Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MIS01-01 Room:314 Time:April 29 14:15-14:30

Evolution and variability of East Asian monsoon and the potential relationship with Himalaya-Tibet uplift

TADA, Ryuji[1*]

[1]Graduate School of Science, the University of Tokyo

Monsoon is climatic phenomenon driven by heat capacity contrast between the continent and ocean, so every continent has its own monsoon system. Asian Monsoon is by far the largest monsoon system on the globe. Although it is regional phenomenon, it exerts significant influence on the global climate. The extremely large size of Asian Monsoon system is considered as having been caused by the presence of Himalaya and Tibetan Plateau (HTP). The large size and high altitude of HTP resulted in higher temperature at ca. 5000 m altitude compared to the surrounding area during summer that resulted in ascending air and development of low pressure cell over the plateau. Topographic effect could be also important to enhance summer monsoon. Large size of Asian continent enhanced cooling over continent during winter, resulted in development of high pressure cell known as Siberian High. HTP plays a role of topographic barrier that keeps Siberian High stronger and stable. Consequently, presence of HTP could have been playing a crucial role to strengthen Asian Monsoon. If correct, uplift of HTP could have resulted in intensification of Asian Monsoon.

Climatic simulations can be used to test the hypothesis that uplift of HTP has intensified Asian Monsoon if uplift history of HTP is known well. However, timings, modes, and magnitudes of HTP uplift have been poorly understood until recently. Situation is rapidly improved recently due to accumulation of thermo-chronological data from the various parts of HTP. Namely, collision of Indian Subcontinent against Eurasian Continent approximately at 40 Ma caused the 1st phase of Tibetan uplift that raised southern Tibet close to the present height by 35 Ma. From 25 Ma to 15 Ma, Main Central Thrust (MCT) and South Detachment System (STDS) in frontal Himalaya were activated and lower crust was extruded and eroded extensively. Approximately at 15 Ma, these fault system ceased their movements and east-west extension started in Tibet. From 15 Ma to 10Ma is the 2nd phase when Tibetan Plateau grew southeastward and possibly also northward. The 3rd phase of uplift started from approximately 5 Ma when northwestern Tibet, TienShan and Altai Mountains uplifted. Using this uplifting history of HTP as a boundary condition, it is possible to estimate what kind of paleoclimatic changes are expected in response to these 3 uplift phases based on climate simulation results.

In this presentation, I will review a recent progress in researches on tectonics-climate linkage as HTP uplift and Asian Monsoon evolution as an example.

Keywords: Monsoon, Himalaya-Tibet, Tectonics-Climate Linkage, East Asia, Japan Sea, Westerly Jet

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MIS01-02 Room:314 Time:April 29 14:30-14:50

Pre-Miocene Birth of the Yangtze River

ZHENG, Hongbo[1*] ; CLIFT, Peter[1] ; WANG, Ping[1] ; TADA, Ryuji[1] ; JIA, Juntao[1] ; HE, Mengying[1] ; JOURDAN, Fred[1]

[1]Nanjing Normal University

The development of fluvial systems in East Asia is closely linked to the evolving topography following India-Eurasia collision. Despite this, the age of the Yangtze River system has been strongly debated, with estimates ranging from 40?45 Ma, to a more recent initiation around 2 Ma. Here, we present new $^{40}Ar/^{39}Ar$ ages from basalts interbedded with fluvial sediments from the lower reaches of the Yangtze together with detrital zircon U/Pb ages from sand grains within these sediments. We show that a river containing sediments indistinguishable from the modern river was established before ˜23 Ma. We argue that the connection through the Three Gorges must post-date 36.5 Ma because of evaporite and lacustrine sedimentation in the Jianghan Basin before that time. We propose that the present Yangtze River system formed in response to regional extension throughout eastern China, synchronous with the start of strike-slip tectonism and surface uplift in eastern Tibet and fed by strengthened rains caused by the newly intensified summer monsoon. Birth of the eastward flowing Yangtze River around the Oligocene/Miocene boundary changed largely the 'source to sink' regime in the East Asia-West Pacific region

Keywords: Yangtze River, birth, Tibetan Plateau, drainage capture, Asian monsoon

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MIS01-03 Room:314 Time:April 29 14:50-15:10

The missing volcanic record captured by dispersed ash in sediment of the Japan Sea/East Sea and NW Pacific Ocean

MURRAY, Richard[1*] ; SCUDDER, Rachel P.[1] ; DUNLEA, Ann G.[1] ; IKEHARA, Ken[2] ; IRINO, Tomohisa[3] ; TADA, Ryuji[4] ; ALVAREZ-ZARIKIAN, Carlos A.[5] ; KUTTEROLF, Steffen[6] ; SCHINDLBECK, Julie[6] ; SCIENTIFIC PARTY, Expedition 346[5]

[1]Boston University, [2]Geological Survey of Japan, [3]Hokkaido University, [4]University of Tokyo, [5]IODP-TAMU, [6]GEOMAR, Kiel

Volcanic ash in marine sediment provides a wealth of information not only about volcanism and arc evolution, but also potentially regarding climate change, geochemical mass balances, hydration of marine sediment during alteration, the geodynamics of subduction zones, and other key components of the earth-ocean-atmosphere system. Ash occurs both as discrete *layers* as well as isolated grains and shards *dispersed* throughout the bulk sediment, and with highly variable grain sizes.

