Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-01 Room:104 Time:May 24 11:00-11:15

The role of tectonics and climate linkage in the Earth System history - An example of the mountain uplift and strengthen

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The linkage between tectonics and climate could be an important process to control earth's surface environment on million years or longer time-scale. Collision of continents and consequent uplift of mountains is an important part of Wilson Cycle during the assembly of super continent and should enhance physical weathering. Enhancement of physical weathering, in turn, increases specific surface area of rocks and minerals in the earth's surface environment and enhance chemical weathering. Enhancement of chemical weathering consumes CO2 in the atmosphere and also resulted in the increase in nutrients supply to the ocean, the latter further enhance the uptake of CO2 by the increase in biological productivity in the ocean. Furthermore, formation of supercontinent and/or large plateau will cause strong monsoonal climate that further accelerate chemical weathering through enhanced precipitation. A series of these processes, triggered by continental collision and uplift of mountains, should act as a strong positive feedback to promote global cooling. However, validity of this idea has not been vigorously tested by geological evidence due to the technical difficulty.

Uplift of Himalaya and Tibetan Plateau (HTP) has been believed to have caused enhancement of monsoonal circulation in Asia and pCO2 decrease during Cenozoic. Because it is the most recent example of the continental collision and regarded as a textbook example of tectonics-climate linkage, it is worth to evaluate the possibility of the positive feedback explained above. Exploring when and how Asian monsoon evolved and whether such evolutional process was closely related with the uplift of HTP is the first step to test the existence of the positive feedback loop to enhance global cooling. IODP is planning series of expeditions to explore this possibility and Exp. 346 to the Japan Sea and northern East China Sea is the first one to proceed this direction.

Keywords: tectonics, climate, monsoon, chemical whethering, pCO2, nutient supply

Japan Geoscience Union Meeting 2013
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MZZ42-02 Room:104 Time:May 24 11:15-11:30

Quantitative reconstruction of river discharge due to East Asian summer monsoon since the last glacial period in the nor

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In this study, $d^{18}O$ of seawater ($d^{18}O_w$), which is a indirect indicator of sea surface salinity, in the northern ECS during the last 45 ka is reconstructed using Mg/Ca ratio and $d^{18}O$ of planktic foraminiferal shells. According to modern observation, interannual variations in sea surface salinity in summer in the northern past of the ECS is mainly controllled by the discharge from the Changjiang, i.e., rainfall in the drainage area of the Changjiang River. Thus, changes in the sea surface salinity in the northern ECS are interpreted as reflecting variations in the EASM precipitation in South China. It is confirmed that the relationship between salinity in the northern ECS and Changjiang discharge by analyzing the observational salinity data from 1950 to 1994.

The reconstructed freshwater discharge from the Changjiang revealed that there is no long-term decreasing trend in the Changjiang freshwater discharge since the middle Holocene to the present, implying that there is no significant change in EASM precipitation in South China. This result reveals that temporal change in summer precipitation in south China during the Holocene does not follow the summer insolation changes in the northern hemisphere. Instead millennial-scale variations in the discharge of the Changjiang freshwater are predominant and its variability is larger than decadal variability. The result reveled that variability of the flux of the Changjiang freshwater during the Holocene on centennial to millennial timescale is larger than decadal scale, but much smaller than interannual scale.

On the other hand, based on the $d^{18}O$ balance calculation in this study it is suggested that surface water in the northern ECS become fresher (1-1.5 PUS lower than present), but estimated average freshwater flux was approximately 25% lower during MIS 3 than during the Holocene. On millennial time scale lower events of the freshwater discharge coincide with Dansgaard-Oeschgar (DO) stadials and Heinrich events in North Atlantic high latitude, while higher discharge events coincide with DO interstadials.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-03 Room:104 Time:May 24 11:30-11:45

