Multi-isotopic chemostratigraphies of drill core samples in the Ediacaran

TSUYOSHI KOMIYA[1,2]*, YUSUKE SAWAKI[1], MIYUKI TAHATA[1] AND TAKASHI SHIMURA[1]

[1]Department of Earth & Planetary Sciences, Tokyo Inst Tech, Japan (*correspondence: tkomiya@geo.titech.ac.jp)
[2]Scholl of Earth & Space exploration, ASU, USA

The Ediacaran is the most dramatic period when the oldest animals appeared, and decoding surface environmental change is one of the key issues. We carried out drilling in Three Gorges area, south China to collect complete section from the Marinoan Snowball Earth to early Cambrian. We made chemostratigraphies of $\delta^{13}C$, $^{87}Sr/^{86}Sr$, $\delta^{18}O$, $\delta^{88/86}Sr$ and $\delta^{44/42}Ca$, and Fe, Mn, REE and P contents of carbonates and $\delta^{13}C$ of organic carbon mainly of the drill cores to estimate primary productivity (PP), oxidation of DOC, continental weathering influx (CW), temperature, nutrient contents, and redox condition of seawater (SW). Its comparison with fragmented records of other sections in the world indicates it shows primary and global change of SW chemistry.

In the Ediacaran, are at least six negative and positive $\delta^{13}C$ excursions: N1-N6 and P1-P6, respectively. Especially, the large negative values correspond to cap carbonate (N1), 580 Ma Gaskiers glaciation (N4), and the Shuram excursion (N6), respectively. Large $\delta^{88/86}Sr$ and $\delta^{44}/^{42}Ca$ anomalies, and high $^{87}Sr/^{86}Sr$ values and high P contents around N1 indicate high Ca, Sr and P contents of SW supplied by CW. At N4, line of evidence of regression, positive $\delta^{18}O$ and negative $\delta^{13}C$ excursions indicates global cooling and consequent decomposition of buried OC. $\delta^{18}O$ and $\delta^{13}C$ excursions precede positive $^{87}Sr/^{86}Sr$ excursion, indicating global cooling raised CW. The termination of the global cooling, defined by the maximum $\delta^{18}O$ value, is coincident with the beginning of $\delta^{13}C$, $^{87}Sr/^{86}Sr$, Fe and Mn content changes, namely recovery of PP, transgression, and oxidation of SW, respectively. At the early stage of N6, increase of $^{87}Sr/^{86}Sr$ precedes and Fe and Mn contents and the large negative Shuram $\delta^{13}C$ excursion, indicating that high CW possibly due to building of Transgondwanan Supermountains caused enhancement of sulfate reduction and remineralization of DOC due to high sulfate influx and deoxidation of SW, inconsistent with the idea that oxidation of surface environment caused the Shuram excursion. At the late stage, decrease in Fe and Mn contents and large Ce anomaly suggest oxidation of shallow seawater.

Our data indicate simultaneity of emergence of Metazoan and Ediacara Fauna and the $^{87}Sr/^{86}Sr$ positive anomaly, and suggest that enrichment of nutrients in seawater due to enhanced CW possibly caused sudden biological evolution instead of increase of oxygen content of seawater.

Oceanic Nickel depletion and a methanogen famine before the Great Oxidation Event

K.O. KONHAUSER[1], E. PECOITS[1], S.V. LALONDE[1], D. PAPINEAU[2], E.G. NISBET[3], M.E. BARLEY[4], N.T. ARNDT[5], K. ZAHNLE[6] AND B.S. KAMBER[7]

[1]Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton, Canada, T6G 2E3 (kurtk@ualberta.ca)
[2]Carnegie Institution of Washington, Washington DC, USA
[3]Royal Holloway University of London, UK
[4]University of Western Australia, Crawley, Australia
[5]Université Joseph Fourier, Grenoble, France
[6]NASA Ames Research Center, Moffett Field, USA
[7]Laurentian University, Sudbury, Canada

Banded iron formations (BIF) preserve a history of Precambrian oceanic elemental abundance that can be exploited to address nutrient limitations on early biological productivity. Here we show that secular trends in BIF Ni/Fe record a reduced flux of Ni to the oceans ca. 2.7 billion years ago, which we attribute to decreased eruption of Ni-rich ultramafic rocks. We determined that dissolved Ni concentrations may have reached ~400 nM throughout much of the Archean, but dropped below ~200 nM by 2.5 Ga and to modern day values (~9 nM) by ~550 Ma. As Ni is a key metal cofactor in several enzymes of methanogens, its decline would have stifled their activity in the ancient oceans and disrupted the supply of biogenic methane. The photochemical reduction of O_2 by methane would have limited the accumulation of atmospheric O_2 whilst the source of biogenic methane was abundant, suggesting that a collapse of methane precluded the Great Oxidation Event some 2.4 billion years ago. Hence, the enzymatic reliance of methanogens on a diminishing supply of volcanic Ni links mantle evolution to the redox state of the atmosphere and biosphere.