

## 全球凍結とカンブリア爆発 Snowball Earth and Cambrian explosion

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We propose a new model that can explain the cause of the Neoproterozoic snowball Earth and the consequent rapid evolution of life called the Cambrian explosion. Starburst in our and outer galaxies modulated by the Earth's core dynamo is the primary driver of large fluctuations of the Earth's surface environment including some unusual extreme conditions such as snowball Earth. When the Earth's dynamo turns weaker by about 50% than that of its present intensity, intense cosmic rays originated from starburst in galaxies can easily penetrate through the Earth's magnetosphere to cause extensive cloud formation and increased albedo, thus the Earth's surface will be covered by ice. The repeated glacial periods in the Neoproterozoic, i.e. Kaigas (770-735Ma), Sturtian (715-680Ma), Marinoan (660-635Ma) and Gaskier (585-582Ma), may have been related to the encounter of our solar system with the Galactic Arms, i.e., Scutum-Crux (Kaigas), Sgr-Carina (Sturtian and Marinoan), and Orion spur (Gaskier), respectively. Galactic arms are generally replete with extensive cosmic radiation by relatively frequent starburst.

In addition, penetration of cosmic rays is controlled also by the Earth's geomagnetism. The weaker the geomagnetism becomes, the more cosmic rays penetrate.

Genome sequences of modern animals suggest the timing of genome-level diversification of animals occurred by 1.2-0.9Ga which is definitely earlier than the so-called Cambrian explosion. Such a large time lag between the fossil record and genome clock has been interpreted as the delay of gene-preparation to make body-plans, in spite that all number of gene had been ready by 1.2-0.9 Ga. The delay of body-plan and explosive diversification can be speculated by the preparation of geochemical environments, (1) oxygen level and (2) chemical saturation of nutrients. It began at 635Ma after ending snowball and first metazoan has emerged to the surface at 582Ma in a lake enriched in nutrients such as Ca, P, Fe<sup>2+</sup>, HCO<sub>3</sub> and others, and became possible in the rifted granitic continent through hydrothermal alteration by then. Biomineralization, began first by the inorganic precipitation in the geochemically saturated small lakes, first around the outerwall of lives, thereafter internal such as vertebrates bone followed by the genome coded the process.

Starburst caused not only the genome-level diversification but also the snowball Earth. For the long-lasting fluctuation from snowball state and interglacial warming period from 770Ma (Kaigas) to 582Ma (Gaskier), gene has diversified by the cosmic radiation, and ready to be explosive evolution if geochemical conditions were ready. We predict 1.2-0.9Ga of the molecular clock for the timing of gene-preparation may be too old, and probably to be 0.77-0.635Ga.