Stable isotope signature of Fe to understand the Fe-biocycle in the hydrothermal-vent

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Recent progresses in isotope analysis based on the mass spectrometry technique enabled us to detect small changes of the many elements in the periodic table. Among the elements, stable isotope studies using Fe has been widely adopted to understand both the mechanism of Fe metabolism in marine organisms and the bio-cycling of Fe in marine environment. Iron is typical essential inorganic nutrients for all plants and animals. For the land organisms, the Fe isotope ratios varies significantly with increase of the trophic level (Walczyk and Blanckenburg, 2002, 2005). In strike contrast, for marine organisms, because of very limited availability of Fe in seawater, the intake efficiency for Fe could be higher than those for the terrestrial animals. Higher intake efficiency of Fe can results in smaller magnitude of isotopic fractionation through dietary process, and therefore, the difference in the Fe isotope ratios for marine organisms of lower trophic levels were close to the seawater sample (Jong et al., 2007; Bergquist and Boyle, 2006). Moreover, there were no significant difference in the Fe isotope ratios (<0.5‰) for high trophic level marine organisms between muscle and liver (Yamagata, in prep). These studies revealed that magnitude of the isotope effects on Fe can reflect both the nutritional status of Fe in animals and the availability of Fe in marine environments. To investigate this, we have measured the $^{56}Fe/^{54}Fe$ and $^{57}Fe/^{54}Fe$ for deep-sea organisms in hydrothermal field for understanding Fe bio-cycle which has both characteristics of environment, terrestrial and marine.
In this study, *Chrysomallon squamiferum* called “Scaly-foot“ gastropod (n=5) and *Gigantopelta aegis* (n=5) from a deep-sea hydrothermal field at the Longqi vent field, Southwest Indian Ridge, were subsidized to the Fe isotope ratio analysis. The *Chrysomallon squamiferum* has unique scale made of iron sulphide on its foot (Suzuki et al., 2006). The *Gigantopelta aegis*, collected in the identical locations for the *Chrysomallon squamiferum*, has a thick iron oxide coating on the shell. Both the *Chrysomallon squamiferum* and *Gigantopelta aegis* has sulphur-oxidizing bacteria in oesophageal gland to form a symbiotic relation. Sclerite samples and soft body samples of muscle, ctnidium, blood, heart, and oesophageal gland were decomposed, and the Fe was extracted by anion-exchange chromatography. The Fe isotopic ratios were analyzed by a multiple collector-ICP-mass spectrometer (MC-ICP-MS) technique (Nu Plasma II) equipped with a desolvating sample introduction system and pseudo high resolution mode.
The resulting Fe isotope ratios demonstrated the distinct variations in the $^{56}Fe/^{54}Fe$ and $^{57}Fe/^{54}Fe$ ratios for Chrysomallon squamiferum and Gigantopelta aegis samples. The resulting $\delta^{56}Fe$ values for all soft body samples collected from the *Chrysomallon squamiferum* were systematically higher than those for the *Gigantopelta aegis*, whereas no significant difference in the $\delta^{56}Fe$ values could be found for oesophageal gland samples collected from *Chrysomallon squamiferum* and *Gigantopelta aegis* samples. It should be noted that the $\delta^{56}Fe$ for all the soft body samples from the *Chrysomallon squamiferum* was rather higher than those for symbiotic bacteria. This can reflect both very high intake efficiency of Fe from marine environments and the small contribution of Fe intake through the symbiotic bacterial for the *Chrysomallon squamiferum*. The Fe isotope signature obtained here demonstrate the clear difference in the Fe metabolism between *Chrysomallon squamiferum* and sulphur-oxidizing bacteria. The details of the mechanism why separate the $\delta^{56}Fe$ values of these two samples will be discussed in this presentation.

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