

Secular change of surface environment in the Neoproterozoic and the biological diversity

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Recently, some environmental issues including global warming occupy an increasing interest of the general public as well as Earth scientists. Especially, many opinions of some environmental issues based on the scientific observations successfully appeal to public opinion, and let them pay attention to environmental problems. However, none of them exactly depend on the environments or the Earth. Therefore, it is also important to understand the secular change of surface environment and its influences on biological evolution and environment itself.

This work presents summary of surface environmental change through geologic time, especially secular change of temperature and composition of seawater and its influence on biological evolution. On the other hand, it was caused not only by drastic change of activity of solid earth and extraterrestrials but also by biological activity. For example, the first environmental destruction by biological activity is oxygenation of atmosphere and seawater by oxygenic photosynthetic organisms. The oxygenation, unique to the earth, eventually contributed to emergence of human being. Namely, the co-evolution of life and earth is an essence of the evolving earth.

Therefore, firstly it is necessary to understand secular change of the solid earth and solar system. We estimated secular change of composition and temperature of the mantle and continental growth through geologic time along with geomagnetic intensity from literatures. The results clearly indicate surface environmental changes strongly depend on them. For examples, it is considered that decrease of CO₂ content of terrestrial atmosphere concomitant with increasing luminosity of our sun keeps the surface temperature of the earth comfortable, but the hypothesis is not necessarily obvious. A continental growth curve since the birth of the earth is apparently similar to the curve of increase of the luminosity: solid earth also played important role on the stability of surface environment. Similarly, the surface of the earth was covered with ice in the Late Archean, the Snowball Earth (ca. 7.5 and 6.3 Ga). Previous works suggested decrease of greenhouse gases of CO₂ and CH₄ caused the Snowball Earth, but the mechanism of the deficiency in greenhouse gases is ambiguous. However, a continental growth curve gives a simple exsolution for the extreme environmental crises. Ultimate responsibility lies with the solid earth.

It is well known that good correlation is present between compositions of life and seawater. However, apparent difference between them exists in detail, and originates from the compositional difference between modern and ancient oceans, and composition of life depends on composition of the ancient ocean because the difference can be explained by variation in their solubility in seawater with different oxygen and CO₂ contents (Komiya et al. 2008). Namely, life must always change the system, dependent on the environmental change. For example, the increase of oxygen content killed many anaerobic organisms but promoted emergence of new respiration mechanism, utilizing oxygen, so that more active organisms were born. In addition, the oxygenation of seawater resulted in deficiency of many nutrients and essential elements except for Mo and sulfate, and improved internal storage system of them; namely biomineralization including a bone. Later, sudden decrease of oxygen content possibly due to the Snowball Earth resulted in the improvement of circulatory system, and appearance of blood for efficient usage of oxygen.

In summary, the co-evolution of life and earth is an essence of the evolving earth. It is the most important to understand life and earth as well as solar system. Recent observation of increase of solar intensity and decrease of solar magnetism possibly explains the recent global warming, and supports understanding solid earth and solar system results even in understanding environment.