Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

BPT024-01 Room:201B Time:May 22 14:15-14:30

Perturbation of eukaryotic life and ocean redox around the Precambrian-Cambrian boundary

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We analyzed the organic geochemistry from shallow-sea sections of upper Ediacaran and lower Cambrian strata including the Precambrian-Cambrian boundary in Kunming area, South China. The results showed a correlation between organic geochemical redox indicators (Pristane/Phytane ratio) and eukaryotic biomass indicator (sterane, sterane/hopane ratio). We report here these new findings on redox changes and eukaryotic biomass changes during the late Ediacaran to the early Cambrian. Sterane concentration and sterane/hopane ratio indicates that eukaryotic biomass increases throughout the interval from the top-Ediacaran to the lower Cambrian marked by Chengjiang Fauna. Pristane/Phytane ratio also coincidentally increases throughout the interval. These correlations suggest the anoxia at the end of the Ediacaran may be related to the extinction of Ediacaran Fauna, resulting the evolution of eukaryotic life in early Cambrian by an increase in dissolved oxygen.

Keywords: precambrian-cambrian boundary, ocean redox, eukaryotic life, biomarker, south china

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BPT024-02 Room:201B Time:May 22 14:30-14:45

Oceanic euxinia and destruction of land vegetation during the Frasnian/Famennian boundary mass extinction

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We analyzed the organic geochemistry, d34SCAS, d34Ssulfide, d13Ccarb, and pyrite diameter from three shallow sea sections in Belgium and South China including the Frasnian/Famennian (F/F) boundary. The results showed a correlation between organic geochemical redox indicators (dibenzothiophenes and 2,3,6-trimethylarylisoprenoids), sulfur and carbon isotope ratios, pyrite diameter, and an organic geochemical indicator of land vegetation destruction (dibenzofurans). We report here these new findings on redox changes and destruction of land vegetation during the Frasnian/Famennian (F/F) boundary mass extinction. We show coincident increases in d34SCAS, d34Ssulfide, d13Ccarb, dibenzothiophenes, 2,3,6-trimethylarylisoprenoids, and dibenzofurans and a coincident decrease in pyrite diameter at or near the F/F boundary in low latitude shallow-seas. These coincidental changes show the development of oceanic euxinia and destruction of land vegetation at this time. These correlations indicate that H2S accumulated in the ocean and input of euxinic waters to the oxic surface waters that most marine organisms inhabit, would have caused marine extinctions at the F/F boundary. Destruction of land vegetation may be related to the shallow-sea euxinia.

Keywords: sulfur isotope, carbon isotope, sedimentary organic molecules, Frasnian-Famennian boundary

Japan Geoscience Union Meeting 2011
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BPT024-03 Room:201B Time:May 22 14:45-15:00

Oceanic euxinia at the end-Permian mass extinction followed by cyanobacterial blooms and land vegetation recovery

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The largest mass extinction occurred in both seas and lands at the end of the Permian, 251 Ma. We conducted a high-resolution study on sedimentary organic molecules at the Huangzhishan section located at 40 km southeast of the GSSP Meishan section, South China, deposited in shallow-water platform. In this section, fossil records indicate that mass extinction across the P/T boundary includes two extinctions. Here we report new findings on euxinic, bacterial, and land vegetation indices of organic molecules in the Huangzhishan section. The results show that (1) ocean euxinia at the end of the Permian caused the former mass extinction and terrestrial vegetation collapse, (2) after the former extinction cyanobacteria bloomed in the ocean and land vegetation recovered from lichens to ferns then to conifers but collapsed at near the P/T boundary and (3) after the later extinction the second bloom of cyanobacteria occurred in the ocean and land vegetation recovered from ferns to conifers. Terrestrial vegetation collapses coincided with spikes of photic zone euxinia indicator. This implies that hydrogen sulfide which accumulated in the ocean released to the atmosphere triggering acid rain, leading to terrestrial vegetation collapse.