Ice sheet mass balance and the timing of 100,000-year glacial cycles

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The waxing and waning of Northern Hemisphere ice sheets over the past one million years is characterised by an approximately 100,000-year (100-kyr) periodicity and a sawtooth pattern (gradual growth and fast termination){Clark, 2009}{Hays, 1976}. The Milankovitch theory proposes that summer insolation at high northern latitudes drive the glacial cycles{Milankovitch, 1941}, but no significant 100-kyr periodicity exists in insolation intensity{Hays, 1976}. Statistical tests have demonstrated that the glacial cycles are linked to orbital eccentricity, obliquity and precession cycles, presumably through internal feedbacks{Saltzman, 1984}{Tziperman, 2006}{Lisiecki, 2010}{Huybers, 2011}. Furthermore, conceptual models have reproduced the glacial cycles by imposing a threshold of ice volume,˜ excess 100-kyr ice˜, for glacial terminations{Raymo, 1997}{Paillard, 1998}{Parrenin, 2003}{Imbrie, 2011}{Huybers, 2011}; however, physical mechanisms have not been identified. Here, using comprehensive climate and ice sheet models, we show that the ˜100-kyr periodicity is explained by orbital forcing and internal feedback amongst climate, ice sheet and lithosphere/asthenosphere system. We found that ice sheets exhibit hysteresis responses to summer insolation{Abe-Ouchi, 1993}{Calov, 2005}{Pollard, 2005}, and that the shape and position of the hysteresis loop play a key role to determine the periodicities of glacial cycles. The hysteresis loop of the North American ice sheet is such that, after its inception, the ice sheet mass balance remains mostly positive or neutral through several climatic precession cycles whose amplitude decreases towards eccentricity minimum. The larger it grows and extends towards lower latitudes, the smaller is the required insolation to turn the mass balance to negative. Once the large ice sheet is established, therefore, significantly negative mass balance continues for several thousand years even with a moderate increase in insolation amplitude, allowing time for disintegration. The fast retreat is governed mainly by rapid ablation due to the lowered surface elevation resulting from delayed isostatic rebound. CO2 plays a supporting, but not controlling, role in the evolution of the ˜100-kyr cycle of ice sheet volume and global climate change.

Keywords: climate, climate model, paleoclimate

Japan Geoscience Union Meeting 2013
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MZZ42-04 Room:104 Time:May 24 11:45-12:00

Paleoclimatic studies using polar ice cores

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Polar ice cores have been extensively used for extracting paleoclimatic and paleoenvironmental information, such as temperature, accumulation, atmospheric aerosols, mineral dust, greenhouse gases, cosmogenic radionuclides, deep-ice biology. They cover the timescales from one year to million years, and the geographical scales from local to global. Here I review the major achievements polar ice core projects, especially those that Japanese communities have played significant roles. They include the Dome Fuji and other ice cores in Antarctica, and NGRIP and NEEM ice cores in Greenland. The future plans of international and Japanese ice core science will also be reviewed.

Keywords: Paleoclimate, Paleoenvironment, Ice core

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MZZ42-05 Room:104 Time:May 24 12:00-12:15

The Role of the North Pacific in the world ocean circulation

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The North Pacific is known as a terminal region of Ocean Conveyer and abyssal circulation from the south flows into the North Pacific, and upwells to mid-depth and returns south as the Pacific Deep Water (Schmitz, 1996). No deep water forms in the North Pacific in the present ocean because the surface water of the North Pacific is not dense enough to sink into the deep basin (Warren, 1983). Instead, the North Pacific Intermediate Water (NPIW) originated from the Okhotsk Sea lies at depths of 300 to 800 m (Talley, 1993).

The glacial Pacific Ocean had two water masses: well-ventilated and nutrient-depleted glacial North Pacific Intermediate Water (GNPIW) above ˜2000 m and less-ventilated and nutrient-enriched deep water below ˜2000 m (Keigwin, 1998; Matsumoto et al., 2002). GNPIW is a thicker and more deeply penetrating water mass than the present NPIW. The possible source of GNPIW was possibly in the Bering Sea inferred from microfossil (Ohkushi et al., 2003) and neodymium isotope evidence (Horikawa et al., 2010). A switch of meridional overturning circulation between the North Atlantic and the North Pacific during the last glacial termination was suggested by a collaborative study of sedimentary proxy data and climate modeling (Okazaki et al., 2010).

The North Pacific appears to have played an active role in global ocean circulation, not always passive during the last glacial cycles. The Role of the North Pacific in the world ocean circulation of the past will be discussed.

