values of *sphagnum* is lower than the other species (Yamamoto and Seki, unpublished data), suggesting that bulk cellulose $\delta^{18}O$ values may have reflected fractional variation in different tissues. In this study, we separated *sphagnum* and plant tissues and measured their cellulose $\delta^{18}O$ for peat core samples retrieved from the Bekanbeushi high mire. The $\delta^{18}O$ values of *sphagnum* were always lower than those of *Vaccinium oxycoccos* and *Calamagrostis neglecta var. aculeolata*. Temporal variation in the $\delta^{18}O$ of *sphagnum* indicated that the value was lower around 1500 years ago and higher around 1100 years ago, corresponding to Dark Age Cold Period and Medieval Warm Period, respectively. The difference of the $\delta^{18}O$ values between plant tisuues and *sphagnum* has a negative correlation with the $\delta^{18}O$ values of *sphagnum.* This suggests that relative humidity was higher in warmer periods, which is analogous to modern summer climate in Bekanbeushi area..

Keywords: peat, cellulose, oxygen isotopes

Variation of Asian dust during Holocene based on the mineral composition of peat sequence in Mt. Daisetsuzan area, northern Japan

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Asian dust transported to the northern Japan may have a different source from those transported to the southwestern Japan. In spite of this, many of previous dust studies for Asian dust deposition in Japan have been conducted for the paleo-archives collected from the southern area. On the other hand, the Mt. Daisetsuzan area located just below the northern route of Asian dust transport receives a significant amount of dust in spring time, which dies snow surface brown, and the geology mainly consists of volcanic materials. This area is also characterized by well-developed high moors on the mountains covering the last 4000 - 7500 yrs, which would continuously record the history of climate change during the middle to late Holocene. Peat collected from these high moor could be also a suitable material for a precise age determination using the radio carbon, and its inorganic fraction might consist of aeolian dust of continental origin and volcanic materials of the local origin which could be easily distinguished from each other.

In order to reconstruct the Holocene variability of Asian dust deposition in the northern Japan, we collected peat cores from the high moor in the Mt. Daisetsuzan area, and measured the mineral composition contained in peat. After heat treatment of peat samples, we conducted X-ray diffraction (XRD) analysis on the ash fraction and semi-quantified the minerals. Quartz, illite, and chlorite showed positive correlation among others, while various feldspars showed another positive correlation among others independent from quartz. Amorphous materials exhibited a variability different from quartz or feldspars. High ash content was associated with high feldspars or amorphous. Comparing these mineral compositions with those of aeolian dust deposited in this area and the local riverbed materials, we judged that the inorganic fraction could be explained by mixtures of aeolian dust and two kinds (crystalline and amorphous) of local volcanic materials.

The average Asian dust content in the peat was estimated 89.7 mg/g dry peat, using ash contents and contribution of aeolian dust endmember calculated from XRD analysis. Assuming the bottom of peat sequence was 7500 yrs BP (Takahashi and Igarashi, 1985) and the dry bulk density of peat was 0.1 g/cm^3 , the average Asian dust flux to the site was calculated as 0.14 $mg/cm^2/yr$, which was consistent with known values (0.2 - 4.5 $mg/cm^2/yr$) from previous studies around Japan. Temporal variation of the reconstructed dust flux generally showed an anti-phase relationship with the dust flux reconstructed in the Jeju Island (Li and Matsumoto, 2007). This might be due to the change in the meandering pattern of the westerly jet which promoted an alternation of the main dust transport pathway between northern and southern routes.

Keywords: aeolian dust, peat, Holocene, Mt. Daisetsuzan

Event sediments in Lake Inawashiro, Fukushima, Japan

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Varve-like sediments with a few millimeter thick are widely developed in the lake bottom of Inawashiro, central part of Fukushima prefecture. Several kinds of event sediments are intercalated in that sediment. The first one is tephra seams, Aira Tn tephra and Numazawa-Lake Numazawa tepha are famous examples. The second one is turbidite sediments caused by quakes of large earthquake, for example, 2011 earthquake off the Pacific coast of Tohoku and Great Kanto earthquake. The third one is dark brownish silty clay with some centimeters thickness underlain by light grey silty clay sediment. The fourth one is relatively coarse sediment with no characteristics in color. This study aims to clarify sedimentation mechanism of the third event layers which show reverse grading at lower part and normal grading at upper part. Sediments are sieved with metallic fine filter and composition of grains were examined. The result shows that light greyish part is mainly composed of quartz, feldspar and volcanic glass shards. And dark brownish part is composed mainly of siderites in adition to quartz, feldspar and volcanic glass shards. Dark parts in soft X-ray photo correspond to dark brownish part which contains siderite grains. Sedimentation model for this fourth event sediment is considered as follows. There was a small lake with sediment of several tens of meters to the northwest of Mt. Adatara. The sediment in the lake was composed chiefly of volcanic materials with siderite grains. Drainage area of Lake Inawashiro is famous for its heavy snowfall, and during cold ages heavier snowfalls are expected. At these ages large volume of melt water could destruct the wall of the lake which lead drastic flooding into Lake Inawashiro.

