Covariation of nitrogen and iron isotopic ratios in a banded iron formation

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Nitrogen and iron isotopes are powerful tools recently being developped to decipher the paleoenvironments. However, there are not many studies which combine these indicators to see the difference or similarity in their sensitivities to various environmental parameters. We introduce our recent work which compares variations in $^{15}N/^{14}N$, $^{56}Fe/^{54}Fe$ and $^{40}Ar/^{36}Ar$ among different layers from a 2.7 - 2.9 Ga banded iron formation (BIF) sample.

Wide variations in the N isotopic ratio ($\delta^{15}N = (R/R_{air}-1)x1000$; $R = {}^{15}N/{}^{14}N$) are observed among sedimentary rocks, ranging from <0 ‰ in some ~3.5 Ga cherts, to +10 to +30 ‰ among the BIFs. One of the possible reasons for these variations is the differences upon time in the N cycling pathways between the atmosphere and the biosphere. One of the goals of this study is to address the particularly high $\delta^{15}N$ values recorded among the late Archean samples, to seek for an environmental condition that shifted the values.

A BIF sample from Dharwar Craton, India, with a greenschist metamorphic degree, was studied. The alternating Fe- and Si-rich layers were detached. From each layer, fractions enriched in quartz or iron oxide minerals were prepared by gravity separation. The isotopic compositions in mineral separates from respective layers were measured. N was 1-20 times concentrated in the quartz enriched fraction. The mean $\delta^{15}N$ and $\delta^{56}Fe$ values, among the 7 layers which we obtained both values, ranged between 5 to 14 ‰, and 0.9 to 2.1 ‰, respectively. Covariation of $\delta^{15}N$ and $\delta^{56}Fe$ values was observed among layers, which was associated by variations in the radiogenic ^{40}Ar concentrations. The Fe-rich layers tend to show lower isotopic ratios and ^{40}Ar concentrations. We propose a working model which involves a fluctuation between a reducing and oxidizing environment for the location where the BIF precipitation took place. The fluctuation can be explained by material supplies from two endmembers in varying proportions, a reducing one enriched in iron, e.g., from a mantle-related source, and another one enriched in K, e.g., from a continental source.

Fe isotope composition of seston from Canadian lakes: implications for Fe chemistry and bioavailability

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Recent advances in mass spectrometry, specifically high resolution MC-ICP-MS, allow measurement of all Fe isotopes free of interferences. We have developed a method for high precision analysis of Fe isotopes in seston samples using a Neptune high resolution MC-ICP-MS. The method involves field collection of seston samples using filters, total digestion of seston samples, separation of Fe from matrices using a simple ion exchange chromatography, and measurement of Fe isotopes using Neptune MC-ICP-MS with a pseudo-high resolution approach. Using the method, we have analyzed seston samples collected from several Canadian lakes, such as Lake 227 in the Experimental Lake Area. We will present some preliminary results, and discuss the implications of Fe isotope data for Fe chemistry, bioavailability and impact on phytoplankton growth.