

From galaxy to genome: A perspective on snowball Earth and Cambrian explosion

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A new model of snowball Earth and inevitable subsequent Cambrian explosion is proposed herein. Core dynamo and starburst are of primary importance to cause the unusual surface environment on the Earth. If the Earth's dynamo turns weaker by about 50% than that of its present intensity, then the surface of the Earth is covered by ice, if cosmic radiation were extensive by starburst. This is because abundant cosmic rays radiation would cause cloud formation which would shut down the sun energy by the increased albedo on the Earth's surface. The repeated glacial periods from Kaigas (770-735Ma), through Sturtian (715-680Ma) and Marinoan (660-635Ma) to Gaskier (585-582Ma), may correspond to cross the Galactic Arms, Scutum-Crux (Kaigas), Sgr-Carina (Sturtian and Marinoan), and Orion spur (Gaskier) in which more extensive cosmic radiation prevailed.

The cause of weak dynamo convection in the outer core may be attributed to the birth of a second magnetic field driven by the thermal anomaly on the Core-Mantle Boundary (CMB) which is formed by the cold down-flows on the sub-equatorial CMB. Those cold down-flows during the late Proterozoic correspond to the 1.0Ga slab-graveyards that can be observed in the southern Pacific CMB now.

Genome-biology predicted the timing of genome-level diversification occurred by 1.2-0.9Ga which is definitely earlier than the Cambrian explosion. This big time gap has been interpreted by 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^{2+} , HCO^3 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. We summarized the parameters that the Earth has evolved to become habitable. We have classified life into 5 different-types, according to the geologic time and number of parameters. The Archean-type may be wide-spread in our Galaxy, but extremely rare in the case of type V with human being, and even type IV including vertebrates.