Japan Geoscience Union Meeting 2011
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BPT024-04 Room:201B Time:May 22 15:00-15:15

Sulfur isotope of sulfate profiles in the pelagic Panthalassic deep sea at the end-Permian

Satoshi Takahashi[1*], Kunio Kaiho[1], Takahiro Watanabe[1], Takeshi Kakegawa[1], Masahiro Oba[1]

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Japanese accretionary complexes contain Panthalassic deep-water sediments. These pelagic deep-water sediments record environmental changes in the central Panthalassa Ocean during the Permian-Triassic transition which is associated with the most severe mass extinction known to date. This study presents sulfide-sulfur isotopic records from a continuous deep-water Permian?Triassic boundary section located in northeast Japan (the Akkamori section-2). The data demonstrate a 10 permil rise in sulfide-sulfur isotope ratios at the end-Permian followed by a sharp drop (return to pre-rise values). Such large sulfur isotopic swings have also been reported in carbonate-associated sulfates from the end-Permian mass extinction horizon in the shallow Paleotethys. These sulfur isotopic swings suggest the accumulation of H2S followed by a massive release of 32S-enriched sulfur to the shallow ocean environment at the end of the Permian at least encompassing central pelagic Panthalassa and shallow Paleotethys environments. This widespread sulfur isotopic event is therefore likely to be a global phenomenon. The end-Permian sulfur isotopic drop coincides with a reported demise among radiolarian fossils, the onset of carbonaceous black claystone deposition, and a negative excursion in organic carbon isotopes. These facts can be connected to one another by our proposed hypothesis, as follows. (1) Panthalassic euxinic deep-water bodies increased in volume to push the chemocline upward in the Changhsingian. Such expansion of anoxic water mass provide an increase in the consumption of sulfate by sulfur reduce bacteria and sulfate-poor ocean, result an increase in sulfur isotope of oceanic sulfate. (2) The euxinic deep waters caused the chemocline to rise to a very shallow water depth, while oxidation and re-reduction of sulfide (sulfur disproportionation) were accelerated. Such oxygen-poor shallow-water conditions can explain the coincidence of this sulfur isotopic drop, the radiolarian collapse, and the increase in the proportion of undecomposed organic matter in sediments. This expanded euxinic deep water might represent one of the causes of the end-Permian mass extinction in the central Panthalassa.

Keywords: Mass extinction, Panthalassa, Pelagic deep sea, Permian, Triassic, Sulfur isotope

Japan Geoscience Union Meeting 2011
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BPT024-05 Room:201B Time:May 22 15:15-15:30

Ocean redox histry during the Early Triassic

Ryosuke Saito[1*], Masahiro Oba[1], Kunio Kaiho[1], Shun Ariyoshi[2], Satoshi Takahashi[1]

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The greatest mass extinction occurred at the end of the Permian. A substantial biotic recovery was delayed until the end of the Early Triassic, which lasted about 5 million years. This was an unusually long delay for biotic recovery after a mass extinction, the Early Triassic therefore has often been viewed as an interval when global conditions repeated hostile to life. Several euxinic phases during Early Triassic have been reported. However, ocean redox history information of whole Early Triassic epoch is not enough. Here we show euxinic ocean appeared several times in the Early Triassic and euxinic conditions gradually became much stronger toward the end of the Early Triassic. The most severe condition occurred just before the recovery. However, this condition suddenly disappeared and dissolved oxygen levels abruptly increased in the Middle Triassic. This phenomenon coincided with biotic recovery in the Middle Triassic. Dibenzothiophenes and arylisoprenoids are detected which provide unequivocal evidences for depositional environment euxinia and photic zone euxinia at ˜80 m water depth. These biomarkers became more abundant toward the end of the Early Triassic. Okenane, a biomarker for photic zone euxinia at ˜20 m water depth, is never detected without the end of the Early Triassic. Moreover, crocetane which is a biomarker for anaerobic methanotrophic Euryarchaeota (ANME) is detected from the middle Spathian to the latest Spathian. Crocetane indicates existence of methane in the Early Triassic sea. This methane might be derived from methane hydrates. Anaerobic oxidation of methane is the chemical reaction: the consumption of methane and the formation of sulfide (e.g. hydrogen sulfide) from sulfate at a molar ratio of 1:1 by consortia of ANME and sulfate-reducing bacteria. Dissolved oxygen in the sea would have to be eliminated at least twice of hydrogen sulfide generated by anaerobic oxidation of methane given the stoichiometry of the reaction. The overproducing of hydrogen sulfide would induce the uprise of chemocline. Consequently, anaerobic oxidation of methane might make the sea with euxinic condition. The most severe euxinic condition at the end of Early Triassic was possibly caused by anaerobic oxidation of methane triggered by melting methane hydrates. This is a model case that melting methane hydrates is not only a driver of global warming but also a driver of ocean euxinia.