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Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-06 Room:104 Time:May 24 12:15-12:30

Significance of the geomorphological approach for the reconstruction of paleo ice-sheets

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In the paleoenvironment research, there are at least two data obtained only by using the geomorphological approach. The one is the history of paleo ice-sheet dimension and subglacial environmental data based on the glacial geomorphological technique, and another is the history of the relative sea-level variations used the coastal geomorphological technique. These data can provide the information about the geographical distribution of past ice sheet, mass balance mechanisms and ice-volume changes using glacial isostatic adjustment model. In this presentation, we introduce the paleo environmental significance of geomorphological approach using the case of East Antarctic ice sheet.

Keywords: ice sheet, glacial geomorphology, subglacial environment, coastal geomorphology, relative sea-level variation, glacial isostatic adjustment

Japan Geoscience Union Meeting 2013
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MZZ42-07 Room:104 Time:May 24 12:30-12:45

Recent enrichment of nutrient and heavy metal deposition in Japanese mountain lakes due to anthropogenic dust

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Recent studies revealed that nutrient inputs such as nitrogen and phosphorus through atmospheric deposition to aquatic ecosystems have been increasing (Elser et al. 2009; Neff et al. 2008). In addition to nutrients, large emissions of heavy metals such as antimony (Sb) and indium (In) to the atmosphere is expected to be extensive (Filella et al., 2002; Tian et al., 2012; White and Hemond, 2012). East Asia plays an important role in global anthropogenic emissions, but little is known about the effects of nutrient emissions on terrestrial ecosystems and changes in the extent of the metal pollution during its rapid economic growth in recent decades. In this study, we examined fossil pigments and zooplankton remains in dated sediments taken from high mountain lakes at some Japanese National Parks in Hokkaido and Honshu area, to uncover the historical changes of plankton community over the past 100 years. Simultaneously, we measured the geochemical variables such as heavy metals, nitrogen and lead stable isotope to uncover the historical changes of metal deposition, and to identify causal factors including dust source regions. Sedimentary results showed that the fluxes of heavy elements of Sb and In increased at Lake Hachiman-Numa and Hourai-Numa in recent years (Kuwae et al. 2013). Furthermore, the fluxes of phytoplankton abundance in Lake Hourai-Numa (Tsugeki et al. 2012) and Lake Mikurigaike and Niseko-Onuma drastically increased since around 1990 when N stable isotope ratios in sediments decreased, probably due to expanding atmospheric N deposition. In parallel with this, *Daphnia*, a keystone herbivore, increased. During this period, there seems not to be expanding human activities in the watershed around these lakes, suggesting that the increases in nutrients and heavy metals were not resulted from inputs from watershed. Alternatively, Pb stable isotope data in Lake Hachiman-Numa and Hourai-Numa showed that dust deposition with nutrient and metal substances originated from the Asian continent were increasingly transported to study lakes in recent years (Tsugeki et al. 2012; Kuwae et al. 2013). These results imply that long-range transports of anthropogenic dusts have promoted not only Sb and In deposition but also eutrophication in a wide range of Japanese lakes even far from direct human disturbance.

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Keywords: paleolimnology, Asian continent, anthropogenic dust and nutrient deposition, plankton, heavy metal, stable isotope

Japan Geoscience Union Meeting 2013
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MZZ42-08 Room:104 Time:May 24 14:15-14:30

High-precision temperature change at the western Japan during the past 3,000 years and its effect on the human activity

Hodaka Kawahata[1*], Megumi Matsuoka[1], Ami Togami[1], Naomi Harada[2], Yusuke Yokoyama[1], Katsunori Kimoto[2], Yuichiro Tanaka[3], Michinobu Kuwae[4]