Keywords: Lake Inawashiro, event sediment, Flood

Preliminary reconstruction of Lake-level changes based on fossil diatom assemblages in Lake Biwa

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This is a preliminary report of a research for reconstruction of lake-level change history of Lake Biwa based on the transfer function of diatom assemblage into water depth of surface sediment. We investigated diatom assemblages in drilling core sample from the lake bottom and surface sediment samples from the lake bottom from 5 m to 30 m in depth off estuary of Echi River, Lake Biwa.
Rate of planktonic species and water depth can be changed into the transfer function. The transfer function applied to drilled sediment from Lake Biwa into lake-level change history.The result shows that lake-level changes in Lake Biwa reflects climate changes. Before 1.5 ka, water depth rose under relatively cold conditions. During the last 1.5 ka, water depth rose under relatively warm conditions. The difference of response to climate condition suggests that snowfall in winter depending on East Asian winter monsoon and rainfall in summer depending on East Asian summer monsoon influence water balance of Lake Biwa.

Keywords: Lake Biwa, off estuary of Echi River, drilling core, planktonic diatom, transfer function, lake-level change

Extraction of paleoclimatic signal from the Eocene Green River Formation Lake Sediments in Utah, USA

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EECO (Early Eocene Climatic Optimum) is known as the warmest period in the Cenozoic era. The Eocene Green River Formation, distributed at Utah, Colorado and Wyoming in US. consists of lake sediments in foreland basin of the Rocky Mountain. Most study about Green River Formation focused on oil shale with petroleum geology and organic geochemistry, However, there are only few sedimentological and inorganic geochemical works for reconstruction of paleoenvironment from the Green River Formation. Here we tried to reconstruct climate change during the EECO from the Green river Formation at the Uintah basin, based on the sedimentary analysis and geochemical analysis.
The Green River Formation is divided into 6 lake stages; fresh lake, transitional lake, highly fluctuating lake, rising lake, high lake and closing lake (Milkeviciene and Sarg, 2012). We investigated sedimentary facies at the Indian Canyon section, Utah, and recognized 3 –5 lake stages resulted from facies analysis. High lake stage, called Mahogany zone, was suggested as the peak of EECO. Furthermore, we established depth ranks by lithofacies and development of lamination to estimate detailed changes in paleo-lake levels. We also examined XRF and elemental analyzer measuring CNS to examine the inorganic and organic geochemical analysis, respectively.
Stable Ti/Al variation implies the changes in provenance would be negligible. The fluctuations of Ca/Al and Mn/Al are similar to that of depth rank record. K/Al shows high value at the high lake interval (Mahogany zone), implying enhanced chemical weathering intensity. Additionally, high TOC and low C/N in the Mahogany zone suggest the increased algae productivity in this zone. Our results suggest that the development of warm and humid environment in the middle-latitude North America at the EECO. We will analyze drilling core sample of Green River Formation with high-resolution.

Winter monsoon intensification during the last geomagnetic reversal in the Chinese Loess Plateau

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A link between geomagnetic field and climate is an unresolved long life research subject. Correlation between galactic cosmic rays (GCR) flux and low cloud cover can provide a theoretical rationale to this subject. Namely, the geomagnetic field intensity can change low cloud cover through GCR, and finally change the climate. The East Asian Monsoon (EAM) system significantly affects the climate in East Asia, including Japan. In order to clarify whether the EAM was influenced by geomagnetic field changes in the past, we analyzed loess paleosol deposits of the Chinese Loess Plateau (CLP) for the Marine Isotope Stage (MIS) 19 interglacial, during which the Matuyama-Brunhes magnetic polarity transition (MBT) accompanying a large field intensity decrease occurred.
For Chinese loess-paleosol deposits, magnetic susceptibility and frequency dependence are regarded as proxies of summer monsoon (SM) intensity, and grain size as a proxy of winter monsoon (WM) intensity. We collected samples from sections of about 7 m thick in Xifeng and 8 m thick in Lingtai, about 100 km south of Xifeng, in the CLP. Magnetic and grain size analyses were conducted at about 2.5~20-cm depth intervals. In both sites, the high-resolution paleomagnetic data reveal the detailed MBT with multiple polarity swings.
The SM and WM proxy curves, obtained from magnetic susceptibility and grain size data, show consistent variations well correlated the precessional sea level changes. The correlation shows that our data have an average resolution of about 120 yr. The SM intensity increases and WM intensity decreases during the MISs 19.3 and 19.1 seal-level highstands, and the opposite changes occur during the MIS 19.2 lowstand. This variation pattern is the same with the results of a number of previous studies. However, our high-resolution data reveal that the WM briefly strengthens around highstand MIS 19.3 which should be warm. The WM strengthening interval is partly overlapped with the MBT. According to the paleomagnetic intensity stack for the last 800 kyr (S-int 800), the WM strengthened when the geomagnetic field intensity decreased below one third of the present intensity, and also when the GCR flux increased to above 1.4 times, and about 2 times at maximum. The temporary WM strengthening occurred around highstand MIS 19.3 may be related to the climatic cooling observed in Osaka Bay, Lake Baikal, Israel, and Italy, probably caused by an increase in GCR due to the significant geomagnetic field decrease.