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BPT024-06 Room:201B Time:May 22 15:30-15:45

Reconstruction of paleoenvironment in the Pacific Ocean during the mid-Cretaceous Oceanic Anoxic Event 2

Hiroshi Nishi[1*], Reishi Takashima[1], Toshiro Yamanaka[2], Kazushige Tanabe[3], Keiichi Hayashi[4]

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The presence of negative carbon isotope excursions at the base of some Oceanic Anoxic events and PETM are explained to have been associated with massive inputs of mantle-derived volcanic CO2 or the dissolution of methane hydrates. In particular, prominent negative carbon isotope excursions have been found at the base of the Toarcian OAE and OAE 1a. In the OAE2, however, negative carbon isotope excursion have not been always observed close to the base of the OAE2 at the several studied areas. A negative carbon isotope excursion below the 1st build-up phase is explained by a diagenetic signal, or a reflection of local oceanographic episodic events, such as fresh water input.

We identified a negative carbon isotope excursion just below the 1st build-up phase from two distant sections of the Pacific regions. In Hokkaido (North Japan), the negative excursion is recognized immediately below the OAE2 horizon in Upper Cretaceous Yezo Group sediments from the Shumarinai to Hakkin sections of central-northwestern Hokkaido. This evidence suggests the occurrence of a negative shift in the carbon isotope composition of global atmosphere and/or the change in global terrestrial climate and hydrological cycles immediately before the onset of the OAE2. The negative shift began 23?51 ky before the onset of the 1st build-up phase of the OAE2, which is generally consistent with the onset of the volcanic pulse manifested by the negative 187Os/188Os shift and increased pCO2 levels. The negative d13Cwood excursion is also recognized in the Buddy Canyon Formation of the Cretaceous Great Valley Group exposed in the California, USA. The negative spike identified in the two sections of NW and NE Pacific Ocean may reflect massive input of volcanic CO2 immediately before the onset of the OAE 2.

Keywords: Pacific Ocean, Oceanic Anoxic Event 2, Cretaceous, carbon isotope

Japan Geoscience Union Meeting 2011
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BPT024-07 Room:201B Time:May 22 15:45-16:00

Short-term euxinia coinciding with rotaliporid extinctions during the Cenomanian-Turonian transition

Masahiro Oba[1*], Kunio Kaiho[1], Takashi Okabe[1], Marcos A. Lamolda[2], James D. Wright[3]

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Oceanic anoxic event 2 (OAE2), which occurred during the Cenomanian-Turonian (C-T) transition and lasted 10^6 years, is characterized by a positive global carbon isotopic excursion and stepwise extinctions in marine biota. To examine temporal variations in the dissolved oxygen content of the water column, shallow-marine C-T sediments from northern Spain were analyzed for concentrations of dibenzothiophenes, which are indicators of euxinic depositional environments, and 2,3,6-trimethylarylisoprenoids, which probably indicate photic-zone euxinia. The positive excursion in $d^{13}C$ values of carbonates is accompanied by short- (10^3 to 10^4 years) and long-term (10^5 years) increases in dibenzothiophene and 2,3,6-trimethylarylisoprenoid concentrations, suggesting that the bottom water and photic zone of the eastern marginal sea of the North Atlantic Ocean were euxinic. Two of the short-term increases in organic compound concentrations took place just after the last occurrence of the planktonic foraminifers Rotalipora greenhornensis and R. cushmani. These transient maxima indicate that the extinction of both planktonic foraminifers was due to short-term OAEs lasting 10^3 to 10^4 years.

