Late Archean diversity of organisms: evidence from carbon isotopes and a reconstruction of sedimentary environment

Ryusuke Sakurai[1]; Yoichi Tamaki[2]; Yuichiro Ueno[3]; Kouki Kitajima[4]; Shigenori Maruyama[5]

[1] Earth and Planetary Sci., Tokyo Int. of Tech; [2] Earth and Planetary Sci.,T.I.T.; [3] Earth Science and Astronomy, Univ. Tokyo; [4] Earth and Planetary Sci., T.I.T.; [5] Earth and Planetary Sci., Tokyo Institute of Technology

The Geological record of surface environment of the 2.8 Ga Earth is important to discuss the evolution of early life. Start time of oxygenic photosynthesis is interpreted to be about 2.8 Ga from the birth of large-scale appearance of stromatolites (Buick, 1992; Holland, 1994). The deposition of Banded Iron Formation which continued from 2.8 Ga to 2.5 Ga indicates that oxygen produced by photosynthetic organisms increased in the ocean (Cloud, 1973). The Tumbiana Formation is a sequence of sedimentary rocks that deposited on the continental shelf in c.a. 2.8 Ga. The metamorphic grade of the Tumbiana Formation is very low grade and subsequent folding and faulting are almost absent. Therefore the Tumbiana Formation is the best place to study the latest Archaean biosphere and. The reconstruction of depositional environment of the Tumbiana Formation is a purpose of study. Some previous workers insisted that the depositional environment was lake, whereas the others interpreted in marine. This problem is still controversial. We studied lithofacies and sequence stratigraphy of the Tumbiana Formation in the Redmont area, based upon three-dimensional analyses of onshore outcrops, by field mapping with 1/5000 scale. The 18 column sections in detail have been completed. As the result, the Tumbiana Formation in Redmont area is divided into 3 facies assemblage. There are the lower facies assemblage deposited in the fluvial fan, the middle deposited in lower shoreface to foreshore environment, and the upper deposited in tidal flat, respectively. The Tumbiana Formation in Redmont area is interpreted to have deposited in marine environment rather than lacustrine environment from continuities of stratum and sedimentary structures that exhibit the presence of tidal current.

The carbon isotope composition of carbonaceous matter is a critical guide to the biochemical evolution through geologic time. Systematic carbon isotopic analyses of carbonaceous matters during the time span, 2.8 to 2.6Ga, were completed. The d13C values of carbonaceous matters range in the wide spectram from -10.25 to -51.85permil, but it changed systematically. The d13C values of about -24permil suddenly dropped down to -51permil at c.a. 2715 Ma, and gradually recovered up to -33permil spreading the time span c.a. 30 million years, although d13C values depends significantly upon lithology of host rocks. d13C values lighter than -40permil is negative anomaly.

It is interpreted that this change was caused by the explosive increase of methanotrophic bacteria, which was an inevitable result by the rapid rise of partial pressure of O2 in shallow marine environment. This coincide with the widespread appearance of stromatolites over the world at 2.8 to 2.7 Ga.