Paleoproterozoic redox condition and microbial activity that recorded in Gunflint Formation, Ontario, Canada.

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The age of ca. 2.0 Ga has been considered by previous investigators as an important age for rise of atmospheric oxygen. The problem of the atmospheric rise of oxygen is directly connected to the evolution of the surface environments of the Earth and life. Anaerobic microbes have flourished on the Earth before the oxygen rise. This type of microbes would have isolated in deeper parts of anoxic sea or sediments after the oxidation of surface oecan water. In other words, contrasted ecosystem existed in the same sedimentary basin during the oxidation of surface environments. This indicates the possibility that the shallower sediments may have recorded the new life forms adapted to oxygen, and the deeper sediments may have recorded the old type of life. This further indicates an evolutionary pathway can be reconstructed by reading the microbial activities recorded in a successful geological section of 2.0 Ga.

Geological survey was conducted at the Gunflint formation, in Ontario, Canada, probably representing sub-tidal to hemipelagic environments. Some parts of Gunflint formation samples contain oolite, and mainly consisted of carbonate, chert, and black shale.

Total organic carbon and sulfur contents of all collected samples were determined by elemental analyzer. S(pyr)/C(org) ratios of the Gunflint formation are similar to modern marine sediments. Kerogen were extracted from the representative samples, and their compositions were determined with the carbon isotope compositions. Mineralogical studies were performed by using EPMA and the standard petrographic microscope.

Different morphology of pyrite was found in the Gunflint samples. A framboidal-like pyrite, one of the minor morphology, included a minor element, but majority of pyrite did not contain As. Such contrast suggesting the diagenetic and syngenetic origin of pyrite. The local occurrence of phosphate minerals is also found in the Gunflint carbonate samples. High productivity of microbes followed by high-rates of sedimentation may have increase the phosphorous in sediments.

All of the above phenomena are explained by the extremely high biological productivities at the redox boundary in shallow Gunflint sea. Lipid-biomarker was extracted from some typical rocks and analyzed using GC-MS. As a result, biomarker of cyanobacteria (2-alpha methyl hopane), was found. This suggests that the primary producers at (or above) the redox boundary was cyanobacteria.

The results of kerogen analyses indicates that difference of amount of N in kerogen, probably connected to the problem of the redox condition of contemporary oceans.

Stable carbon isotope compositions ($d^{13}C$) of kerogen were ranging from -33.6 permil. to -31.4 permil. (PDB). $d^{13}C$ vs. H/C ratio diagram suggests that kerogen suffered from the composite diagenetic effect. Simulating the several models using the Rayleigh distillation equation, the following possibilities are suggested : (1) initial kerogen(when H/C ratio was ˜1.5) have had already variety of $d^{13}C$ values and had same diagenetic process, or (2) that initial kerogen have had same $d^{13}C$ and had different diagenetic process (for example petroleumgenetic or metanogenetic). For further discussion, it is necessary to accumulate more date of kerogens' compositions, $d^{13}C$ and examine their generality.