Keywords: Cenomanian-Turonian, oceanic anoxic event, foraminiferal extinction, dibenzothiophenes, 2,3,6-trimethylarylisoprenoids, brachiopods

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BPT024-08 Room:201B Time:May 22 16:00-16:15

Oceanic redox and land vegetation across the Cretaceous/Paleogene boundary in Caravaca, southern Spain

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An extraterrestrial impact at the Cretaceous/Paleogene (K/P) boundary ca. 65.5 million years ago caused a mass extinction and rapid changes of surface environment on the Earth. Here we report changes of oceanic redox and land vegetation across the K/P boundary at Caravaca, southern Spain using sedimentary organic molecules. The results reveal that the basal 3-mm thin layer of the K/P boundary-clay is marked by a rapid increase in concentrations of terrestrial long-chain n-alkanes and dibenzofuran, indicating a destruction of land vegetation and an increase in supply of terrestrial organic matter into the marine environment at the K/P boundary. This layer also have a rapid increase in concentrations of dibenzothiophene, indicating a change in redox conditions from oxic to anoxic/euxinic conditions. The low-oxygen condition could have been caused by an increase in flux of terrestrial organic matter into the ocean. A rapid increase in concentrations of retene and retene/cadalene occurred in the upper part of the boundary-clay, indicating a recovery of angiosperm which withered at the K/P boundary.

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BPT024-09 Room:201B Time:May 22 16:30-16:45

Occurrence of the Cretaceous limestones from IODP Expedition 330: Louisville Seamount Trail

Kazuyoshi MORIYA[1*], Johnathon Kell[2], David Buchs[3], Shin-ichi Sano[4], Anthony Koppers[5], Toshitsugu Yamazaki[6], Joerg Geldmacher[7], IODP Expedition 330 Scientific Party[7]

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Recent paleotemperature proxy and fossil assemblage analyses, particularly in the Atlantic and Indian Ocean, have described the late Cretaceous climate cooling followed by Paleogene warming. On the other hand, in the Pacific Ocean paleoclimatic and paleoceanographic analyses of these events based on biological provincialism and geochemical records are surprisingly poor. Because the Pacific was the largest ocean during the Cretaceous-Paleogene climate transition interval, investigating paleoceanographic conditions in the Pacific is key to understanding the nature of greenhouse climate systems. IODP Expedition 330 along the Louisville Seamount Trail in the South Pacific, between December 2010 and February 2011, collected epi- and/or mesopelagic sediments containing abundant Cretaceous to Paleogene fossils from several flat-topped seamounts. These fossils will help to constrain ancient paleoclimatic and paleoceanographic conditions in the Pacific Ocean.

According to geomantle dynamic models (Steinberger and Antretter, 2006), the Louisville Hotspot, which created the seamount trail, is modeled to have been located at approximately 40-50o S (this will be refined by paleomagnetic analyses post-cruise) during the Cretaceous. Therefore, the epi- and meso-pelagic sediments capping the seamounts will provide an important record of the paleobiogeography and paleoceanography of Pacific southern mid- to high latitudes. Late Cretaceous planktonic foraminifers and molluscs found in the sediments have ages comparable to previous 40Ar/39Ar age estimates for these seamounts or interpolations from the Louisville age progression. The planktonic foraminiferal assemblages are composed of double- and single-keeled globotruncanids, hedbergerids, and heterohelicids. The relative abundances of globotruncanids in the Louisville sediments compared to those in pelagic sediments in the Atlantic and Indian Ocean southern high latitudes, indicate a warmer water environment in the late Cretaceous southern mid- to high latitude Pacific. Our preliminary results contribute to an improved understanding of the expansion of tropical and subtropical climates during the Cretaceous cooling and Paleogene warming events. We will also discuss the paleobioprovince and paleoclimate at high latitudes in the southern Pacific during the Cretaceous.

Steinberger, B., and Antretter, M., 2006. Conduit diameter and buoyant rising speed of mantle plumes: implications for the motion of hot spots and shape of plume conduits. Geochem., Geophys., Geosyst., 7(11):Q11018.

Keywords: Louisville Seamount Trail, Cretaceous, Limestone

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BPT024-10 Room:201B Time:May 22 16:45-17:00

Radiolarian faunal turnover across the middle/late Eocene boundary at ODP Site 1052

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Radiolarian assemblages have been analyzed quantitatively using the samples of Ocean Drilling Program Site 1052 in the northwest Atlantic Ocean in order to determine the nature of the faunal turnover across the middle/late Eocene boundary. Two discrete extinction phases were recognized through the latest middle Eocene to early late Eocene (38.0 to 37.6 Ma and 37.2 to 36.5 Ma). The initiation of the extinction phase 1 coincides with first positive shift in planktonic foraminiferal??18O and relatively high radiolarian abundance. The second phase just above the middle/late Eocene boundary is associated with a significant drop in radiolarian diversity. We named these extinction phases Middle/Late Eocene Extinction (MLEE) Event.

