After the Snowball Earth: a new approach to the Vendian-Cambrian boundary study

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The debate over the Neoproterozoic snowball Earth event has been the hotest issue in Earth Science community lately. The low-latitude glacial deposits observed in field, detailed chemostratigraphical data, and relevant modeling suggest that average surface temperature of the earth may have changed for nearly 100 degree in a short time, and that the snowball Earth event with ice invasion to equatorial regions may have repeated twice or maybe three times in the Neoproterozoic (Kirschvink, 1992; Hoffman et al., 1998; Hoffman & Schrag, 2002). The atmospheric CO2 budget have been definitely involved, however, the ultimate cause of such an unusual geologic event has not been fully clarified yet. The terminal Neoproterozoic is also known as the moment when one of the major steps in evolution occurred in the Earth's life. Details of post-snowball sequence of events, including the Ediacaran predominance/extinction and Cambrian radiation, were analyzed by precise dating and isotope geochemistry. Concerning the origin of hard-tissued animals and various body plans, fitting appears possible between the results from molecular clock analysis and direct lines of fossil evidence. From the viewpoint of cause-effect link among these events, particularly interesting is the notion on seawater absorption into mantle (Maruyama et al., 2002). Ever since its birth, the planet Earth experienced a unidirectional cooling history, and after the degree of cooling reached a threshold, hydrous minerals started to subduct with plates into mantle. Loss of water from the Earth's surface may have brought a dramatic change in ocean chemistry, in atmosphere-ocean circulation system, and in biodiversity.

Conventional studies on the Upper Neoproterozoic including the Vendian-Cambrian boundary event were carried out solely on continental shelf sequences worldwide, simply because the mid-oceanic sediments then were all consumed by plate subduction and totally disappeared from the Earth's surface. It is not fair to discuss the global environmental issue without having any piece of information from oceanic domain that have occupied nearly 70 % of the Earth's surface then as today. Here we propose a new viewpoint and strategy for the V-C boundary research, on the basis of the knowledge on the Phanerozoic accretionary complexes (accumulated and summarized by Japanese geoscientists). For an example, we show the latest research results on the Cambrian accretionary complex in southern Russia with the Vendian mid-oceanic shallow marine limestone primarily formed on top of ancient oceanic plateau (or seamount). Direct dating using Pb-Pb isochron method gave 598 +- 25 Ma age as the first age framework for the extremely fossil-poor Vendian limestone. Shallow marine limestone with numerous ooids and stromatolite yielded rare but various microfossils with hard skeletons made of phosphate and silica. These probably represent the world oldest hard-shell bearing community. Background seawater geochemistry then is also checked by secular changes in Sr and C isotope ratio in continuous sections. Such an approach opens a new window not merely for reconstructing ancient global environment but also for further researches on older Precambrian events.