The study of this dispersed component has lagged behind the sedimentologic and chemical assessment of the ash layer record. For example, while decades of smear-slide studies of bulk sediment in volcanic-rich regimes have presented visual estimations of the abundance of volcanic glass, shards, and other components, the quantitative importance of the dispersed ash or cryptotephra remains largely unconstrained on local, regional, and global scales. Also, compared to the often visually stunning ash layer records, which in certain settings can leave single layers with thicknesses of 10s of cm, the dispersed ash component and cryptotephra are unable to be visually differentiated from detrital clay.

We summarize here preliminary results regarding the distribution, composition, and accumulation of dispersed ash in sediment from the Japan Sea/East Sea (gathered during IODP Expedition 346, Asian Monsoon, and ODP Legs 127/128), and compare it to the record provided by discrete ash layers. We will interpret our work in the context of our ongoing studies of dispersed ash throughout the northwest Pacific, Nankai, and Izu-Bonin regions, which is based on sediment from DSDP/ODP/IODP Sites 52, 444, 579/581, and 1149, as well as from Sites C0011 and C0012.

Multivariate statistical treatments are an integral part of our approach, as the bulk determination of the major, trace, and REEs provides the chemical context for our determination of provenance, and the statistical models allow distinctive resolution of the different aluminosilicate components based on their individual geochemical signature(s). A corollary benefit of our approach is an improved determination of the eolian component, as we are able to discern how contributions of dispersed ash have been inadvertently attributed to the eolian aluminosilicate inventory. Q-mode Factor Analysis can help determine the number, and composition of, potential end member contributions. Applying these results in conjunction with Total Inversion, a linear regression technique, allows determination of the compositional variation of these end members.

Consistent with the qualitative smear-slide estimates, in these ash rich regions we find that the dispersed component can account for up to 40% of the total sediment. We are able to document abundances to a relatively high degree of precision (+/- 3-5%) on a sample-by-sample basis, and are further able to distinguish between different chemistries of the dispersed component, and document sources that change through time and space. In addition to providing an overview of " the missing volcanic record ", we will discuss some ongoing challenges, including how to best examine the relationship between the composition of the discrete ash layers compared to the discrete component, and what information can be gained from examining similarities and differences between their respective sources.

Keywords: volcanic ash, sediment chemistry, Japan Sea, East Sea, volcanism

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MIS01-04 Room:314 Time:April 29 15:10-15:25

Tephrochronology and evolution of volcanic activities in Japanese islands during late Cenozoic

IKEHARA, Ken[1*]

[1]Geological Survey of Japan, AIST

The Japanese islands are located along an active plate margin, and are home to many active volcanoes along an island arc. Large, explosive volcanic eruptions have yielded numerous volcanic ash layers (tephras) over geological time. Because tephras are deposited in both onland and seafloor areas, they represent a unique and important link between the geological records of the two settings. There are several source volcanoes to provide tephras to the Japan Sea floor. These are, for example, Kikai, Aira and Aso volcanoes in Kyushu, Sanbe and Daisen volcanoes in Chugoku, Asama volcano in north Kanto, Towada volcano in Tohoku, Toya volcano in Hokkaido, Ulleung volcano on Ulleung Island in the western Japan Sea, and Baegdusan volcano on Korean Peninsula. Most of the previous marine tephra studies in the Japan Sea have been concentrated for the late Quaternary in age. Because of shallow CCD and shallow gateways of the Japan Sea, oxygen isotope stratigraphy is not a perfect tool for age determination, especially in the deep-sea basins. Under the condition, wide-spread tephra works as a key bed connecting among marine cores, and give us a good time-marker. Quaternary Japan Sea sediments are characterized by alternating light- and dark-colored layers. The late Quaternary dark layers were deposited basin-wide in relation to enhanced summer monsoon during the interstadials of the Dansgaard-Oeschger cycles. Recent study on marine tephras among several marine cores in the central Japan Sea suggested the synchronicity of the dark layer deposition. This is clear evidence on significance of marine tephra study for inter-core correlation. Furthermore, tephra may connect the events in marine environments and those in terrestrial and lacustrine environments. Thus, tephras in the Japan Sea sediments are important for the paleoceanographic and paleoclimatic study in and around the Japan Sea. Information on longer time-scale occurrence of tephra layers and their source volcanoes will give us spatio-temporal variation of volcanic activities and their relations to the regional tectonic movements around the Japan Sea, because the continuous and muddy Japan Sea has been a good recorder of tephra layers after its opening.