Keywords: Winter monsoon , Matuyama-Bryunhes boundary, Chinese Loess Plateau

Reconstruction of sea surface temperature over 50 years using coral Sr/Ca ratios from Seribu Island, Indonesia

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The Indonesia archipelago is located between the Pacific and the Indian Ocean where is important place for the study of climate changes related to El Niño/Southern Oscillation (ENSO), Asian monsoon and/or Indian Ocean Dipole. However, instrumental and observed records such as water temperature and salinity has not been reported enough to understand climate systems around the Indonesian seas. Then, in this study, we have reconstructed sea surface temperature (SST) for more than 50 years from Sr/Ca ratios in a coral core collected from Seribu Island, Indonesia. Measurements of Sr/Ca ratios were performed by ICP-OES with monthly resolution and precision (RSD) was better than 0.3%. Based on the temperature records reconstructed by coral Sr/Ca ratios and time-series analysis, relationship between SST and climate events around Indonesian seas will be discussed.

Holocene environmental change of coastal lagoon inferred from diatom assemblage in Lake Hwajinpo, Korea

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Hwajinpo is the largest lagoon in Korea, and its bottom sediment preserves good the Holocene records. To reconstruct the evolution of the Hwajinpo inner lake, analysis of AMS radiocarbon dating, OSL dating, grain size, and diatom assemblage were performed to the 11 m core obtained from the small river mouth of the inner lake (HJ02). According to diatom assemblage and grain size analysis, the environments were divided into 6 periods, labeled unit 1 to 6. The Hwajinpo lagoon was an estuarine environment which was influenced by marine water about 8 ka (Unit 1). Unit 2 is dominated by bay indicator species, meaning that the estuary changed to open bay condition which is connected to ocean. After then, marine species gradually decreased and the open bay changed to semi-closed bay as developed the sand bar. In case of Unit 4, marine species didn’ t occur because sand barrier is completely developed and there was a hiatus between 5.5 and 1.7 ka in about 7m depth because of flooding and delta switching event. Then, the environment of this site changed to an Oligohaline lagoon (Unit5) because of climate change especially precipitation increase. Since 1ka, the environment changed to like modern lagoon condition based on diatom assemblage which has been similar to modern assemblages.

Keywords: lagoon, diatom , paleoenvironmental change

Timing and characteristics of eolian-sand turbidites collected from the northeastern Arabian Sea

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The relationship of sea-level changes and climatic changes in late Quaternary with turbidite deposition is reported. We found two ungraded and massive sand layers which were intercalated in calcareous clay in a sediment core (ER-4; W.D. 3,550 m) collected from the northeastern Arabian Sea. The characteristics of these contained dominantly the gray colored, pellet shaped marble grains which were consist of well-sorted and well-rounded of fine to medium sands. According to these features, these sand layers could be described as redistributed eolian sand, so-called “eolian-sand turbidites” (Sarnthein and Diester-Haass, 1977), derived from Thar Desert. The timing of these turbidite occurrences were determined after Heinrich event 5 and L.G.M., respectively, in response to major glacial to interglacial sea-level shifts and variability in the NE-Indian monsoon climate change. Thus, the frequency of eolian-sand turbidites must be influenced by sea-level variations, by cyclic processes of climatic origin and by variations in the subbottom morphology.

Keywords: eolian-sand turbidite, northeastern Arabian Sea, sea-level change, marine core

Sea surface environmental changes during the early to middle Miocene in the Indian, Atlantic and eastern equatorial Pacific Oceans based calcareous nannofossil assemblages

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During the early–middle Miocene, global ice volume was smaller than today and seawater temperatures in the oceans were likely higher until the Middle Miocene Climatic Optimum (MMCO: approximately 17 to 15 Ma). After the MMCO, global cooling had developed due to strong glaciation of the Antarctica and enhanced thermohaline circulation associated with deep water cooling (Shevenell et al., 2008; Billups and Schrag, 2002). This study investigates calcareous nannofossil assemblages of ODP cores in the southern Atlantic, Indian, and eastern equatorial Pacific Oceans in order to clarify sea surface environments during the early–middle Miocene. Calcareous nannofossil zones from CN1 to CN5a (Okada and Bukry, 1980) were identified in the investigated ODP cores and corresponding numerical ages are approximately 23 to 12 Ma. *Cyclicargolithus*, *Discoaster* and *Reticulofenestra* specimens dominantly occurred throughout the cores. Generally, an inverse relationship of relative abundances between *Discoaster* and *Reticlofenestra* seems to be observed. *Reticulofenestra* dominated assemblages imply that turbulent conditions of sea surface waters with rich nutrients occurred and they correspond to the time during low $\delta^{18}O$ conditions. Conversely, abundant occurrences of *Discoaster* indicate that well-stratified sea surface waters with poor nutrients developed in the time of high $\delta^{18}O$ values (Sato and Chiyonobu, 2009). In the examined sites, abundant occurrences of *Reticulofenestra* with fewer *Discoaster* specimens were found in approximately 21 and 15 Ma and they correspond to the beginning of the glacial periods Mi-1a and of Mi-2 (Billups et al., 2002), respectively. It suggests that these variations had mainly been controlled by cyclic developments of the Antarctic ice sheets. Moreover, calcareous nannofossil floras in each ocean were influenced and modified by local environmental changes, e.g. upwelling in the equatorial regions and/or western margin of Indian Ocean.

