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

BPT25-01 Room:416 Time:May 2 14:15-14:30

Rapid change of atmosphere in the Hadean Earth: Beyond Habitable Trinity on a tightrope

OMORI, Soichi[3] ; ARAI, Tatsuyuki[2] ; MARUYAMA, Shigenori[1*]

[1]ELSI Tokyo Institute of Technology, [2]Tokyo Institute of Technology, [3]Open University

Surface environment of Hadean Earth is a key to bear life on the Earth or not. All of previous works assumed that high PCO2 has been decreased to a few bars in the first a few hundreds millions of years (e.g., Zhanle et al., 2011). However, this process is not easy because of material and process barriers as shown below. Four barriers are present.

First, the ultra-acidic pH (<0.1) of 4.4Ga ocean prevented the precipitation of carbonates at mid-oceanic ridge or its pseudo-system through water-rock interaction after the birth of primordial ocean. To overcome this barrier, primordial (anorthosite + KREEP) continents must have been above sea-level to increase pH rapidly through hydrological process.

Second, major cap rocks on the Hadean oceanic crust must have been komatiite with minor basaltic rocks to precipitate carbonates through water-rock interaction and transport them into mantle through subduction at higher than the intermediate P/T geotherm on the Benioff plane. If not, carbonate minerals are all decarbonated at shallower depths than the Moho plane. Komatiite production depends on mantle potential temperature which must have been rapidly decreased to yield only Fe-enriched MORB by 3.8Ga.

Third, the primordial continents composed of anorthosite with subordinate amounts of KREEP basalts must have been annihilated until 4.0Ga to alter pH to be possible to precipitate carbonates by hydrothermal process. The value of PCO2 must have been decreased down to a few bars from 35 bars at TSI (total surface irradiance) = 75% under the restricted time limit. If failed, the Earth must have been Venus state which is impossible to bear life on the planet.

Fourth is the role of tectonic erosion to destroy and transport the primordial continent of anorthosite into deep mantle by subduction. Anorthosite + KREEP was the mother ' s milk grow life on the Earth, but disappeared by 4.0Ga or even earlier, but alternatively granites were formed and accumulated on the Earth to supply nutrients for life. This is time-dependent process to increase new continents.

Fifth is the water content 3-5km thick, if the value was over, no way to bear life nor evolution afterwards.

After all, the Hadean Earth has passed the really naive tightrope processes to bear life. If any of above five conditions was lost, life has not been appeared.

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Global paleogeography and life evolution: 3. Paleozoic

ISOZAKI, Yukio[1*] ; MARUYAMA, Shigenori[2]

[1]Univ. Tokyo/Dept. Earth Sci. & Astronomy, [2]Tokyo Inst. Technology/ELSI

In modern oceans, there is no remaining information about past oceans older than 200Ma. For reconstructing paleo-plate motions with respect to collision-amalgamation of continents, on-land geology, in particular, orogenic belts that cemented older continents provide a sole source of information.

The onset of the Paleozoic is marked by the Gondwana semi-superocntinent formation at 540Ma around the South Pole. During the Paleozoic, Gondwana broken up, whereas Laurentia aggregated to form a real supercontinent by 430 Ma. Immediately after that, Gondwana began to be rifted, and its fragments and other blocks such as Baltica, Kazakhstan, Siberia, N China, South China, Indochina, and smaller pieces of Cimmeria, were dispersed; most of these were eventually amalgamated to from the northern half of Pangea, i.e., Laurasia.

The mode of mantle dynamics was represented by the high MORB production rate during 540-350Ma, almost the same as that in the Cretaceous, but it dropped after 350 Ma, probably by the activation of Pacific superplume. According to such continental assembly/ disassembly, sea-level changed remarkably as represented by the glaciation/deglaciation; the major Gondwana glaciations during the Carboniferous-Permian with 3 more minor episodes; the Paleozoic-Mesozoic transition interval might be close to the snowball Earth condition with extremely cold climate. The continent dispersion/amalgamation likely drove the development of remarkable floristic provincialism, e.g., Gondwana, North America, and Angara, that particularly reflected the formation of Laurentia. Not only the post-Ordovician land trees, this also controlled the diversification pattern of soil bacteria, moss, and land animals. Biodiveristy changes including mass extinctions occurred in accordance with the secular change in seawater Sr isotope ratio; extremely high in the Cambrian with high bio-divesrification, and the minimum at the G-L boundary (Permian) with onset of the greatest mass extinction.

