Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

MIS01-05 会場:302 時間:5 月 21 日 14:45-15:00

生物の大進化と大絶滅のトリガーとプロセス
Triggers and process of macroevolution and mass extinctions

海保 邦夫 [1*], 大庭 雅寛 [1], 菊池 みのり [1], 千馬 直登 [1], 静谷 あてな [1], 谷津 進 [1], 伊藤 幸佑 [1], 古賀聖治 [2], 水上 拓也 [1]
KAIHO, Kunio[1*], OBA Masahiro[1], KIKUCHI Minori[1], SENBA Naoto[1], SHIZUYA Atena[1], YATSU Susumu[1], ITO Kosuke[1], KOGA Seizi[2], MIZUKAMI Takuya[1]

[1] 東北大学大学院理学研究科, [2] 産総研
[1]Tohoku University, [2]National Institute of Advanced Industrial Science and Technology

Two of the most significant events in Earth biotic evolution occurred in the Ediacaran and the early Cambrian periods. The first event is characterized by the appearance of primitive marine animals such as sponges and cnidarians in the Ediacaran, and the second step is the appearance of diverse marine animals in the early Cambrian. Here we show that a two-step rise of oxygen level in shallow seas coincided with the rise of animal life in the Ediacaran and Cambrian. We hypothesize that the two-step rise in dissolved oxygen is related to the two-step evolution of metazoans in the mid-Ediacaran and the Cambrian.

The Late Devonian mass extinction was characterized by stepwise extinctions of marine organisms during the spread of vascular land plants. Here we show that massive soil erosion occurred rapidly in the latest Frasnian, which marks the culmination of the stepwise Late Devonian mass extinction and sea level rise. The Late Devonian is an unique period marked by massive soil production in flood plains by vascular land plants and massive sediment yield in uninhabited hinterland by rapid physical weathering before development of seeds in the Famennian, resulting in the massive accumulation of soil and sediments on plains. Therefore, similar events have not occurred after the Devonian. We hypothesize that flooding due to global sea-level rise eroded the massive soil and sediments, providing abundant nutrients and a massive mud supply to marine ecosystems, which resulted highly selective decimation of shallow-water sedentary organisms.

The largest mass extinction of animals and plants in both the ocean and on land occurred at the end of the Permian, largely coinciding with the largest flood basalt volcanism event in Siberia. Our depth-transect data of organic and isotopic geochemistry show that euxinia frequently developed at 100-m water depth in the Changhsingian, followed by anoxia or disoxia developed in 200- to 40-m water depths during the extinction. This implies that accumulation of hydrogen sulphide in intermediate and deep waters following oxidation of hydrogen sulphide led to dissolved oxygen consumption, surface-water anoxia, and acidification, resulting in the end-Permian mass extinction in the seas. In the case of a coincident massive release of CH4 from the Siberian igneous province and H2S from the euxinic ocean to the atmosphere, our calculations indicate that massive release of CH4 and H2S to the atmosphere did not cause ozone collapse and that an approximately 10% decrease in atmospheric O2 levels would have occurred in the case of a large combined CH4 and H2S flux. The slight decrease in atmospheric O2 levels may also have contributed to the extinction event. Rather than an increase in UV radiation levels and a decrease in atmospheric O2 levels, the direct causes of the end-Permian mass extinction of terrestrial animals were likely significant global warming and an increase in CO2 levels probably induced by the Siberian volcanism.

Triggers of five mass extinctions are probably glaciation for the end-Ordovician, global sea-level rise eroding the massive soil and sediments for Late Devonian, massive volcanism for the end-Permian and end-Triassic, and a bolide impact for the Cretaceous-Palaeogene (K-P) boundary. The mass extinction at the K-P boundary is the only mass extinction caused by an extraterrestrial impact. On the K-P mass extinction, we show that (1) coincidence of tsunami and wildfire by the bolide impact, (2) massive soil erosion at the extinction level, and (3) recovery of woods 10 kyr after the mass extinction using sedimentary organic molecules.

キーワード: 大進化, 大量絶滅, 酸素濃度, 植物の陸上進出, 大火山活動, 小天体衝突
Keywords: macroevolution, mass extinction, oxygen concentration, spread of vascular land plants, massive volcanism, extraterrestrial impact