Keywords: tephra, Japan Sea, stratigraphy

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MIS01-05 Room:314 Time:April 29 15:25-15:40

Identification of Asian dust in hemipelagic sediments of East Asian marginal seas

IRINO, Tomohisa[1*]

[1]Hokkaido University

Detrital fraction contained in marine sediments can be generally used as climate proxies because variations in provenance and mineralogy could be affected by the precipitation distribution and weathering intensity. Element composition of marine sediment is essentially controlled by the mineral composition that is also affected by sorting effect during their transport process. The inland deserts such as Taklimakan and Gobi are large detrital sources for the East Asian marginal seas, and the detrital fraction in the sediments collected from the abyssal part of the Japan Sea / East Sea has been regarded as the mixture of eolian dust and the detritus derived from the Japan Arc. This feature can be used to reconstruct the variability of provenance and transport pathway of detrital fraction in the sediments. Relative contribution of dust from Taklimakan / Gobi could be strongly affected by dust availability in source area and wind system transporting the dust. Major changes in such detrital provenance are more easily reconstructed from the proximal soil record at loess plateau, where many provenance studies have been conducted. Loess can be classified into two types based on their element composition. One is typical loess distributed close to desert area. The other is peripheral soil (weathered loess) distributed surrounding typical loess and desert area. Weathered loess is distributed in the northeastern and southern China in modern times. Spatial distribution of these two types of soils have been also changed from time to time. In order to detect the change in provenances and interpret the terrestrial environment using detrital proxies in the marginal sea sediments, it is necessary to know the variability or range of the element and mineral composition of a particular provenance during the targeted time periods as well as the sorting biases during the transportation.

Keywords: hemipelagic sediment, aeolian dust, provenance, mineral composition, element composition, isotope composition

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MIS01-06 Room:314 Time:April 29 15:40-16:00

Carbon and Sulfur Cycling in Shallowly Buried Sediment of the Japan Sea/East Sea

DICKENS, Gerald[1*] ; KINSLEY, Christopher W.[2] ; DUNLEA, Ann G.[3] ; ANDERSON, William A.[4] ; DA COSTA GURGEL, Marcio H.[5] ; LEE, Kyung eun[6] ; MURRAY, Richard W.[3] ; TADA, Ryuji[7] ; ALVAREZ ZAREKIAN, Carlos[8] ; EXPEDITION 346, Scientific party[8]

[1]Rice University, [2]Massachusetts Institue of Technology, [3]Boston University, [4]Florida International University, [5]Universidade de Sao Paulo, [6]Korea Maritime University, [7]University of Tokyo, [8]Texas A&M University

Continental slopes cover about 10% of Earths surface and represent the primary repository for sediment and organic carbon accumulation on long-time scales. For decades, the geochemical community has introduced and discussed various models for how ocean carbon and sulfur chemistry changes over time. Remarkably, in most of these models, the seafloor on continental slopes is either absent or passive. In the latter case, the prevailing view is as follows. During burial, organic carbon passes through a gauntlet of microbially mediated reaction in shallow sediment, especially including organoclastic sulfate reduction and methanogenesis. Although these reactions generate dissolved species (HCO3-, HS-, CH4), burial fluxes exceed those of upward advection or diffusion. The end process, therefore, is accumulation of remnant solid organic carbon, authigenic carbonate, and authigenic Fe-sulfides. As suggested in several recent papers, this view may be incorrect. Instead, on the slope, a good fraction of solid organic carbon bypasses organoclastic sulfate reduction to produce dissolved inorganic carbon, dissolved organic carbon, and methane at depth. Large portions of these species return toward the seafloor because upward dissolved fluxes exceed burial. However, upward migrating methane reacts with dissolved SO42- to produce HCO3- and HS- via AOM in shallow sediment. The end process is still accumulation of remnant solid organic carbon, authigenic carbonate, and authigenic Fe-sulfides, but the fluxes are linked through the formation, storage and consumption of methane.

It is entirely possible that variations in methane cycling within slope sediments drive significant long-term and short-term changes in ocean carbon and sulfur concentrations. To entertain this idea, however, the broad Earth Science community needs quantified fluxes of solid and dissolved components from appropriate settings. One current problem is that very few locations on continental slopes that have detailed pore water profiles extending 200 m below the seafloor with companion sedimentary records.

