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

BPT24-01 Room:301B Time:May 24 09:00-09:15

Molecular mechanisms of shell coiling in gastropods

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Various shapes of gastropod shells have evolved ever since the Cambrian. Although theoretical analyses of morphogenesis exist, the molecular basis of shell development remained unclear. We compared expression patterns of the decapentaplegic (dpp) gene in the mantle tissues at various developmental stages between coiled and non-coiled shell gastropods. In the two non-coiled shell limpets, Patella vulgata and Nipponacmea fuscoviridis, the dpp showed symmetric expression pattern at the mantle edge. On the other hand, in the dextral snail Lymnaea stagnalis, dpp is expressed at the right-hand side of the mantle. Moreover, we analyzed the functions of dpp using the Dpp signal inhibitor dorsomorphin in order to understand developmental mechanisms and evolution of shell formation in gastropods. When the embryos were treated with Dpp signal inhibitor at the trochophore and veliger stage after the shell gland formation, juvenile shells grew to show a cone-like form rather than a normal coiled form. These results suggest that the dpp gene plays important roles in the shell coiling in gastropods.

Keywords: Shell coiling, Left-right asymmetry, Shell, Gastropod

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BPT24-02 Room:301B Time:May 24 09:15-09:30

Deposit-feeding strategy as an adaptation to substrate: comparison of Phymatoderma from shallow- and deep-sea deposits

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Phymatoderma is a branching burrow system consisting of tunnels filled with fecal pellets, and has been interpreted as a product of a surface deposit-feeding animal. Elemental analyses of Phymatoderma were conducted to reveal the feeding mode of its producer, using samples from the Lower Jurassic epicontinental shelf deposits in the Dotternhausen section, southern Germany and from the Upper Pliocene continental slope deposits in the Shioura section, central Japan. Elemental compositions of the pelletal infill of Phymatoderma and its overlying mudstone from the Dotternhausen section show no significant difference, suggesting that the tracemaker was a non-selective deposit feeder. In contrast, elemental compositions of the tuffaceous pellets of Phymatoderma from the Shioura section and its overlying volcanic ash show a difference: Ca is significantly concentrated in the pellets. Because microfossils such as foraminifera and coccoliths are occasionally found in the tuffaceous pellets, Ca accumulation in the pelletal infill indicates that the Phymatoderma-producer that lived in the Pliocene slope setting selectively ingested particles with higher biomass of such microorganisms (or ingested microorganisms themselves) when feeding the surface sediments. These two feeding modes of the producer were recognized in Phymatoderma of different bathymetrical settings, and each feeding mode seems to be an effective strategy to intake nutrients from the surface sediments, reflecting an adaptation of the tracemaker to the food-contents in the surrounding substrate. This study demonstrated for the first time that geochemical composition of fecal pellets of trace fossils can be a useful indicator of grain-selective/non-selective deposit-feeding strategies of ancient animals.

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BPT24-03 Room:301B Time:May 24 09:30-09:45

Organic carbon cycling in deep-sea benthic ecosystem during the Paleocene-Eocene Thermal Maximum

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The Paleocene-Eocene Thermal Maximum (PETM) has been held up as a past analog to future warm environments and presents the opportunity to study climate impacts on marine communities. Today the deep-sea benthic ecosystem contributes substantially to carbon cycling in seafloor sediments. During the PETM, amount of carbon would have input into ocean and biosphere. The carbon could be taken up by organisms with higher metabolic rate under warm condition. However, the role of metabolic rates in benthic organisms has never been elucidated. Metabolic rates reflect respiration, that exchanges carbon between organic matter and carbon dioxide, thus respiration reflects both carbon cycling as well as metabolic rates in an organism. Here we evaluate respiration of ostracodes from DSDP Site 401, outer Bay of Biscay, North Atlantic through the onset of the PETM. Ostracode respiration can be calculated using body size and temperature. We measured ostracode body size and analyzed benthic foraminifer Mg/Ca thermometer. Body sizes of three species decreased through the onset of the PETM, while temperature of the bottom water increased. Estimates of the body size and temperature suggest a decline in lifetime respiration in ostracode individuals during the PETM interval. The reduced respiration might be related to decreases in metabolic rates and oxidation of organic matters. Dwarfed ostracodes during the PETM core interval would uptake less organic matters than ostracodes in the pre-PETM interval, since ecological studies show that modern ostracode grazing rates depend on their body-sizes. Hence we consider major changes in the energy and carbon balance of the benthic food-chains and the reduction of organic carbon flux between the ostracodes and sediments during the PETM. The decline in ostracode carbon flux contrasts with previous interpretations that benthic foraminifers switched their taxonomic composition that recycled more organic matters.

Keywords: DSDP Site 401, Ostracoda, Body size, Metabolic rate, Paleocene-Eocene Thermal Maximum, Organic carbon cycling

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BPT24-04 Room:301B Time:May 24 09:45-10:00

Environmental changes spanning the end-Devonian extinction: Evidence from biomarkers

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Oceanic anoxia and marine extinction events occurred several times during the late Devonian marked by development of land vascular plant, which should have produced a lot of organic soils. One of the severe ocean anoxic and extinction events during the late Devonian occurred at the end of the Devonian (”Hangenberg Event” marked by ”Hangenberg Black Shale”). However, the cause and processes of this event are still remained unknown. We investigated the strata, which were probably deposited on the continental slope, containing the D/C boundary of the Pho Han Formation located in the Cat Ba Island, eastern Vietnam to show the palaeoenvironment spanning the end-Devonian extinction using organic geochemical analyses.