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Keywords: Calcareous nannofossils, Miocene, Upwelling, Stratification, ODP

The variation in mineral fraction corresponding to Iceberg collapse obtained by X ray powdered diffraction method at MIS104

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The climate change in the period that the ice sheets appeared and then developed in the northern hemisphere was unknown in many respects. However, the development and collapse of the continental ice sheets are considered to be closely related to climate change. We have researched that how the relationship of ice sheet collapse and deep water circulation at thousands of years scale varied with the development of the ice sheet by comparing ice rifted debris (IRD) count and rock magnetic records in the marine sediment core drilled in the North Atlantic Ocean. The records in the sediment core around marine isotope stage (MIS) 100 in which the continental ice sheet is considered to have greatly developed have been reported (Ohno et al, 2016).
In our earlier study, IRD count and rock magnetic analysis in MIS 104 (2.58 - 2.62 Ma) before MIS100 have been reported (Makio et al., JpGU 2015), but minerals constituting the sediments in MIS 104 have not been mentioned. Minerals in the sediment provide us useful information such as the origin of continental ice sheets and the carbonates constituting marine plankton shells. Therefore, we estimated the relative amount and/or the weight ratio of minerals in the sediment samples by the X-ray diffraction (XRD) decomposition method.
The samples used in this study are in a sediment core drilled at Integrated Ocean Drilling Program (IODP) Site U1314 off southern Iceland. This sea area is a flow channel of the North Atlantic Deep water formed in the northern part of Iceland, and the deep water transports basaltic clusters around Iceland. The sediment samples corresponding to around MIS 104 (2.58 - 2.62 Ma) were collected at intervals of about 4 cm (about 200 - 400 years) . For XRD measurements, a standard sample, zincite (ZnO), was added in a fixed percentage (5 wt%) to the sediment sample, and then they were mixed and homogenized with an agate mortar . XRD measurements were performed by the step scan method using a RIGAKU X-ray Diffractometer RINT 2100V. The XRD data obtained were decomposed into each component (intensity (area) of each elementary peak) by the XRD decomposition method (profile fitting method) using the program software MacDiff (Petschick, 2000).
The relative fluctuation records of each mineral were reconstructed during MIS 104. Especially, minerals which are suggestive of continental origin, such as quartz, mica, feldspar, showed a sharp increase at the term of the IRD events. On the other hand, calcite gradually increased and decreased over the glacial - interglacial period. The results obtained in this experiment supported the results of IRD count and rock magnetic measurements in MIS104 in our previous study.

Keywords: Ice Rafted Debris, Rock magnetism, X ray powdered diffraction method

Variations in paleovegetation recorded by terrestrial plant biomarkers in the sediments from IODP Site U1385 off the SW Iberian Peninsula

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Terrestrial plant-derived biomarkers such as long chain *n*-alkane, fatty acid and alcohol are prevalent in marine sediments, and are used as diagnostic tools for reconstructing terrestrial input, paleovegetation and atmospheric conditions. Plant terpenoids, another class of higher plant biomarkers, also occur in various types of marine sediments. Chemotaxonomic feature of plant terpenoids has been emphasized by dataset of recent plant natural product as well as geochemical analysis of geological samples (e.g. peat, plant fossils and coals). Hence, compositions of plant terpenoids in marine sediments may reflect paleo vegetation and climate condition. However, occurrence and composition of these plant terpenoids in marine sediments are hardly known. In the present study, we analyzed the terrestrial plant-derived biomarkers in the sediment core recovered by IODP exp. 339 Site U1385 to reconstruct past variation of flux and composition of the plant terpenoids.

We used sediments samples from in the northeastern Atlantic off the SW Iberian Peninsula (IODP site U1385), so-called ‘Shackleton Site’. The age ranges between Marine Isotope Stage (MIS) 12 and MIS 10 are analyzed, and especially, the paleoclimatic reconstruction of the MIS 11 is focused. Several studies have been examined the climatic variations of MIS 11 by a high-resolution direct land-ocean comparison from the Site U1385 (e.g. Oliveira et al., 2016, *Quat. Res.*). Lipids were extracted with dichloromethane / methanol, and separated to aliphatic, aromatic and polar fractions. Lipids were identified and quantified by GC/MS. In addition to the plant biomarker analyses, we estimated the paleotemperatures of sea surface layer using alkenone unsaturation index (UK'_{37}).