Radiolarian assemblage changes indicate reduction of the paleo-Gulf Stream and enhancement of upwelling between 37.8 and 36.5 Ma, consistent with previously published faunal and floral assemblages and stable isotopes. The paleoceanographic changes in the North Atlantic Ocean might have triggered a severe cooling and major extinctions in the North America and Europe. The absence of typical deep-water species indicates the paleodepth of the Blake Nose was shallower than 1000 m during the middle Eocene.

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BPT024-11 Room:201B Time:May 22 17:00-17:15

Molecular paleontological characteristics of plant fossils from plant fragment-condensed bed in Cretaceous Futaba Group

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Lipids such as hydrocarbons and isoprenoids and resistant macromolecules as cutin and suberin constituting living plants are stable and have resistance to microbial degradation and diagenesis. And they are considered the main parts of plant fossils and plant-origin sedimentary organic matters (SOM). But it is unknown that what factor affects the preservation of composition of molecular unit. In this study, we analyzed resistant macromolecule of a wide variety of plant fossils collected from the same Cretaceous coal layer and investigated variability of composition of their molecular units.

We analyzed mesofossils of angiosperms and gymnosperms collected from Ashizawa Formation, Futaba Group, Kamikitaba, northeastern Japan. For example, fruit fossils of *Hironoia fusiformis* and *Archaefagacea futabensis*, flower fossils of *Esgueiria futabensis*, leaf fossils of *Juniperus*, a stem fossil of *Epfedra* and some fossils of fruits, seeds and woods which are uncertain about taxonomy. Powder somples of above fossils were solvent-extracted normally and under high temperature to be removed free compounds completely. The residues were operated saponification by KOH/methanol to be extracted ester-bond compounds. For classification and determination of compounds, GC-MS are used.

First, as a result of analyses of free compounds in living-like plant fossils obtained from the Cretaceous rock in the same way of above fossils to investigate the maturity, beta-sitosterol and *n*-alkanes with high-CPI were detected. They are indicators of living higher terrestrial plants. It indicates the existence of fossils that have not been affected diagenesis, even in Cretaceous fossils. Secondly, as a result of investigation of ester-bond molecular units of resistant macromolecules, fatty acids (C_{10}-C_{28}) and *n*-alkanols (C_{10}-C_{28}) were detected in all samples. Distributions of carbon number of fatty acids were clearly different according to a part of samples. In organs have cuticles (e. g. flowers, fruits and leaves), C_{14} /C_{16} ratios of fatty acids are high and C_{18} /C_{16} ratios are low. In other hands, in woods, C_{14} /C_{16} ratios are low and C_{18} /C_{16} ratios are high. Possibly, it indicates the characteristic composition of cutin and suberin respectively. From scatter diagram used these ratios as independent variables, a linear function which distinguish flower, fruit and leaf fossils from wood fossils was obtained. In the future, this function will be useful to determine the parts of broken fossils. And from scatter diagram used C_{20} /C_{18} ratios and C_{20} /C_{16} ratios of *n*-alkanols as independent variables, wood fossils are separated from flower, fruit and leaf fossils roughly. The high ratio of C_{20}*n*-alkanol may indicate the composition of suberin.

Keywords: Cretaceous flower fossil, evolution of angiosperm, resistant macromolecule, suberin, cutin, chemotaxonomy

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BPT024-12 Room:201B Time:May 22 17:15-17:30

Three-dimensional morphological analysis of tooth row of a new skull specimen of a polycotylid plesiosaur from the earl

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1. Introduction

Manemergus anguirostris Buchy et al. 2005 is a Cretaceous ”short-necked plesiosaur” belonging to the family Polytycolidae. Because this species was proposed on the basis of a single immature specimen (holotype), adult features including the number of teeth are still unknown, causing serious problem for determination of a higher-level phylogenetic position of this species. that are useful for phylogenetic analysis The holotype of this species has 5 premaxillary, 10 maxillary, 15 dentary teeth including 9 symphysisial teeth; the number is approximately half of the average number of teeth in other polycotylids. Buchy (2005) assumed that the smaller number of teeth observed in the holotype represents a diagnostic feature of this species, since Carpenter (1996) stated that the number of premaxillary teeth of a polycotylid plesiosaur Dolichorhynchops osborni and the number of the teeth of the Recent crocodiles do not increase with growth.