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A continuous record of terrestrial environments is difficult to reconstruct because terrestrial sediments are often eroded and transported away by wind or water. In contrast, marine sediments often provide a continuous record of both marine and terrestrial environments in their sedimentary sequence. Therefore, the continuous reconstruction of paleo-temperature in Holocene was conducted by using coastal marine cores in Hiroshima Bay, which shows very high correlation between the alkenone sea surface temperature (SST) and atmospheric temperature (AT) and enables to estimate a bi-decadal time resolution of record of quantitative temperature in historical period in the western Japan. During the last three millennia, the SSTs (ATs) showed a maximum in 830A.D. (24.3C (25.9C)) and two minima in 780B.C. (22.2C (23.8C)) and 960 A.D. (22.4C (24.0C)) with a mean value of (23.6C (25.2C)), which was comparable to the man value in mid 20th century natural condition. The low SSTs (ATs) in 800-610B.C. and 990-1190A.D. and relatively low values in 1100-900B.C., 490-320B.C., 550-660A.D. and 1380-1740A.D. corresponded the minima of total solar irradiance (TSI). As TSI change was not sufficient to account for observed temperature amplitude, it is suggested that TSI potentially works as a trigger to drive the other internal forcing in climatic system. Largest volcanic eruptions in 535-536A.D., 1258A.D. and 1452A.D. certainly reduced temperature. Adding instrumental observation records, large shifts in social system such as Hunter-gather to Parry-rice farming and the establishments of Imperial and aristocratic political system, Feudalism and Modern nation, matched large minimal temperatures in cold climate while recovered warm climate afterwards could promote new social systems.

Keywords: Alkenone temperature, Atmospheric temperature, Solar radiation, Historical age, Yayoi People, Japanese

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-09 Room:104 Time:May 24 14:30-14:45

The Pacific Decadal Oscillation and North Pacific regime shifts during the last 2900 years

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We generated 8-year-resolution records of paleotemperatures using UK37 and the abundance of anchovy and sardine scales in Beppu Bay, Kyushu Island, Japan. Beppu Bay is a small silled basin filled with oxygen-deficient bottom water. Because of oxygen deficient environment, organic matter and fish scales are well preserved in sediments, and bioturbation is limited. Fourteen piston and gravity cores were retrieved at the center of the basin. Correlation of cores was conducted using sand and silt seams (event layers), and the age-depth model was created by wiggle-matching of forty-two AMS radiocarbon dates from bivalve mollusk shells and excess Pb-210 and Cs-137 concentrations. The sedimentation rates were 230-300 cm/ky. UK37 record showed both centennial-scale and multi-decadal variations. Multi-decadal variation, having a significant periodicity at 50-70 years that is typical in the Pacific Decadal Oscillation in the 20th century, is superimposed on centennial-scale variation. The amplitude of the multi-decadal oscillation varied on a multi-centennial scale. The ratio of anchovy to the sum of anchovy and sardine was synchronous with multi-decal oscillation in SST. Anchovy was more abundant in warmer periods, while sardine was more abundant in cooler periods. This relationship is the same as that was seen in the regime shifts in the 20th century. This is the first evidence showing that North Pacific regime shifts were operated prior to the 20th century.

Keywords: PDO, Regime shift, Holocene, SST, marine core, Beppu Bay

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-10 Room:104 Time:May 24 14:45-15:00

On the possibility of constraining the climate sensitivity: A view from LGM multimodel simulations

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Charney climate sensitivity (CCS) is defined as the equilibrium surface temperature change under the doubling of atmospheric CO_2 concentration specifically without vegetation, ice sheet, and carbon cycle feedbacks. CCS is one of the most important metrics in climate projections of coming centuries, and past climate has been used to constrain its uncertainty. The use of paleoclimate as a guide for the future needs to be demonstrated based not only on statistical relation between the past and future climate changes but also on sound physical understanding of mechanisms behind the changes. Much attention has been paid to the last glacial maximum of about 21 thousand years ago, and this presentation overviews previous and current effort on estimating CCS based on LGM climate. The emphasis is placed on the activity with general circulation models and the analysis of the latest PMIP3/CMIP5 multimodels. While perturbed physics ensembles of single models (sensitivity to model parametric uncertainty) suggest a relatively high correlation between LGM and $2xCO_2$ global climate feedbacks, multimodel analysis (sensitivity to model structural uncertainty) suggest little correlation between them. This implies that globally averaged LGM climate change does not likely provide a strong constraint on the CCS spread in current models. The radiative feedback analysis indicates that the reason may be cloud feedback induced by the ice sheet forcing unique to the LGM. On the other hand, it was and is proposed that regional change, particularly in the tropics, may be of more use than global mean change. In order to more effectively impose the regional constraint and to increase our confidence, however, uncertainties in proxy data and the forcing estimate need to be reduced and the number of models need to be increased.

