Export flux and carbon budget in the iron fertilization experiments in the subarctic North Pacific

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Biological productivity of HNLC (High Nutrient, Low Chlorophyl) areas are potentially controlled by the micro nutrient such as iron. Meso scale iron fertilization experiments have been carried out in the two types of HNLC area, such as antarctic ocean and eastern equatorial Pacific. The subarctic Pacific is another type of HNLC ocean. Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study (SEEDS) in July 2001 was carried out in the western subarctic North Pacific as Japanese program. Under Canada-Japan collaboration, SERIES (Subarctic Ecosystem Response to Iron Enrichment Study) was carried out in the eastern subarctic North Pacific in July 2002. Iron concentrations of the surface mixed layer were elevated to 2-4 nM in approximately 10 km square of area. Change of carbon export is important to consider its effectiveness in geoengineering carbon fixation.

In SEEDS, phytoplankton growth was apparently observed on 5 days after fertilization and minimum pCO_2 of 226 µatm and maximum chl.-a of 20.5 $\mu g\ l^{-1}$ were observed on 10 days after fertilization. In SERIES, increase of chlorophyl was slower and mimum pCO_2 was 276 µatm on 15 days after fertilization, when maximum chl.-a concentration was observed as 7.2 $\mu g\ l^{-1}$. Export flux was measured at four depths using drifting sediment traps (Knauer type). Organic carbon, silica and metallic elements in the trapped material were analyzed. The depths of the traps were from 20 to 100 m from the sea surface in SEEDS and from 50 to 125 m in SERIES. The majority of trapped material was fecal pellet of zooplankton with green color in SEEDS, but phytoplankton aggregate with brownish color in SERIES. Observed growth of phytoplankton in SEEDS was diatom, however, diatom bloom was preceded by non-diatom growth in SERIES. In SEEDS, the export measurement was done for 2 weeks after fertilization, however, no apparent increase compared with iron patch outside was observed within the period. In SERIES, diatom aggregate and apparent increase of export was observed after 3 weeks of fertilization. Even there observed an increase of export, remineralization of organic carbon in the sub-surface depth prevailed.

The evolution of metabolisms in hydrothermal vents

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Hydrothermal vents are relics of ancient gelogical activity of earth, On the other hand, hyperthermophilic *Archaea* and *Bacteria* that live in hydrothermal vent area are suggested to be the closest relatives of last common ancestor of life. Furthermore, the possibility of amino acids or short peptide synthesis in hydrothermal ecosystem was shown in in vitro analysis. On the basis of these findings, ancient hydrothermal vents are proposed as the place of the origin of life on earth.

We discuss the system of the early evolution of life by comparing the present microbial communiy in hydrothermal vents, geochemical study of archaean ocean and phylogenetic analyses of the genes for respiratory chain. The energy souce of present primary producer in hydrothermal vents are depend on flux from earth like archaean organisms. In hydrothermal vent, huge amount of H_2, CO_2, reductive sulfur compounds and many minerals that depend on volcanogenic activity are supplied as the ancient earth. In these environment, H_2 is the candidates of electron donor and CO_2 and S^0, SO_4 and Fe or other minerals are that of electron acceptors. However, reduction of Fe and sulfate are not strong candidate for the first respiration of life because Fe is soonly reduced inorganicaly under highly reductive environment and recent geochemical report showed that the sulfate levels in archaean ocean was very low (Habicht et al.). In addition, lateral gene transfer events of the key enzyme of sulfate reduction was determined in early diversification of sulfate reducers (Stahl et al.). On the other hand, our culture dependent and independent analysis of hydrothermal vents paticulaly highly reductive environment indicate that the primary producer was CO_2 reducing methanogen or sulfur dependent hydrogen oxidizer and there is no criticaly negative evidence that those respirations are not the candidate of first respiration system. We further discuss the relationship between the evolution of metabolism and respiration, and early divercification of microorganisms.

References

Habicht K.S., Gade M., Thamdrup B., Gerg P. and Canfield D.E. Science 298. 2372-2374.
Stahl D.A., Fishbain S., Klein M., Baker B.J. and Wagner M. Antonie van Leeuwenhoek 81. 189-195.