However, Carpenter (1996) did not discuss the number of other teeth, and the smallest skull of D. osborni specimen described by him is 1.5 times longer than that of the holotype of M. anguirostris. Furthermore, there is not reliable basis to apply the forming processes of tooth of the Recent crocodiles and other animals to the present species.

In this study, the forming process of a tooth of M. anguirostris is directly analyzed by three.dimensional morphological analysis with CT scanning on the basis of an adult specimen newly recovered from the early Turonian of Morocco.

2. Results

The number of alveolus of the preserved symphysis is 6, though the anterior symphysis is missing. At least fifteen alveolus, the teeth of which are not symphysis, are recognized in the CT scanning image. From CT scanning image, the pre-emitted teeth are observed. They are formed in bilateral symmetrical process. The new teeth are formed in bilateral symmetrical process, in pair. In the specimen examined, the pre-emitted teeth pairs are observed at intervals in teeth row, not in succession pairs. The newly formed tooth is positioned to adjacent to the caudal side of the old ones .

3. Discussions

The observed tooth forming process by CT image is different from that of the crocodiles, in that a new tooth appears below of the old teeth. Therefore Buchy’s (2005) assumption that the tooth forming process is comparable with in polycotylids and crocodiles is inadequate. This study demonstrates that direct observation of the three-dimensional morphology by means of CT scanning technique is more reliable for reconstruction of teeth forming process of polytycolids than the assumption from the Recent animals.

The specimen examined provides additional adult characters of M. anguirostris, which may be useful for future phylogenetic analysis of plesiosaurs.

Keywords: Paleobiology, Paleovertebrate, Paleophysiology, Plesiosaur

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BPT024-13 Room:201B Time:May 22 17:30-17:45

The quantitative analysis method of three dimensional morphometry by segmentation of planktonic foraminifera chambers.

Hikaru Ito[1*], Osamu Sasaki[2], Tomohiro Iwashita[3], Hiroyuki Nagahama[1], Harumasa Kano[2]

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Most of existing morphometric methods of planktonic foraminifera (e.g. Lohmann, 1983; Malmgren et al., 1984; Hull and Noris, 2009; Scott *et al.*, 2007) are based on 2-D specific sideviewing pictures of shells that are distorted from 3-D shape and affected by researcher's arbitrariness. In addition, various shell ontogeny 3-D models (e.g. Berger, 1969; Tyszka and Topa, 2005) suggest that shell morphology of planktonic foraminifera can be described by 3-D parameters of chamber's shape, size, and angle of connection. While size and angle of connection of chamber were dealt with by Kennett (1966) and Wei and Kennett (1988), 3-D shape of chamber was not analyzed.

Whereas, the recent computer evolution enable us to analyze biomorphology of three dimensional (3-D) shapes. 3-D specimens scanned with X-ray computed tomography (X-ray CT) have been generally available for 3-D morphometric methods. For example, Hodges and Garland (2003) visualized horned lizards 3-D skull, and Wiley *et al.* (2005) traced primate skull evolution with 3-D images. Therefore, various analytical procedures were proposed by the parametrization of closed surfaces for 3-D shape description (Brechbuhler, 1995), the spherical mapping (Shen and Makedon, 2006), Eigensurface analysis (Polly and Macleod, 2008), and others. Speijer *et al.* (2008) applyied 3-D morphological analysis to planktonic foraminifera research.

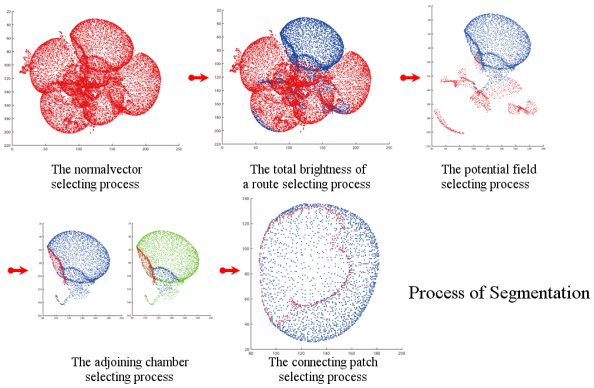
We present a new method of individual chamber segmentation procedure, quantitative analysis of chamber's 3-D parameter, and comparison of each chambers.