Keywords: climate sensitivity, last glacial maximum

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-11 Room:104 Time:May 24 15:00-15:15

Recent progress in researches on biogenic magnetite and applications to paleoceanography

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Magnetotactic bacteria, which have chains of magnetite crystals, were discovered in 1975 by Blakemore, and magnetites of bacterial origin preserved in marine sediments (magnetofossil) were first reported in 1986. Since then, biogenic magnetites have been recognized as one of sources of magnetic minerals in sediments. Biogenic magnetites can be identified with TEM from their sizes confined within a single-domain range (several tens of nano-meter) and their characteristic morphologies under biological control. Yet, quantitative estimations such as a proportion of biogenic and terrigenous magnetic minerals were difficult because it is required to extract magnetic minerals for TEM observations, which may distort original magnetic mineral assemblages. However, recent progress of rock magnetic techniques has enabled quantitative estimations for amount and morphology of biogenic magnetites (e.g., Egli, 2010), and it is revealed that biogenic magnetites are dominant magnetic minerals in sediments at least in high latitudes and the equatorial zone (Roberts et al., 2012; Yamazaki and Ikehara, 2012). Quantification of biogenic magnetites have opened new applications to researches on paleoceanography and paleoenvironment, as a kind of fossils. In this presentation, I will introduce examples of such applications.

On the other hand, the discovery for the dominance of biogenic magnetites in sediments has strongly impacted paleomagnetism and its applications, because models of remanent magnetization acquisition processes of sediments did not incorporate contribution of biogenic magnetites. Remanent magnetization of sediments has been explained by a zone magnetization model; remanent magnetization is acquired within a zone with some thickness below the seafloor during compaction after deposition of sediment particles. This implies that there is a lag between a horizon of remanent magnetization fixing and seafloor or the bottom of the bioturbation mixing zone (called lock-in depth). Various models for the amount of the lock-in depth have been presented so far, from few centimeters to more than 40 cm, and have debated for more than thirty years. This is a significant problem when correlating magnetostratigraphy with biostratigraphy and oxygen isotope stratigraphy. Recently, Suganuma et al. (2010) apparently settled the problem by concluding a lock-in depth of ~15 cm from the comparison of geomagnetic paleointensity minimum at the Brunhes-Matuyama polarity transition with abundance of a cosmogenic nuclide 10Be, which is an independent method for estimating paleointensity devoid of a depth-lag. However, previous arguments on remanent magnetization acquisition mechanism did not seriously consider contribution of biogenic magnetites. It is thought that magnetotactic bacteria live in a sharp chemical gradient from oxic to anoxic in a sediment column and that near the Fe-redox boundary is the most preferable position for magnetotactic bacteria. If this is true, and if biogenic magnetites are the main carrier of remanent magnetization, the magnetization will be fixed near the Fe-redox boundary and the amount of the depth-lag will vary from millimeters to tens of meters depending on sedimentary environments. At present, importance of biogenic magnetites as a carrier of remanent magnetization is not clear even if they are dominant magnetic minerals. This is a significant issue to be solved.

Keywords: biogenic magnetite, magnetotactic bacteria, rock magnetism, paleoceanography, depositional remanent magnetization, Fe-redox boundary

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-12 Room:104 Time:May 24 15:15-15:30

Preliminary study of the Cretaceous tephrochronology in Japan and its application to biostratigraphic study

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Tephrochronology is a useful tool for high-resolution stratigraphic correlation and age determination for Quaternary marine and non-marine sediments. However, this method is very difficult to apply to the old sediments such as Paleozoic and Mesozoic because glass in tephra is very sensitive to diagenetic alteration. On the other hand, several heavy minerals in tephra are resistant to diagenetic alteration, and their variations in chemical composition are useful to distinguish individual tephra (Lowe, 2011). Recently, the validity of such mineral analysis as a tool for tephra fingerprinting was supported by Ordovician K-bentonites in North America and Scandinavia (Sell and Samson, 2011).