Diterpenoids such as dehydroabietic acid (gymnosperm origin) as well as triterpenoid such as β-amyrin, friedeline and lupeol (angiosperm origin) have been mainly identified as the plant terpenoids in almost samples. The dehydroabietic acids / β-amyrin ratios, which are representative of gymnosperm / angiosperm ratios, tend to decrease during the interglacial period of MIS 11. The dehydroabietic acid is typical biomarker as conifer woods. Thus, the decreasing of the relative abundances of the dehydroabietic acid in marine sediments during MIS 11 is assumed to decline the coniferous vegetation in hinterland areas around the Site U1385. The variations in the other gymnosperm / angiosperm ratios such as total diterpenoids / triterpenoids ratios are similar trends during MIS 12 –MIS 11. On the other hand, the lupeol / β-amyrin and lupeol / total triterpenoids ratios are lower during glacial periods including MIS 12 and MIS 10, but tend to increase during interglacial period MIS 11. The lupeol is known to be originated from various angiosperms, especially legume and aster families including lupines. The variations in lupeol ratios are concordant with those in $\delta^{18}O$ values, alkenone-based temperatures, and pollen percentages of the Mediterranean forest species in the Site U1385 (Oliveira et al., 2016). Interestingly, increasing spikes are observed in the lupeol ratios during the cooling stages in MIS 11 (ca. 390 ka), and well correlated to the minimal values of the Mediterranean forest. Thus, the lupeol ratios can be an indicator of cooler vegetation. From these results, the indices using the plant terpenoids in marine sediments have potentials for reconstructing paleoclimatic variations via paleovegetation changes at the glacial/interglacial cycling during the Quaternary.

Keywords: paleovegetation, biomarker, plant terpenoid, MIS 11, northeastern Atlantic Ocean

Sea-surface temperature chanhes in the Japan Sea off Wakasa since the Last Glacial Maximum based on silicoflagellete assemblages

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The Japan Sea is a marginal sea, connecting to the East China Sea, the North Pacific and the Okhotsk Sea through the Tsushima, Tsugaru, Soya, and Mamiya straits. During the Last Glacial Maximum, the connections between Japan Sea and the circumjacent seas were highly limited due to sea-level drop down to ~130 m. Because of significant decrease in the Tsushima Warm Current (TWC) inflow into the Japan Sea, sea-surface temperature (SST) of the glacial Japan Sea must have been chilled. However, no previous study was unable to constrain glacial sea-surface temperature of the Japan Sea caused by low salinity surface water and semi-closed environments. For instance, oxygen isotopes of planktic foraminiferal shells showed significantly light values highly influenced by the glacial low salinity. Alkenone paleo-thermometry did not work well due to low salinity, indicating unusually high SST during LGM. Silicoflagellate is a marine phytoplankton with biogenic opal skeletons. Most of the modern silicoflagellates are belonging to two genera: *Dictyocha* mainly distributing tropical to temperate regions and *Stephanocha* mainly distributing polar to subpolar regions. In addition, silicoflagellates can survive in brackish water. Therefore, silicoflagellates has a great potential to reconstruct glacial SST in the Japan Sea. Here we present SST reconstruction in glacial Japan Sea based on silicoflagellate assemblage in Japan Sea sediment. The sediment core KR15-10 WB6 was collected off Wakasa at water depth 845 m. Age model of the piston core has been established based on radiocarbon datings on planktic foraminiferal shells. Based on modern analog technique of the silicoflagellate assemblages, quantitative SST reconstruction of SST was performed for the past 28.5 kyrs. Reconstructed SST of the glacial Japan Sea indicated 5 degree C or colder. Gradual SST increase was observed since 14 ka and reached 14 degree C (modern SST) at 11 ka. These suggest that resuming of TWC inflow into the Japan Sea occurred at ~14 ka. Since 11 ka, TWC strength would have been comparable to the present one.

Keywords: Japan Sea, Last Glacial Maximum, Sea-surface temperature, Silicoflagellate assemblage

Estimation of past intermediate water temperatures in the northwestern Pacific based on radiolarians: it’ s suitability and constrains

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The use of siliceous microfossil assemblages, such as radiolarians for reconstruct past sea water temperature were developed since decades but all the studies only deal with reconstruction of Sea Surface Temperatures (SST). The most known reconstructions are those of the CLIMAP project, reconstructing worldwide SST during the Marine Isotopic Stage (MIS) 2. In this project, SST of Southern Ocean and Pacific Ocean, were reconstructed by the use of diatoms and radiolarians applying a Q-mode factor analysis following the statistical procedure of Imbrie and Kipp (1971). Following this method, numerous studies reconstructed past SST in the Southern Ocean and Pacific Ocean. In the North Pacific, the vertical distributions of radiolarian species have been well investigated and we know that several species are living at the intermediate water depths (200- 1000 m). Therefore, the establishment of a new data-set composed of intermediate water depth living taxa would potentially enable for the first time the estimation of the paleo intermediate water temperature. In this study, we propose a new data-set of radiolarian assemblages from the surface sediment of the Northwestern Pacific for reconstruct past intermediate water temperature.