IODP Expedition 346 drilled multiple holes at seven sites across the Japan Sea/East Sea. The primary objective behind this cruise was late Neogene and Quaternary paleoceanography: more specifically, to reconstruct changes in surface and deep ocean water properties, riverine outflow, and dust input over the last 5-10 million years, which might be linked to the evolution and temporal differences in the Asian monsoon system. One interesting outcome of this goal was that the sites span a wide range of slope environments with considerable variation in organic carbon accumulation. Another was exquisite sediment recovery, with spliced cores between holes giving complete records from the seafloor to several hundred meters.

Expedition 346 provided a golden opportunity to chase the dynamic geochemical cycling of carbon and sulfur on continental margins. Using a combination of rhizon sampling and whole round squeezing, about 680 pore water samples were collected at the seven sites and analyzed for a broad array of dissolved species. The shipboard pore water geochemistry profiles generated on Expedition 346 are truly remarkable in terms of species examined, their detail across zones of chemical reaction, and the ability to directly couple them to the sedimentary record. Here, on behalf of the Expedition 346 scientists, we discuss the generation of the pore water profiles and their significance to carbon and sulfur cycling on continental slopes. For example, at Site U1427, there is no question as to the dominant process and where species are being produced and consumed in shallow sediment. Upward migrating CH4 is reacting with SO42- via AOM to produce HCO3- and HS-, the first product leaking to the seafloor, the latter product being consumed into sulfide minerals.

Keywords: Methane, AOM, carbon cycle, sulfur cycle

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N.incompta Mg/Ca-paleothermometry in the Japan Sea and its application to Holocene climate reconstruction

HORIKAWA, Keiji[1*] ; KODAIRA, Tomohiro[1] ; IKEHARA, Ken[2] ; MURAYAMA, Masafumi[3] ; ZHANG, Jing[1]

[1]University of Toyama, [2]AIST, [3]The Center for Advance Marine Core Research, Kochi University

We present new core-top calibration for *Neogloboquadorina incompta* Mg/Ca-paleothermometry in the Japan Sea using 15 core-top surface sediments taken from the southern Japan Sea. Using this new Mg/Ca-paleothermometry, we generate the first high-resolution Mg/Ca-derived SST record for the past 7000 years from the sediment core (YK10-7-PC09) taken from 738 m water depth off Niigata. The age model for core YK10-7-PC09 was based on 8 AMS ^{14}C data of mixed planktic foraminifera, and the conventional ^{14}C ages were converted to the calendar ages using Marin13 and delta R of 0±100 yr. Trace metal/Ca ratio of *N.incompta* was measured by a SF-ICP-MS (Thermo Fisher Element II) and the precision (1sigma) of Mg/Ca ratios of the international $CaCO_3$ standard (BAM-RS3) was 0.786±0.008 (n=100).

We have performed paired analyses of δ^{18}Oc and Mg/Ca ratios of *N. incompta* at 15 sites. First, to calculate the mean temperatures of waters in which the foraminiferal shells were formed (i.e., calcification temperature), we have used modern local salinity and temperature data (http://www.jodc.go.jp/) in the following paleotemperature equation; T (℃) = 21.4-4.19×(δ^{18}Oc-δ^{18}Osw) + 0.05×(δ^{18}Oc-δ^{18}Osw)^2 (Oba, 1980). The δ^{18}Osw was calculated from the following salinity-δ^{18}Osw equation in the Japan Sea (δ^{18}Osw (‰ VSMOW) = 0.27×Salinity-8.98; this study). The comparison of the predicted δ^{18}Oc values with the measured δ^{18}Oc shows that *N. incompta* shells were formed at 0-125 m water depths from June to December in the Japan Sea. Given that previous studies show that *N.incompta* dwells in the shallow waters (<100 m) in November to December (Kuroyanagi and Kawahata., 2004; Sagawa et al., 2013), we calculated the calcification temperatures at each site assuming shells were formed in November to December. The cross plot of the calcification temperatures and the Mg/Ca ratios for our core-top samples gives the following equation; Mg/Ca (mmol/mol) = 0.361×exp (0.043×Temp).

Using this new Mg/Ca-paleothermometry, the 7000-years *N.incompta* Mg/Ca records (0.6 to 0.9 mmol/mol, n=127) from core YK10-7-PC09 were converted to the temperature record. Compared to the present winter SST of ca.15 ℃, the 7000-year SSTs varied from 13.5 ℃ to 20.8 ℃. We identified four periods (ca.6000 yr BP, 4000-3500 yr BP, 3000-2300 yr BP, and 800 yr BP) that were warmer than the present and distinct colder periods at ca.4500 yr BP and ca.1500 yr BP than the present. This SST variability for the past 7000 years was almost consistent with the record of relative abundance of F.doliolus, which is the dominant species in the Tsushima Current (Koizumi et al., 2006). This finding indicates that the Tsushima Current influx might have changed with time and altered the heat transport into the Japan Sea, and probably induced significant changes in terrestrial precipitation and vegetation over the northern part of Japan facing the Japan Sea.