We analyzed biotite and apatite chemistry of 100-80 Ma tuffs in the Yezo Group exposed in Haboro, Kotanbetsu, Yubari, Hobetsu and Urakawa areas in Hokkaido in order to confirm their efficacy for tephrochronology. Both minerals occur in most tuffs of the Yezo Group. Although some biotites from the lower part of the Yezo Group in Yubari section are mostly altered to chlorite, apatite is always well preserved in all areas and horizons. Binary plot of Mg# vs TiO_2 of biotite and those of MgO vs FeO and F vs Cl of apatite analyses obtained using EPMA are proven to be useful indicators to distinguish individual tuff beds.

Using above method, we identified widely traceable two tuffs in the Yezo Group that are intercalated near the Albian/Cenomanian and the Santonian/Campanian boundaries. These two tuffs from various sections in Hokkaido are plotted in the same field on above mentioned binary plots of biotite and apatite, respectively, and show same U-Pb ages within the margin of error. Correlation of tuffs of the Albian/Cenomanian and the Santonian/Campanian boundaries demonstrate that horizons of first and last occurrences of several age-diagnostic fossils are not always synchronous among areas in Hokkaido. This may attribute to the differences in sedimentary environments and preservation of calcium carbonate among areas. Therefore, tephrochronology using heavy minerals is very useful method to identify ”true” biostratigraphic datum, and will improve resolution of biostratigraphy.

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Keywords: Tephrochronology, Cretaceous, Apatite, Biotite, biostratigraphy

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-13 Room:104 Time:May 24 15:30-15:45

Bio- and chemo-stratigraphy and U-Pb ages of the Cretaceous sequence in Japan

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Most of GSSPs (Global Boundary Stratotype Section and Points) and their candidate sites of the Cretaceous stages are located in Europe where the stage boundaries are defined by the detailed biostratigraphy (e.g., Gale et al., 1996). Recent studies of integrated stratigraphy of microfossil, megafossil and carbon isotope of those sequences have greatly improved resolution of international stratigraphic correlation. However, few radiometric ages are determined from those sequences because of rare intercalations of volcaniclastic sediments. In order to understand detailed Cretaceous paleo-climatic changes, it is necessary to improve resolution of Cretaceous chronostratigraphic framework based on the radiometric dating.

The Yezo Group, accumulated at approximately 30-40 degree North along the Asian active continental margin in the northwestern Pacific Ocean, ranges from Aptian to Paleocene in age and consists mainly of hemipelagic mudstone and turbidite sandstone. Total thickness of this sequence attains 10,000m. This sequence is suitable for establishment of Cretaceous chronostratigraphic framework because it yields abundant felsic tuffs and well preserved age-diagnositic marine macro and micro fossils.

In this study, we established integrated stratigraphies of planktic foraminifera and carbon isotope of wood fragments of the Yezo Group exposed in Tomamae, Yubari and Urakawa sections. Detailed correlation of integrated stratigraphy of planktic foraminifera and carbon isotope between the Yezo Group and European sequences enabled the determination of Cretaceous stage boundaries and oceanic anoxic events (OAEs) in the Yezo Group. The felsic tuffs of the Yezo Group are intercalated at or near stratigraphic datum levels and environmental events, such as Aptian/Albian, Albian/Cenomanian, Cenomanian/Turonian, Turonian/Coniacian, Coniacian/Santonian, Santonian/Campanian boundaries and OAE 1b, OAE1c, OAE1d. The U-Pb ages of these tuff beds are consistent with the inferred age-model of Geologic Time Scale 2012 (GST2012) within the margin of error concerning Aptian/Albian, Albian/Cenomania, Cenomanian/Turonian, Turonian/Coniacian, Coniacian/Santonian boundaries. On the other hand, Santonian/Campanian boundary, OAE1c and OAE1d show discrepancy about 1 m.y. These discrepancies between this study and GST2012 may attribute to the scarcity of radiometric age of European sections. Therefore, determination of a large quantity of U-Pb age in the Yezo Group will greatly improve the resolution of Cretaceous chronostratigraphy.

References

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