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Recent progresses in the ICP-mass spectrometry as rapid, accurate and flexible analytical tool for isotopes geosciences

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Rapid and unremitting developments in inorganic mass spectrometry, including a multiple collector-ICP-mass spectrometry (MC-ICPMS), have revolutionized the precision of the isotopic ratio measurements, and the applications of the inorganic mass spectrometry in geochemistry, metrology and biochemistry were beginning to appear over the horizon. Analytical community is actively solving problems, such as spectral interference, mass discrimination drift, high-yield chemical separation and purification processes, or reduction of the contamination of analytes. The variations in isotopic ratios of the heavy elements can provide new insights into past and present geochemical and biochemical processes.

Stable isotope tracers are now increasingly being used in studies of elemental metabolism, bioavailability or toxicity of nutrients, as well as evaluating the elemental turnover time. Besides an absence of harmful radiation, this approach has the further advantage of enabling multi-element studies, in which different isotopes can be added to the same meal. The metabolism of higher organisms can be transcribed as stable supply of the most essential elements through transfer, absorption, and storing processes, which form the basis of homeostasis function. Because of the homeostasis control, fluctuations or changes in the concentration of the essential nutrients would be highly restricted to maintain the biochemical functions. This suggests that the impairments in the metabolism or nutritional status of both the essential and toxic metal elements could not be evaluated only by the concentration of the elements in fluids. Variations in the isotopic composition of the elements induced through dietary or metabolism processes have potential to become novel biochemical markers for assessing impairments in metal metabolism or nutritional status of the elements.

Iron is one of the most important inorganic nutrients for all terrestrial plants and animals, and the natural variations in isotope ratio of Fe have been used to trace the food chain. For land organisms, it is widely recognized that the Fe isotope ratios (^{56}Fe/^{54}Fe and ^{57}Fe/^{54}Fe) changes by 0.1% with increase the trophic level (Walczyk and Blankenburg, 2002, 2005). In contrast, the Fe isotope data for marine organism of lower trophic levels (plankton, shrimp and tuna) did not vary significantly from the Fe isotope ratio for the seawater. The small variations in the Fe isotope ratios for marine organisms could be explained either by higher intake efficiency of Fe from the dietary foods, or by the smaller isotope fractionation due to intake of hemo-Fe (Fe(II)). However, it should be noted that the reported Fe isotope ratios for marine organisms were very limited, and therefore, possible link between the ^{56}Fe/^{54}Fe and ^{57}Fe/^{54}Fe ratios and the trophic level was not clearly demonstrated. To investigate this, we have measured the ^{56}Fe/^{54}Fe and ^{57}Fe/^{54}Fe for series of marine creatures of various trophic levels using multiple collector-ICP-mass spectrometer (MC-ICPMS). The measured ^{56}Fe/^{54}Fe isotopes for marine organisms of higher trophic levels became significantly lower than those for lower trophic levels animals. Several important features of the Fe isotopes for marine creatures could be derived from the present results. The obvious changes in the Fe isotope ratios could be due to different Fe biocycling for higher trophic level animals. Another important feature obtained from the Fe isotopes was that the definition of the trophic level, based on the ^{13}C/^{12}C and ^{15}N/^{14}N isotope, would not reflect the food chain for inorganic nutrients including Fe. The details of the mechanism in the variation of the ^{56}Fe/^{54}Fe ratios for both the marine and land organisms will be discussed in this presentation.

Keywords: stable isotope, isotope signature, MC-ICP mass spectrometry, Fe biocycle, trophic level