Keywords: Japan Sea, Holocene climate change, Mg/Ca-paleothermometry, Tsushima Current, Neogloboquadorina incompta

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MIS01-08 Room:314 Time:April 29 16:30-16:45

Shallow water environmental change in the Sea of Japan during the last 30 kyr deduced from foraminiferal isotopes

SAGAWA, Takuya[1*] ; UCHIDA, Masao[2] ; MURAYAMA, Masafumi[3] ; TADA, Ryuji[4]

[1]Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University, [2]National Institute for Environmental Studies, [3]Center for Advanced Marine Core Research,, Kochi University, [4]Department of Earth and Planetary Science, Graduate School of Science, The Univeristy of Tokyo

The Sea of Japan is a marginal sea that connects with North Pacific and adjacent marginal seas by four shallow straits. Because water depth of the deepest straits today is ˜130 m (Tsushima Strait and Tsugaru Strait), environments of Sea of Japan have been strongly affected by sea level fluctuations related to the glacial-interglacial cycles. Previous studies report that foraminiferal oxygen isotope variation from Sea of Japan is distinct from that commonly seen in seas of the world. Since Sea of Japan is nearly isolated from adjacent seas during the glacial maxima, salinity of surface water significantly decreases, and therefore foraminiferal isotopes show the lowest values due to the unique fresh water balance. The peak value of oxygen isotope is ˜0.5 per mil at the last glacial maximum, which is ˜2.5 per mil lighter than at 30 ka. We review literature data and present new results of two sediment cores from northeastern and southern part of Sea of Japan. The new data from southern core has ˜70-yr resolution and shows abrupt shift that may correspond to abrupt climate change reported from the Greenland ice core and Asian monsoon proxy data of Chinese Cave and Loess. The new results suggest that the surface environment of Sea of Japan is sensitive to eustatic sea level change as well as abrupt climate changes.

Keywords: Sea of Japan, oxygen isotope, planktonic foraminifer

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Micropaleontological evidence of oceanic circulation changes in the Japan Sea during Pliocene to Pleistocene transition

ITAKI, Takuya[1*]

[1]Geological Survey of Japan, AIST

Oceanic circulation in the Japan Sea is characterized by flowing of the Tsushima Warm Current and deep-water formation during the interglacial periods, while deep circulation was stagnant due to weakened deep convection with development of the low salinity surface water during the glacial periods. Such cycles of oxic and anoxic deep-water conditions recorded in sediments as alternations of light and dark hemi-pelagic mud layers occurred since ca. 2.5 Ma near Pliocene to Pleistocene transition. The results of micropaleontological studies from previous ocean drilling sites and many onshore sequences have provided various insights into oceanic changes related to global climatic and regional tectonic events during Pliocene to Pleistocene.

Fossil records of shallow dwelling plankton and shelf related benthos are composed of the assemblage associated with upper water environments. Warm-water ostracods and molluscs are rarely recognized from onshore sequences in Japan along the Japan Sea side during the Pliocene climatic optimum (3.2 to 2.7 Ma), and they were most likely associated with subtropical water mass entered from the southern strait. However, planktonic foraminiferal and radiolarian assemblages in hemipelagic sediments suggest that the warm-temperate water was originated from the northern strait during this period. Such conflict interpretation could be explained by a characteristic surface circulation, which was composed of two different water sources from the northern and southern straits. The warm water mass from the southern strait was restricted flowing along the Japanese coastal area, while another water mass from the northern strait was present offshore areas of the sea. Abundance of cold-water calcareous nannofossil species increased significantly at 2.75 Ma corresponding to the global cooling. In this period, ostracode assemblage also indicates cooling in the intermediate water. According to planktonic foraminifers and radiolarians, significant inflow of the subtropical water from the southern strait started at 1.7 Ma, which might be related to the deepened Tsushima Strait and the Okinawa Trough (ca. 2 Ma).

Deep-water environments in the Japan Sea are little known compared with that of shallow environments. Benthic foraminifers in deep-sea sediments changed their faunal composition from agglutinated fauna to calcareous fauna through 3 to 2 Ma. Similarly, deep-water radiolarians show faunal replacement from the Pacific-type deep dwellers to the Japan Sea-type deep dwellers at ca. 2.6 Ma. Such faunal changes recognized from benthic foraminifers and radiolarians imply that the unique deep-water circulation in the Japan Sea was formed with geographical isolation from the Pacific deep water. In actual, this timing is almost coincident with beginning of oxic and anoxic cycles in the Japan Sea. It is likely resulted from either the global cooling or local tectonic motion during the Pliocene to Pleistocene transition.