In this context, we analyzed 87 surface sediment samples covering the northwestern Pacific Ocean from 1˚ to 50˚N and 120˚ to 167˚E. Among, 77 samples were collected by the Geological Survey of Japan and 10 samples were collected by the Japan Agency for Marine-Earth Science. Changes in radiolarian assemblages have been analyzed on these samples. When we try to reconstruct temperature of the intermediate water based on microfossil assemblages, two major issues constrain the reconstruction. Because intermediate water species represent a much lower portion of the total assemblage, the variation of their relative abundances are less significant than those recorded in the surface and would cause some biases in the reconstruction. The second issue is that the intermediate water temperature changes greatly between 200 and 1000 m. This also create biases. For try to minimize the effect of such biases, we proposed a normalization of the data-set and tied our normalized assemblage to the temperature at water depth of ca. 500 m. This water depth has been chosen because of the relative stability of temperatures between 500-1000m, and most of our selected species cover the water depth of ca. 500 m. This enable us to estimate past intermediate water temperature at ca. 500 m within an error margin of 1.2 ℃ (R^2 =0.84), which is promising. However, some concerns remain, particularly for temperature higher than 9℃, but for temperature lower than 9℃, it seem that our method is relatively suitable (R^2=0.89).

Keywords: Northwest Pacific, Intermediate water temperature, Radiolarians

The undatables: Quantifying uncertainty in a highly expanded Late Glacial - Holocene sediment sequence recovered from the deepest Baltic Sea basin –IODP Site M0063

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Laminated, organic-rich silts and clays with high dissolved gas content characterize sediments at IODP Site M0063 in the Landsort Deep, which at 459 m is the deepest basin in the Baltic Sea. Cores recovered from Hole M0063A experienced significant expansion as gas was released during the recovery process, resulting in high sediment loss. Therefore during operations at subsequent holes, penetration was reduced to 2 m per 3.3 m core, permitting expansion into 1.3 m of initially empty liner. Fully filled liners were recovered from Holes B through E, indicating that the length of recovered intervals exceeded the penetrated distance by a factor of >1.5. A typical down-core logarithmic trend in gamma density profiles, with anomalously low density values within the upper ~1 m of each core, suggests that expansion primarily occurred in this upper interval. Thus, we suggest that a simple linear correction is inappropriate. This interpretation is supported by anisotropy of magnetic susceptibility data that indicate vertical stretching in the upper ~1.5 m of expanded cores. Based on the mean gamma density profiles of cores from Holes M0063C and D, we obtain an expansion function that is used to adjust the depth of each core to conform to its known penetration. The variance in these profiles allows for quantification of uncertainty in the adjusted depth scale. Using a number of bulk ^{14}C dates, we explore how the presence of multiple carbon source pathways leads to poorly constrained radiocarbon reservoir age variability that significantly affects age and sedimentation rate calculations.

Keywords: 14C, IODP, Age modeling, Sediment expansion, Paleomagnetics

Marine Isotope Stage 2 sea-level records deduced from sediment cores in the Bonaparte Gulf and glacial isostatic adjustment model

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Marine Isotope Stage 2 (MIS 2) is the latest glacial period (30,000–15,000 years ago), including the Last Glacial Maximum (LGM) characterized by the maximum of global ice volume. The comparison of various paleoclimatic records with sea-level change derives an understanding of the earth climate system. However, global sea-level change during MIS 2, especially the LGM, is less understood due to its paucity of data and its uncertainty. The Bonaparte Gulf, northwestern Australia, is a suitable region to reconstruct the global sea level change since the Gulf is far from the former ice sheet and tectonically stable. Here we present the new sea-level records from the Bonaparte Gulf and the revision of the global ice volume history during the MIS 2 using marine sediment cores, paleo-tidal model and glacial isostatic adjustment (GIA) model. To reconstruct relative sea level in the Bonaparte Gulf, we employed exceeding 250 radiocarbon dates of carbonates and bulk organic matters from cores with various depths, combined with the two-dimensional tidal model for the evaluation of paleo-tidal effects to the past sea level in the Bonaparte Gulf. We also propose the revised global ice volume history during the MIS 2 based on results from GIA model and the new relative sea-level records for the Bonaparte Gulf.

Keywords: Sea Level, GIA model, MIS2, radiocarbon dating

Scale and frequency of cooling-drought events by asteroid impact

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Asteroid impacts to the Earth can form global stratospheric soot and sulfate aerosols sourced from target rocks leading to global decreases in sunlight, temperature, and precipitation. Scale of the cooling-drought events is decided by amount of those aerosols. Their amounts vary widely depending on impact location and impact energy. However, impact site variation has not considered for calculation of probability of the cooling-drought events by asteroid impacts. We analyzed climate changes by different size of asteroids hitting various impact locations. Here we show that significant cooling in high-middle latitudes with drought in low and high latitudes occur in frequency of once/7 million years, which decreases to one eighth of previous thought. The cooling-drought events by bolide impacts become more rare events for humans, but can occur during the duration of anthroposphere. Cooling in high-middle latitudes by >5 ˚C on land and drought in low latitudes damage vegetation and agriculture globally, which can induce a significant decrease of number of animals including humans. In order to avoid the disasters, an asteroid orbit should be controlled to hit to the oceans when impacts cannot be avoided, because of low amount of stratospheric aerosol sources inducing cooling in the ocean areas, and a little amount of stratospheric sulfate aerosol formed by impacts.

