Origin of negative carbon isotope anomaly in a 2.7 Ga shallow water deposits

*Beomsik Kim, Yuichiro Ueno, Alexis Gilbert

1. Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Meguro, Tokyo, 152-8551, Japan (Dept. EPS, Tokyo Tech.), 2. Earth-Life Science Institute (WPI-ELSI), Tokyo Institute of Technology, Meguro, Tokyo, 152- 8550, Japan (ELSI, Tokyo Tech.), 3. Department of Subsurface Geobiological Analysis and Research (D-SUGAR), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Natsushima-cho, Yokosuka 237-0061, Japan

Sedimentary organic carbon in some Late Archean rocks are anomalously depleted in $^{13}$C ($\delta^{13}$C$_{org} = -45$ to -60‰). The origin of the isotope anomaly is still unknown and is possibly resulted from biological uptake of methane (methanotrophy) or deposition of hydrocarbon haze. To test the hypotheses, small-scale isotopic analyses of both inorganic and organic carbon were conducted for various lithologies of 2.7 Ga sedimentary rocks in Fortescue Group, Western Australia. For this purpose, a new analytical method was developed for measuring small samples. As a result, low $\delta^{13}$C organic matter occurs not only in stromatolite as previously pointed out, but also in black laminated mud. Also, the $\delta^{13}$C$_{org}$ seems not correlated with $\delta^{13}$C$_{carb}$ value as opposed to the case expected when methanotrophs are active because methanotrophs typically produce not only very $^{13}$C-depleted organic matter but also CO$_2$. These results do not support the methanotrophy scenario. Furthermore, a relationship between $\delta^{13}$C$_{org}$ value and TOC contents is consistent with a mixing of two organic end-members with different isotopic ratios. The observed $\delta^{13}$C$_{org}$-TOC trend appears to occur in each lithology of the sedimentary rocks, suggesting that the source of the low $\delta^{13}$C$_{org}$ distributed uniformly irrespective to the depositional environment. This may suggest that the anomalously $^{13}$C-depleted organics could have been deposited from atmosphere at about 2.7 Ga.

Keywords: Archean, Carbon isotopes, Stromatolite, Methanotrophs, Organic haze