Keywords: Microfossils, Paleoceanography, Grobal cooling event, Tectonic event, Tsushima Warm Current, Deep water

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Evolution of the Kuroshio Current and its impact on East Asian marginal seas

LEE, Kyung eun[1*]

[1]Korea Maritime and Ocean University

Quaternary is characterized by the onset of the Quaternary ice ages as well as the progressive cooling of the high latitude. Many proxy records from high latitude evidence this. On the other hand, records from low latitudes indicate that the sea surface temperature of the tropical warm pool regions remained relatively stable during the last 4 Ma. Hence these suggest a dramatic increase in the zonal (west?east) and meridional (north?south) gradients in sea surface temperature, which was accompanied by a progressive cooling of the water upwelled along the eastern margins of the Pacific. It is most likely believed that the evolution of the west-east and north-south temperature gradients in the North Pacific is closely related to the evolution of the western boundary current and North Pacific subtropical gyre during the Plio-Pleistocene. It, in turn, caused changes in weather and climate patterns of East Asian margins. In this presentation, previously published data and hypothesis will be reviewed to clarify future researches related to these.

Keywords: Kuroshio, North Pacific Subtropical Gyre, sea surface temperature

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Variations in intermediate water and ocean circulation during the last 26 ka based on a new benthic Mg/Ca calibration

KUBOTA, Yoshimi[1*] ; KIMOTO, Katsunori[2] ; ITAKI, Takuya[3] ; YOKOYAMA, Yusuke[4] ; MATSUZAKI, Hiroyuki[5]

[1]National Museum of Nature and Science, [2]Japan Agency for Marine-Earth Science and Technology, [3]Geological Survey of Japan, AIST, [4]Atmosphere and Ocean Research Institute, University of Tokyo, [5]School of engineering, University of Tokyo

In order to understand variations in ocean circulation at intermediate depth in the North Pacific in subtropical area, bottom water temperatures (BWT), carbon isotope of benthic foraminifera, and oxygen isotope of seawater were reconstructed since 26 ka off east main Okinawa Island, northwestern Pacific. A new regional Mg/Ca calibration for benthic foraminifera *Cibicidiodes wuellerstorfi* was established in order to convert benthic Mg/Ca value to temperature, based on twenty-nine surface sediment samples, including core top samples, retrieved around main Okinawa Island. On the other hand, in order to reconstruct changes in water properties since 26 ka,core GH08-2004 that was retrieved from water depth of 1166 m off east main Okinawa Island was used in this study. As a result, during the LGM from 24 ka to 18 ka, BWT showed relatively constant as approximately 2 ℃, which was ~1.5-2 ℃ lower than today. One of the prominent features of our BWT records was a millennial scale variation in BWT during the last deglaciation. During the last deglaciation, BWT was higher in Heinrich Stadial 1 (H1) (~17 ka) and Younger Dryas (YD) (~12 ka), while lower in Bølling/Allerød (BA) interval (~14 ka). During the interval from 17 to 15 ka, BWT tended to decrease in association with a decrease in carbon isotope of *C. wuellerstorfi,* likely interpreted as increased upwelling of the older water mass that was stored in the abyssal Pacific during the glacial time. The timing of the signal of the upwelling coincided with deglacial atmospheric CO_2 rise initiated at ~17 ka, suggesting the increased upwelling in the subtropical northwestern Pacific from 17 to 15 ka contributes the carbon release to the atmosphere from the Pacific.

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Long-term evolution of the North Pacific subtropical gyre: Implication from the late Quaternary record

UJIIE, Yurika[1*]

[1]Faculty of Science, Shinshu University

The North Pacific subtropical gyre drives a transportation of huge amount of heat from low to high latitude area to maintain warm climate in the northwestern Pacific area. This gyre system largely controls the zonal temperature gradient and west-east asymmetric climate, currently observed in the Pacific Ocean. The stepwise enhancement of these temperature gradients has partly been observed in the equatorial and east Pacific area since the late Pliocene. However, a lack of long-term observation in the west Pacific Ocean impedes a better understanding of the development of the Pacific climate.