We applied chamber segmentation procedure to *Neogloboquadrina himiensis* and *Neogloboquadrina dutertrei* that have enough size to be scanned with our X-ray CT machine, because *Neogloboquadrina*'s chamber that has diversity of form and doesn't have particular peculiarity is competent for a sample of our method and the chamber's shape were represented by inner wall not to be affected by secondary calcification that is different from outer wall.

All processes of segmentation and analysis were carried out on numerical analysis software MATLAB (Mathworks, Inc), and shell tomographical images were converted into patch objects which surfaces are represented by an aggregate of microtriangle (patch). Each patch have eigennormalvectors that define inside and outside.

Our chamber segmentation procedure is composed of five phases that are the normalvector selecting process, the total brightness of a route selecting process, the potential field selecting process, the adjoining chamber selecting process, and the connecting patch selecting process. The normalvector selecting process chooses patches that each eigennormalvector are headed for a marker-point within selecting chamber. The total brightness of a route selecting process chooses patches that each total brightnesses between a marker-point within selecting chamber and each vertex of patches are over optional threshold. The potential field selecting process chooses patches which each vector field involve a inner wall of selecting chamber. The adjoining chamber selecting process removes outer wall's patches of adjoining chamber. Each normalvector of outer wall's patches are turned around a marker-point within adjoining chamber. The connecting patch selecting process removes patches which are satisfied with above-mentioned processes whereas don't belong to inner wall of selecting chamber.

Analysis and comparison of chamber is carried out by morphometric map that 3-D chamber specimen data is described. Morphometric map is made from a standardized griddata by the center of gravity and chamber's aperture position, and null fields of chamber's data are masked. This method enabled us to analysis the chamber shape without scale difference. In addition, output hypsographic or clinometric map is useful for morphologic comparison of chamber. These methods for polar region become warped, so we attempt to develop a new method of comparison.



Keywords: planktonic foraminifera, morphometric analysis, quantitative analysis, 3-D specimen, X-ray CT

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BPT024-14 Room:201B Time:May 22 17:45-18:00

Availability of morphological analysis using X-ray computed tomography in microfossil study: Example of planktonic foram

Takayoshi Endo[1*], Osamu Sasaki[2], Hiroyuki Nagahama[1]

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X-ray computed tomography (X-ray CT) reconstructs non-destructive measurement of three-dimensional structure and interior by calculating the X-ray absorption. Also fossil studies, X-ray CT can reconstruct any tomographic image and transmission image in any size fossils. In addition, X-ray CT can also freely enlarge, reduce and rotate images. X-ray CT has become popular as a new technique for observing fossils which are more difficult to observe.

Theoretical morphological models have been developed to describe quantitatively the form of organism (e.g., Thompson, 1915; Raup, 1966; Okamoto, 1988). Models of planktonic foraminifera are developed by many researchers (e.g., Berger, 1969; Tyszka and Topa, 2005). Those models are based on three-dimensional shell form, but measurement methods are based on the two-dimensional images such as optical or electron micrograph and X-ray transmission. So, the error due to distortion of the measurement angle and the projection operation is ignored, which means reproducing the structure of the sample is impossible in principle. In this study, we solved this problem by using X-ray CT. Firstly, we developed measurement method for planktonic foraminifera. Secondly, we discussed on an array pattern and growth pattern of planktonic foraminifera. Finally, we show the availability of X-ray CT analysis in microfossils.

High resolution X-ray CT imaging system used in our study ScanXmate-A150S145/2 (producted by Comscantecno) has 5 micron resolution and pixel size of tomographic image is 2.5 micron. The basic principle of X-ray CT is as follows. Firstly, when X-rays transmitted through the sample is irradiated, detectors measured the X-ray absorption value of the path integral as projection image. Secondly, projection images are taken in many different directions. Thirdly, the X-ray absorption value is reconstructed from many projection images by the discrete Fourier transform. This is mathematically equivalent to solving the inverse Radon transform problem (Radon, 1917). Finally, the X-ray absorption value is output as a brightness value on a tomographic image.