The values of total organic carbon contents (TOC), total sulfur contents, and dibenzothiophene show a drastic increase from the base of the black shale to the D/C boundary in this section, which suggests anoxic condition extending in the sea at that time. Dibenzofuran and coronene, which are organic molecules indicative of the inputs of organic soils made by land vascular plants, have more detecting points in the beds between the base of the black shale and the D/C boundary than the other beds. Values of cadalene, which is derived from terrestrial higher plant, in the top Devonian beds are ten times of those in the other beds, which also showing an increase in inputs of terrestrial organic soils in the area at that time. Hopanes, which are derived from bacteria, and steranes, which come from eukaryote, are detected continually in the top Devonian beds show distinct increases compared with those in the other beds, and the values of $C_{27}/(C_{27}+C_{29})$ sterane are more than 0.45 indicating the ratio of the organic matters from ocean primary production are more than that from terrestrial plants. These results indicate that bacteria and eukaryote kept on being active during the end of the Devonian, and thereby marine-derived organic matters are dominant compared with terrestrial-derived organic matters. It may have been resulted from the increases of the inputs of terrestrial nutrients. The increase in oceanic primary productivity may have caused consumption of seawater oxygen and reducing environment expanding in the sea resulting high TOC. Moreover, the values of 2-methyltetradecane and 3-methyltetradecane, which are derived from sulfate reducer, and aryl isoprenoids, which could come from green sulfur bacteria, show increases more continually in the top Devonian beds, implying that sulfate reducer kept on being active and reducing environment extended up to the photic zone in the sea at that time. Input of soils leading reducing environment in the sea may have caused the end-Devonian extinction.

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BPT24-05 Room:301B Time:May 24 10:00-10:15

Leaking Earth: An ultimate trigger of the Cambrian explosion

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The Phanerozoic time began from the Cambrian explosion. Most of the ancestral life forms, more than at least 20 Phyla, appeared in a short time from 540-520Ma. Metazoans up to 35 Phyla appeared by the end of the Cambrian at 488Ma. Since then, animals and plants began to diversify extensively in association with environmental and geochemical diversifications. This is initiated by the global supply of nutrients. An abrupt increase of nutrient supply was caused by the emergence of huge landmass, because the amount of water in the mantle wedge must have increased from 1.0wt% to 6.5 wt%, if subduction zone geotherm began to cut the boundary of the stability field between clinochlore peridotite and antigorite peridotite during the cooling. This means the initiation of return-flow of seawater into mantle during the Neoproterozoic, so called Leaking Earth.

We envisage the following processes for the dawn of the Phanerozoic. (1) initiation of return-flow of seawater into mantle was caused by hydration of mantle wedge, (2) leading to the drop of sea-level. (3) Subsequently, the coast line moved oceanward to increase the size of landmass, (4) with the resultant birth of huge river systems to transport large volumes of sediments (5) which buried organic matter synthesized by photosynthesis by algae and cyanobacteria. (6) The burial of organic matter resulted in accumulating oxygen in atmosphere as back reaction to consume free oxygen in atmosphere is prevented. (7) High pO2 began to be kept and finally diffused upwards to form the ozone layer. (8) Ozone layer shielded the ultraviolet radiation from Sun, thereby enabling plants and animals to invade the land. Firstly, cyanobacteria invaded in the swamp along the river to lake. It gradually evolved to algae, bryophytes and to Tracheophytes by late Devonian.

Initiation of return-flow of seawater into mantle began 4.0 b.y after the birth of planet with R (radius) = 6400km and only 3-5km thick ocean. It brought a golden era of life, accompanying global supply of nutrients continuously. The leaking Earth was the fate of cooling planet, Earth, covered by ocean. It is an ultimate trigger of the Cambrian explosion.

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BPT24-06 Room:301B Time:May 24 10:15-10:30

Neoproterozoic thrombolite and spherical structures from Brazil: Expected images of the oldest multicellular animal

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Intensive researches on the Neoproterozoic sediments in the last two decades have demonstrated drastic climate changes and unveiled traces of biological evolution. We studied the Neoproterozoic Salitre Formation (Una Group) in central Bahia (Brazil) for seeking novel signature of early life. This formation contains cap carbonate on the base, and overlies diamictites corresponding to Marinoan or Sturtian glaciation.

Lithofacies of the Salitre Formation are various from shallow-water stromatolite to deep-water slumped bedded carbonate. Organic-rich carbonate unit partly appears an enigmatic feature consisting of digitate structures of 5 mm in width. This has been called thrombolite. The digitate structures are concentrated in a lentic body of ˜5 m thick and ˜20 m wide. In the silicified degitates, aggregation of clots or peloids was observed. The thrombolites could be microbial, as stromatolites, but this interpretation is inconsistent with homogenous outer forms and lack of internal lamination. This might be a structure originated from a lithified animal body. According to the historical background of the animal evolution, a most likely candidate was a sponge. The clots and peloids found in the silicified part resembles in appearance of strictures formed in decayed body of sponge (Neuweiler et al., 2007).

The Salitre carbonate also contains spherical structures of ˜4 mm in diameter. The spheroids have organic membrane and calcite filling. They are too large for acritarchs that are abundant in the Neoproterozoic strata. They are unlikely giant microbes, such as Thiomargarita. An animal egg was a possible origin, but they are again too large as an egg of the modern sponges. Digitate and spherical structures may bring novel material considering evolution of multicellular animals if they were originated from sponges.

Neuweiler et al. (2007) Jour. Sediment. Res., 77, 552?563.
Sial et al. (2010) Development in Precambrian Geology, 16, 31-69.

Keywords: Neoproterozoic, animal evolution, carbonate, Brazil