Keywords: paleogeography, Paleozoic, supercontinent, Gondwana, Pangea, evolution

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BPT25-03 Room:416 Time:May 2 14:45-15:00

Neodymium isotopic signature for deep/intermediate water formation in the late Cretaceous northwestern Pacific

MORIYA, Kazuyoshi[1*] ; MOIROUD, Mathieu[2] ; PUCEAT, Emmanuelle[2] ; DONNADIEU, Yannick[3] ; BAYON, Germain[4] ; DECONINCK, Jean-francois[2] ; BOYET, Maud[5]

[1]Dep. Earth Sci., Kanazawa Univ., [2]UMR CNRS Lab. Biogeosciences, Univ. Bourgogne, [3]UMR CEA/CNRS Lab. Sci. Climat Environ., CE Saclay, [4]IFREMER,Unite Recherche Geosciences Marines, [5]UMR CNRS Labo. Magmas Volcans, Univ. Blaise Pascal

The Cretaceous is known to be one of the archetypal greenhouse periods, and intensively studied for evaluating the climate sensitively in the high pCO2 region. The meridional sea surface temperature distribution, secular changes in sea surface and deep water temperatures have also been discussed globally. In addition to the thermal structure, analyses of ocean circulations on the basis of neodymium isotope signatures become more popular especially in the Atlantic Ocean. On the other hand, the ocean circulation in the Pacific Ocean is still uncertain, because of fundamental lack of deep sea sediments in the Pacific. In this study, instead of deep sea sediments, fore arc basin sediments have been utilized for discussing the ocean circulation in the late Cretaceous (late Turonian through early Campanian) northwestern Pacific.

Neodymium isotopic signatures in fish remains obtained from clayey sediments in the Yezo Group show highly radiogenic values of -1 to -2 ϵ-unit. These values are significantly higher than those in the Atlantic and the equatorial Pacific. This result indicates the presence of highly radiogenic intermediate/deep water formation in the northwestern Pacific, because it is expected that the radiogenic neodymium has been delivered from volcanic arcs in the northwestern Pacific. This results is also supported by climate models showing the potential deep water formation in the late Cretaceous northwestern Pacific.

Keywords: Cretaceous, Ocean circulation, Neodymium isotopes, North Pacific, Deep water, Intermediate Water

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BPT25-04 Room:416 Time:May 2 15:00-15:15

Campanian-Maastrichtian clay-rich sequences along North Pacific Margin: Early Cooling History of Cretaceous Greenhouse

HASEGAWA, Takashi[1*] ; MORIYA, Kazuyoshi[2] ; HAGGART, James[3]

[1]Kanazawa Univ., Univ. BC, Geol Serv. Canada, [2]Kanazawa Univ., Univ. British Columbia, [3]Geol. Serv. Canada, Univ. British Columbia

Cretaceous shelf and fore-arc basin sandstone and mudstone are preserved in the coastal regions of Japan, Far East Russia, and the Pacific coast of Canada and USA. Several of these sequences have been variously assessed in terms of their biostratigraphy and chemostratigraphy, and correlated to the Aptian through Maastrichtian. In addition to macro- and microfossil biostratigraphy, carbon isotope (δ^{13}C) stratigraphy has also identified some important event horizons within these successions, such as OAE2. Owing to the clay-rich nature of the strata, parts of the sequences yield excellently preserved calcareous fossils available for oxygen isotope thermometry (Moriya et al., 2003).

This study examines the Campanian-Maastrichtian interval. Its chronostratigraphy, including detailed δ^{13}C stratigraphy, has been summarized recently (Voigt et al., 2012) and it records the initial phase of global cooling of the Cretaceous greenhouse Earth (Moriya, 2011; Friedrich et al., 2012). As the northern paleo-Pacific Ocean had a large heat capacity, its paleoceanography should provide insights for understanding the subsequent environmental transition from greenhouse to ice house Earth.

The Yezo Group and its equivalent in Hokkaido (Japan) and Sakhalin (Russian Far East), as well as the Nanaimo Group of the Canadian Pacific coast (British Columbia), are examined in this study. From the Yezo Group, a clear negative δ^{13}C excursion as large as 1.4?2 ‰ has been identified. On Sakhalin, its Campanian-Maastrichtian boundary age is constrained by local bio- and magnetostratigraphy, and the excursion is thus identified as the Campanian Maastrichtian Boundary Event (CMBE), associated with some subevents.

Carbon isotopic event, CMBE, suggested from magneto- and biostratigraphy (Haggart et al., 2011; Ward et al., 2012) of the Nanaimo Group near the top of the Northumberland Formation is well observed at the expected mudstone-dominated interval of the formation with negative 1.5 ‰ excursion. These progresses of stratigraphic correlational potential enable us to correlate CMBE interval between NW and NE Pacific with higher resolution.

Friedrich, et al., 2012, Geology, 40, 107-110; Haggart et al., 2011, Can. Paleont. Conf., Field Trip Guidebook No. 16, 31-62; Hasegawa et al., 2003, Palaeo-3, 189, 97-115; Moriya, 2011, Paleont. Res, 15, 77-88; Moriya et al., 2003, Geology, 31,167?170; Voigt et al., 2012, Newsl. Str., 45, 25-53; Ward et al., 2012, GSA Bull., 124, 957-974.