The Kuroshio Current, flowing from the Okinawa Trough to eastward off the Japan, act as a heat-transfer along the North Pacific subtropical gyre margin. The variation in this surface current would reflect to the changes of the West Pacific climate. Especially, the Okinawa region is an ideal place for paleocenographic reconstruction, as (1) the Kuroshio Current shows an oscillation with surrounding water masses and (2) the sediments are buried in high rate. Through the short-term paleoceanographic records in the Okinawa region, the planktonic foraminiferal assemblage showed the decrease of the Kuroshio indicator and increase of the coastal- and cold-water masses indicators under the modern Kuroshio path (the East Chia Sea) during MIS 2. Interestingly, the long-term record, which was the first to cover the past 200 kyrs in this region, represented different oceanic condition during MIS 6. The indicator of the upper intermediate water in the subtropical gyre increased over whole of the Okinawa region at this time. Moreover, the Mg/Ca paleo-temperatures in the surface and upper intermediate layers showed that warming in the upper intermediate layer was continuing from MIS 6 to MIS 5e, while warming in this layer was rapidly stopped at MIS 2. Both records of the paleo-temperature and planktonic foraminiferal assemblage congruently suggest the development of the intermediate water in the North Pacific subtropical gyre during MIS 6, instead of the dominance of cold water mass observed during MIS 2. The intermediate water has likely been undergone an independent process from the changes of the surface water masses at least by MIS 5. Even the 200 kyrs record successfully inferred two different glacial mechanisms of MIS 2 and 6, associating with the changes of surface water masses and deeper waters. Future study with longer record will lead a comprehensive understanding how the modern water column structure has been developed in the Pacific Ocean.

Keywords: North Pacific subtropical gyre, Kuroshio, water column structure, Pleistocene

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MIS01-P01 Room:Poster Time:April 29 18:15-19:30

Changes of water structures in the Sea of Japan during the Late Pliocene

YAMADA, Katsura[1*] ; IRIZUKI, Toshiaki[2]

[1]Shinshu University, [2]Shimane University

An analysis of fossil ostracode assemblages in the Kuwae Formation, central Japan, clarify the paleoenvironmental changes related to glacial and interglacial cycles during MIS G19 and G10 (Irizuki et al., 2007). Added to this, temperate intermediate waters which were warmer than those of today, were existed in interglacial periods during 3.5 to 2.8 Ma. Radiolarian faunas inferred that enhancement of ventilation due to global cooling started at approximately 2.5 Ma (Kamikuri and Motoyama, 2007). However, temperatures of the temperate intermediate waters and the timing are uncertain. So, our aims are to clarify quantitative temperatures of shallow and intermediate waters during the late Pliocene based on Mg/Ca, and to discuss change of water structures in the Sea of Japan.

Siltstones collected from the Kuwae Formation along the Tainai River were soaked in H_2O_2 for 24 hours before they were washed. Ostracode shells of genus *Krithe* (intermediate water species) and *Cytheropteron miurense* and *Cytheropteron sawanense* (shallow water species) were taken from the residues, and their Mg/Ca were measured by ICP-AES at Kochi University. Two intervals were identified in the study section based on quantitative temperature of intermediate and shallow waters and their vertical changes. Intermediate water temperatures ranged between 0 and 10 ℃ and fluctuated in short-time intervals during MIS G19-G16, although they were stable and showed a small amplitude between 3 and 7 ℃ during MIS G15-G13. Moreover, difference in temperature between shallow and intermediate waters was large in MIS G19 and G16, but was small in MIS G15-G13. These temperature difference and shifts suggest that strong stratification of shallow and intermediate waters during MIS G19-G16 changed to a condition in which temperature gradients were small due to enhance of ventilation in the Sea of Japan. MIS G15 and G13 were characterized by a large oxygen isotope values compared with those in other inter-glacial periods of the study intervals. The relative cooling in inter-glacial periods might be caused a beginning of ventilation in the Sea of Japan.

Keywords: Sea of Japan, Late Pliocene, ostracode, Mg/Ca, water structure

Japan Geoscience Union Meeting 2014
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MIS01-P02 Room:Poster Time:April 29 18:15-19:30

Sedimentary Rhythms in the Middle Miocene Onnagawa Formation in Northern Japan

KUROKAWA, Shunsuke[1*] ; TADA, Ryuji[1] ; TAKAHASHI, Satoshi[1] ; MIZUTANI, Akane[1] ; KUBOKI, Yui[1]

[1]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

The Middle to Late Miocene bedded siliceous rocks, are widely distributed in the Pacific rim. Typical examples are the Monterey Formation, distributed along the coast of California, and the Onnagawa Formation in northern Japan. The Onnagawa Formation is mainly composed by alterations of porcellanite and siliceous mudstone, called ” hard-soft alternation ” , and finer alternations of light and dark porcellanites, in which parallel lamination is relatively well preserved. These alternations show centimeter- to meter-scale rhythms, where meter-scale rhythm is interpreted as reflecting variations in the water mass structure within the Japan Sea induced by sea-level oscillations paced by Milankovitch cycles (Tada, 1991). On the other hand, centimeter-scale rhythm reflects millennial-scale changes whose origin and cyclicity are still poorly understood.

In this study, we aim to reveal origin and cyclicity of light-dark alternation in the Onnagawa Formation, their relationship with variation of water mass structure in the Japan Sea, and implication to global climatic change.