Keywords: climate change, asteroid impact

The response of the climate to changes in the orbital parameters

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Whereas paleoclimatic records consist with Milankovitch theory (Hays et al., 1976), the response of the climate to changes in the orbital parameters (eccentricity, precession and obliquity) is poorly understood. Abe-Ouchi et al. (2013), using comprehensive climate and ice-sheet model (IcIES-MIROC), proposed that 100,000-year glacial cycles in last 400,000 years can be explained by the response of the climate to change in the insolation. It is a mystery that termination 1, the deglaciation from last glacial maximum (LGM; ~20,000 years ago) to present, and termination 5, the deglaciation from marine isotope stage (MIS) 12 to MIS11 (~400,000 years ago), were accompanied with climate changes as large as termination 2 in spiite of the fact that eccentricity was relatively small (relatively small summer insolation change) during termination 1 and 5, while it was large (large summer insolation change) during termination 2 (400,000 years problem). To consider this problem, we analyze the role of the orbital parameters for the climate changes during the terminations by examining the response of the climate to changes in the various orbital parameters. Here, using MIROC-LPJ (O'ishi and Abe-Ouchi, 2011), the sensitivity experiments combined various orbital parameters show that the changes in surface temperature are not always linear to the changes in insolation, furthermore, the large obliquity with winter solstice make the temperature higher than the small obliquity with summer solstice when eccentricity is relatively small. It suggests that the surface temperature during termination 5 with higher obliquity can be higher without increasing carbon dioxide contents, even if the insolation was weaker. In this presentation, we discuss these sensitivity experiments in detail. We will also examine the snapshot experiments in 2,000 years intervals with only changing orbital parameters during termination 1 and 5 by MIROC-LPJ.

Keywords: orbital parameter, glacial-interglacial, model

Impact of glacial ice sheets on the duration of the stadial climate: Role of surface wind and surface cooling

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It has been shown from ice core reconstructions that glacial periods experienced climate shifts between warm interstadials and cold stadials. The duration of these climate modes varied during glacial periods, and that both the interstadials and stadials were shorter during Marine Isotope Stage 3 (MIS3) compare to MIS5. Recent studies showed that the duration of the interstdials is controlled by the Antarctic temperate through its impact on the stability of the Atlantic Meridional Overturning Circulation (AMOC). However, similar relation could not be found for the stadials, suggesting that other climate factor (e.g. differences in ice sheet size, greenhouse gases and insolation) may play a role. Thus, for a better understanding of the stability of the climate, it is very important to evaluate the impact of these climate factors on the duration of the stadial climate. In this study, we investigate the role of glacial ice sheets. For this purpose, freshwater hosing experiments are conducted with an atmosphere-ocean general circulation model MIROC4m under several ice sheets configurations computed in an ice sheet model Icies (Abe-Ouchi et al. 2013). The impact of glacial ice sheets on the duration of the stadial climate is evaluated by comparing the behavior of the weak AMOC after the freshwater forcing is reduced. All experiments show a drastic weakening of the AMOC in response to the freshwater hosing, which accompanied a cooling over the North Atlantic, a southward shift of the tropical rain belt and a warming over the Antarctic. We find that experiments with smaller ice sheet takes more time to recover after the freshwater hosing is reduced. Sensitivity simulations show that differences in the surface wind is important in causing the shorter stadial under larger ice sheets, while differences in the surface cooling has an opposite effect. Thus our result suggests that differences in the surface wind induced by the ice sheets play an important role in causing shorter stadials during MIS3 compare to MIS5.

Keywords: AMOC, Stadial, Ice sheet

Numerical simulation about meandering Kuroshio in LGM

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The Kuroshio Current(KC) is the western boundary current of the North Pacific subtropical gyre. The KC has a role for transportation of heat energy to the subarctic zone from the tropical zone. The KC transports not only heat energy but also plankton, marine resources, and chemical substance, so the KC variation has a major influence on marine environment and climate change in the north Pacific region.
At present, the variation of past KC is mainly reconstructed by proxy analysis from marine core on paleoceanography (e.g., Ujiie and Ujiie [1999], Ujiie et al. [2003], and Kawahata et al. [2003]), but each study (proxy analysis) showed different interpretations about the main route of the KC during the Last Glacial Maximum (LGM) in the Okinawa Trough, and the physical oceanographic approach for the past KC variability is significantly limited.
The main purpose of this study is to reconstruct the main pass of KC in the last glacial using a 3-D ocean model with global sea level change. The numerical simulation with realistic topography was performed using the 2003 version of the Princeton Ocean Model [Blumberg and Mellor, 1987] configured for the western North Pacific Ocean, domain in 5˚N-55˚N and 120˚E-170˚E, and horizontal resolution of 1.3/10˚ - 3.9/10˚.
When the sea level drops at -120m for LGM, the KC passes through the Okinawa Trough, which is almost same route of modern KC. In addition, when the sea level is down, warm- and cold-core eddies tend to form frequency and become large scale in the Sikoku Basin, and the main route of the KC shows a large meander path. These results suggest that the KC became easily large meandering during the LGM because strengthen topographic closed around the Sikoku Basin by sea level drop.