Keywords: Cretaceous, Greenhouse, Cooling, Campanian, Maastrichtian

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Composite trace fossils: Phymatoderma reburrowed by Chondrites/Phycosiphon and its paleoecological implications

IZUMI, Kentaro[1*]

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

Composite *Phymatoderma* specimens from the Pliocene deep-sea Shiramazu Formation in Japan, particularly those reburrowed by *Chondrites* and *Phycosiphon*, were analyzed to reveal the differences caused by the activities of these trace-makers. *Phymatoderma* reburrowed by *Phycosiphon* is significantly larger than non-reburrowed *Phymatoderma*, whereas *Phymatoderma* reburrowed by *Chondrites* shows no significant difference in burrow diameter compared with non-reburrowed *Phymatoderma*. The recognized size selectivity (i.e., preference for larger burrows) by the *Phycosiphon* trace-makers can be explained by considering the different feeding strategies of these two ichnogenera; namely deposit-feeding *Phycosiphon*-makers, which must have processed a significant mass of sediment to obtain sufficient organic matter, whereas chemosymbiotic *Chondrites*-producers, which did not require a lot of sediment to obtain nutrients. In order to test these interpretations, records of the Phanerozoic trace fossils reburrowed by *Chondrites*/*Phycosiphon* were compiled. Consequently, the *Phycosiphon* -preference toward relatively larger burrows was recognized, which supports the results of this study. The compilation also indicates that the burrow size has become a limiting factor for the *Phycosiphon*-producers that tried to rework the sediments within previous subsurface burrows, at least for 80 million years.

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The influences of durations of geologic time units on diversity assessments

UBUKATA, Takao[1*]

[1]Shizuoka University

The study on global diversity change has been at the center of paleontological studies during the past quarter-century. It is well known that the diversity estimates are readily biased by unevenness of sampling density and there have been many debates on how to remove sampling overprints. In addition, taxonomic richness in a given chronological interval can be also biased by variation in time interval duration because the piled up diversity becomes much greater as the interval gets longer. However, there is no simple solution for this problem because the rate of taxonomic turnover is not uniform through time; that's why we can define discrete chronostratigraphic units with various durations. In addition, actual data registered in the Paleobiology Database indicate less correlation between sampled-in-bin taxonomic richness and time interval duration.

In the present study, the following simple computer simulations were performed to understand biases on diversity estimates derived from variation in time interval duration of chronologic units. A total of one million hypothetical taxa originated and went extinct at each time step (= 0.1 Ma) during the Phanerozoic at a given rate. In the present simulations, most (80%) of the turnovers were set to be concentrated at the boundary between intervals. The following different conditions were adopted for the turnover rates and sampling probability per time step within the interval; 1) fixed independent of the interval duration or 2) inversely proportional to the interval duration. The sampled-in-bin richness was counted for each age in each simulation.

As a result of the above simulation, a positive correlation between piled up diversity and time interval duration was generated when sampling probability was fixed through time. This result seems a natural consequence because the number of sampling for each bin depends on the duration of the time interval and the sample-size effect was not removed in the present analysis. The correlation was particularly remarkable when the mean turnover rate was high and/or probability of sampling was low. However, such a correlation was found also in some cases even when the sampling probability per time step was inversely proportional to the interval duration. In the latter case, the correlation was significant when the sampling probability was moderate.

Keywords: paleobiodiversity, time interval duration

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Upper Oligocene to Lower Miocene radiolarian biostratigraphy in the Northwest Pacific

MOTOYAMA, Isao[1*] ; SAWADA, Taiki[2]

[1]Yamagata University, [2]Japan Petroleum Exploration Co.,Ltd.

Ocean Drilling Program Leg 145 Hole 884B core provides the most continuous Neogene sequence of pelagic sediments in the northwest Pacific. We examined radiolarians from the Upper Miocene to Lower Miocene sediment of the core to establish subdivided radiolarian biozones.

The Upper Oligocene sequence can be divided into three zones, *Actinomma* sp. A, *Hexacontium* sp. B and *Cyrtolagena laguncula* Zones, in ascending order. The Lower Miocene sequence can be divided into four zones, *Botryopyle* sp. B, *Pentactinosphaera hokurikuensis* *Stichocorys subligata* and *Dendrospyris sakaii* Zones, in ascending order. Each of *Botryopyle* sp. B Zone and *P. hokurikuensis* Zone has been subdivided into subzones a, b and c.

Some episodes of significant faunal changes of radiolarians are identified within the studied interval. They seem not to reflect global cooling events but to reflect some regional events.

Keywords: Radiolaria, biozone, Site 884, North Pacific