We will create the perfectly continuous column of the Onnagawa Formation and construct detailed age model based on micro-fossil biostratigraphy and cyclo-stratigraphy. Then we will calculate the silica and detritus fluxes, respectively, from chemical composition of the siliceous rocks. We will discuss temporal variation of the water mass structure in the Japan Sea and its relation with global climatic changes.

In this presentation, we will introduce the results of our field study in Yashima area in northern Japan.

Keywords: Miocene, Onnagawa formation, Sedimentary rhythm

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Reconstruction of detrital flux to Lake Suigetsu during the past 20kyrs based on Color and XRF data

SUZUKI, Yoshiaki[1*] ; TADA, Ryuji[1] ; NAKAGAWA, Takeshi[2] ; NAGASHIMA, Kana[3] ; HARAGUCHI, Tsuyoshi[4] ; GOTANDA, Katsuya[5] ; IRINO, Tomohisa[6] ; SUGISAKI, Saiko[1] ; SG12/06, Project members[7]

[1]Univ. Tokyo, [2]Univ. Newcastle, [3]JAMSTEC, [4]Osaka City University, [5]Chiba University of Commerce, [6]Hokkaido University, [7]SG12/06 Project

Lake Suigetsu is known for its highly precise age-depth model based on numerous ^{14}C dating combined with varve counting and wiggle matching with Chinese stalagmite record. For this reason, the sediments are capable of providing extremely precise and high resolution records of past climatic changes. Several paleo-climate reconstruction studies have been conducted based on pollen and diatom analyses of the Lake Suigetsu sediments. However, studies focusing on its detrital material were rare because its detrital component is expected to be a mixture of eolian dust, detrital material derived from surrounding slope of the lake, and suspended material derived from Hasu River that flew into Lake Mikata and came into Lake Suigetsu through a narrow and shallow channel, and it is difficult to separately evaluate materials from these different sources. However, our recent study revealed that it is possible to evaluate the contribution of the detrital material derived from Hasu River through Lake Mikata (See our presentation #01575 in Paleoclimatology and paleoceanography session).

In this study, we tried to reconstruct temporal changes in the flux of detrital material derived from Hasu River during the past 20kyrs based on Color data and XRF data of the major element composition of the sediments analyzed by XRF. We estimated the end-members to explain variations in major element chemical composition using Q-mode factor analysis and oblique rotation of reference vectors. We extracted 4 end members and found that characteristics of factor 2 resemble those of Hasu River suspension. Because number of major element composition data are limited, we estimate contribution of factor 2 to the sediment based on color data. We estimated contents of factor 2 using Multi-regression analysis between color data and factor 2 loading (composition). Factor 2 flux was calculated from factor 2 contents, dry bulk density, and linear sedimentation rates, and the result shows long-term and short-term trends. The short-term trend is characterized by sudden increases and subsequent gradual decreases of factor 2 flux where the sudden increases coincides with sedimentation of ”event layers” that could represent earthquake. The long-term trend, which seems to reflect intensity of river discharge from Hasu-River , seems to reflects rainfall intensity, shows mirroring image against stalagmite record in China suggesting that precipitation decreased in Suigetsu area when precipitation increased in South China.

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

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The East Asian winter monsoon variability during the past 150,000 years

YAMAMOTO, Masanobu[1*] ; SAI, Hirotaka[1] ; CHEN, Min-te[2] ; ZHAO, Meixun[3]

[1]Faculty of Environmental Earth Science, Hokkaido University, [2]National Taiwan Ocean University, [3]Ocean University of China

The response of the East Asian winter monsoon variability to orbital forcing is still unclear, and hypotheses are controversial. We present a 150,000 yr record of sea surface temperature difference (delta SST) between the South China Sea and other Western Pacific Warm Pool regions as a proxy for the intensity of the Asian winter monsoon, because the winter cooling of the South China Sea is caused by the cooling of surface water at the northern margin and the southward advection of cooled water due to winter monsoon winds. The delta SST showed dominant precession cycles during the past 150,000 yr. The delta SST varies at precessional band and supports the hypothesis that monsoon is regulated by insolation changes at low-latitudes (Kutzbach, 1981), but contradicts previous suggestions based on marine and loess records that eccentricity controls variability on glacial-interglacial timescales. Maximum winter monsoon intensity corresponds to the May perihelion at precessional band, which is not fully consistent with the Kutzbach model of maximum winter monsoon at the June perihelion. Variation in the East Asian winter monsoon was anti-phased with the Indian summer monsoon, suggesting a linkage of dynamics between these two monsoon systems on orbital timescale.

Keywords: The East Asian winter monsoon, The South China Sea, The Western Pacific Warm Pool, Precession, Sea surface temperature