This study intended planktonic foraminifera to measure as a test of microfossils. Planktonic foraminifera is one of the important key fossils, the indicator of paleoceanography and the subject for evolutionary. Planktonic foraminifera are going to add a new spherical or egg-shaped shell (chamber) in their growth process. In this study, we selected *Globoconella inflata*, modern planktonic foraminifera. We observed results of reconstruction which each tomographic image and rendering image by software Molcer Plus (producted by WhiteRabbit). We adopted the center of gravity and volume of the each chamber as a site of measurement.

Tomographic images ware processed by the free software ImageJ 1.43 and aggregated calculation by the software Microsoft Excel. Firstly, to detect the contour of the inner wall of each chamber, we binarized tomographic images of the average brightness value as the threshold. Secondly, those images are segmented into each chamber. Finally, volume and growth trajectory of chambers were measured. We determined curvature and torsion of growth trajectory by using Frenet-Serret formula (Frenet, 1847; Serret, 1851), in the reference growing tube model (moving frame models) by Okamoto (1988). Briefly, curvature is the reciprocal of the radius for curve, and torsion is the variable representing the rate of twisting from the plane of curve.

Measurement results were obtained with 11chambers. Volume of chambers tends to increase exponentially, and growth rate of chambers constituting the last whorl more increases. However growth rate of last chamber decreases rapidly. To calculate the curvature and torsion of the growth trajectory, we found that the curvature was positive and increased at a constant rate, and torsion was positive and almost close to zero. We will present these data in detail.

Keywords: X-ray computed tomography (X-ray CT), morphological analysis, planktonic foraminifera

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BPT024-15 Room:201B Time:May 22 18:00-18:15

Geographic division and cryptic speciation of planktic foraminifer in the Indo-Pacific Warm Pool

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The Indo-Pacific Warm Pool (IPWP) has strong correlation with the tropical climate change and oceanic circulation system due to its largest heat capacity on the Earth. This area is a key to document the presence of the boundary for the dispersal of marine organisms, though no study from zooplankton. *Pulleniatina obliquiloculata* is the most representative species of tropical water, in particular, the IPWP and the surface currents originated from this area. We examined the phylogeography of *P. obliquiloculata* by using 893 single cell samples collected from the world oceans; Pacific, Indian, and Atlantic Oceans. The phylogenetic analysis of the partial Small Subunit ribosomal DNA (SSU rDNA) sequences clearly shows the occurrences of three genetic types (Types I to III) with specific biogeographic distributions. Type I is commonly found in temperate water area of the world oceans, whereas Type II is found along the South Equatorial Current in the Pacific and Type III is between tropical and subtropical area of the northwestern Pacific. The geographic distributions of Types II and III were separated in the boundary to dispersal of pelagic zooplankton between the Indian and Pacific sides of the IPWP. Moreover, the divergence time estimation of these genetic types correlated to the development of modern IPWP system. Type I and others diverged around 4.2 Ma, when more Pacific gyre system was reconstructed due to the Panama Isthmus closure. Types II and III branched around 2.6 Ma according to the closure of the Indonesian Seaway. These physical boundaries divided water masses and provided thick mixed layer, where *P. obliquiloculata* invaded as new habitats. Thus, the diversification of pelagic zooplankton could be influenced by the marine environmental change leading the marine boundary.

Keywords: geographic division, cryptic species, planktic foraminifera, Indo-Pacific Warm Pool

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Molecular evolution of the shell matrix protein Aspein in pterioid bivalves

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Acidic shell matrix proteins are likely to have many important functions for shell precipitation. Aspein is one of the unusually acidic shell matrix proteins identified from the mantle tissue of the pearl oyster *Pinctada fucata*. Aspein is inferred to have important roles in the calcite formation in the prismatic layer. In this study, we identified Aspein homologues from a congeneric species *Pinctada maxima*, as well as from two closely related pterioid species *Isognomon perna* and *Pteria penguin*. The results of immunoassay showed that they exist in the calcitic prismatic shell layer but not in the aragonitic nacreous shell layer. The SEP (Ser-Glu-Pro) motif and the DA (Asp-Ala) repeat motif were conserved among these Aspeins, suggesting that those motifs are functionally important. The high proportion of Asp and Gly in D domain, which is believed to have Ca^{2+} binding capacity, is also conserved, suggesting that this feature is important for the function of D domain. However, other features of the primary structure of Aspeins showed a significantly high level of variation among very closely related species, suggesting that any specific sequences as template for nucleation are not required for the function of acidic shell matrix proteins.