Keywords: Kuroshio, Paleoceanography , Paleoclimatology

Silicoflagellates assemblages on the Danjyo Basin in the East China Sea since the last glacial maximum

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The East China Sea (ECS) is a marginal sea of the western North Pacific. ECS is divided into two areas of different water depth character: continental shelves shallower than 200 m in the northeast, which occupies greater than 70% of ECS and deep basin down to >2000 m in the south east (Okinawa Trough). Warmer and more saline Kuroshio Water and cooler and less saline Chinese Coastal Water influence on surface conditions of the ECS. Silicoflagellates are unicellular marine plankton and they have simple geometric siliceous skeletons which are constructed of hollow, tubular rods. There are two major silicoflagellate genera *Dictyocha* and *Stephanocha* dwell mainly tropical to subtropical region and polar to subpolar region, respectively. Hence, ratio of two genera in sediment is a qualitative proxy of sea-surface temperature. Here we present a silicoflagellate assemblage in sediment core sample on the Danjo Basin of ECS sediment to reconstruct sea-surface temperature change since the last glacial maximum. Piston core KY07-04-01 (31˚38.35’ N, 128˚56.64’ E, 758 m) was recovered from the northern edge of Okinawa Trough. Age model of KY07-04-01 was established based on thirteen ^{14}C ages and one tephra layer, K-Ah tephra (Kubota et al., 2010). In this study, silicoflagellate assemblages of KY07-04-01 were investigated by using light microscope (LM). A total of 11 silicoflagellate species were encountered during the microscopic observation. Change in the ratio of the *Dictyocha/Stephanocha* genus of this region showed a tendency to increase for the past 18 kyrs, suggesting intensified Kuroshio Water inflow. The supporting evidence is came from *Dictyocha epiodon*, currently abundant in the Kuroshio Extension and the Gulf of Alaska, showed gradual increase from the last glacial maximum (LGM) to the late Holocene. *Stephanocha speculum* is the representative species in subarctic and polar region. Relative abundances of S. speculum were high during LGM. This indicates colder and less saline surface water was covered on the Danjo Basin. However, constant occurrence of *Dictyocha messanensis*, which widely distributes from tropical to temperate region, shows that Kuroshio Water has been flowed into the ECS even during LGM.

Keywords: silicofagellate, East China Sea, Danjyo Basin, sea-surface temperature

Geological Characteristics in shallow marine around Miyako-jima Island based on Sub-bottom profiles and bathymetric data

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National Institute of Advanced Industrial Science and Technology (AIST) carried out the marine geological survey around the Miyako-jima Island, Okinwa in 2016 using R/V Hakurei belonged to JOGMEC. We obtained the high-resolution data by Sub-Bottom Profiler (SBP) survey and Multi-Beam Echo Sounder (MBES) bathymetric survey. This presentation shows the geological characteristics in shallow area around the Miyako-jima Island based on SBP profiles and MBES bathymetric data.
Flat sea bottom shallower than 200 meters in depth widely spreads around the Miyako-jima and the coral reefs have developed in nearshore area. In this area, high-resolution profiles depicting surface geological structure under sea bottom were obtained by SBP. Sediment under sea bottom is divided into two units. Remarkable unconformity is recognized between upper stratified sedimentary unit and lower unit showing poor internal reflectors. Remarkable unconformity exposed from in the shallow area is indicating remarkable mound topography. Height of the mounds of remarkable unconformity is reaching to 8 meters from sea bottom. The projects are recognized only in shallow marine area than 100 meters in depth. Therefor we presume that these projects are submerged coral reefs developed accompanied by sea level rise since last glacial maximum.

Keywords: Sub-Bottom Profiler , Multi-Beam Echo Sounder bathymetric survey , Miyako-jima Island , coral reef, surface marine geology, shallow sea

High-resolution seismic reflection and SBP surveys on the Miyako-Sone platform, Ryukyu Island Arc, northwestern Pacific

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Shallow seismic profiling using AA300 Boomer system with 24 channels digital streamer cable and parametric SBP (sub bottom profiler) surveys were conducted on the Miyako-Sone platform, northeast of Miyako-jima, Ryukyu Islands, northwestern Pacific Ocean. Study area is reported that existence of the drowned reef probably formed during the final stage of the cooler postglacial period (Arai et al., 2016). High-resolution seismic profiles show a distinct, irregularly-undulated reflector which form the topographic high surround shallowest area, but have internally chaotic reflections. In the other hand, the parallel stratified sediment of less than 20 m (25 ms two-way travel time: calculate thickness using velocity is about 1500 m/s) covers the unconformable erosional surface which is characterized by distinct flat reflector 90-120 m (120-160 ms two-way travel time) in depth. Some small mounds, which are outlined by strong reflections are found above the distinct flat reflector. The feature of this reflector suggests that it represents an erosional surface formed during last glacial maximum. We conclude that the mound shape structures are submerged coral reefs, and reefal deposits, that developed following the last glacial maximum. Such high-resolution seismic profiles may be useful and effective indicator of the detailed paleoenvironment.

Keywords: Ryukyu Arc, marine geology, seismic reflection survey, Quaternary

