Archean fluid-rock interaction: Oxygen and hydrogen isotope ratio from Iron Ore Group, India

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The Archean Iron Ore Group (IOG) in eastern India, is a well-preserved ~3.4 Gyr [1] greenstone belt in a NNE plunging asymmetric synclinorium characterized by low grade submarine basaltic-andesitic lava, shale and banded iron formation, with two major granite intrusions at eastern and western side. The oxygen and hydrogen isotope ratios of these lava and shale samples constrain the nature of Archean fluid-rock interaction and the stable isotopic composition of the Archean hydrosphere.

Oxygen isotope analysis of 23 greenstone lava ($0 \le \delta^{18}O \le 10$ ‰, mean 6.8 ‰) and 11 shale samples ($10.8 \le \delta^{18}O \le 18.2$ ‰, mean 14.3 ‰) exhibits similar range of $\delta^{18}O$ values as their Phanerozoic equivalent rock types. The $\delta^{18}O$ values of coexisting secondary amphibole ($1.6 \le \delta^{18}O \le 7.3$‰) and feldspar ($3.8 \le \delta^{18}O \le 11.8$‰) from 23 lava samples also exhibit variability analogus to modern sea floor hydrothermal rocks. IOG greenstone oxygen isotopic data indicate that the hydrothermal alteration of the IOG greenstones was due to interaction with ^{18}O-shifted Archean ocean water (>0‰) whose most depleted calculated oxygen isotope ratio is similar to modern seawater (~ -1‰)

Hydrogen isotope ratio of 22 greenstone lava samples ($-80 \le \delta D \le -59$‰, except for two values of -94.3 and -114.6‰) and 10 shale samples ($-92 \le \delta D \le -51$‰, except for one value of -138‰), exist within the Phanerozoic δD ranges of similar rocks. This data does not support the proposition of hydrogen loss through the upper atmosphere and the abiotic oxidation of the Earth at least 3.4 billion years ago.

The hydrogen and oxygen isotope data from the IOG greenstone lava and shale samples together are similar to the Phanerozic for both basalt-sea water interaction and clastic deposits resulting from chemical weathering (e.g. shale). IOG data contradicts the view of ^{18}O depleted Archean Ocean suggested from chert isotope data [2]and possibly indicates their formation as hydrothermal deposits.

[1] Basu *et al*.(2008) *GCA* **72**. [2] Hren *et al*. (2009) Nature **462**, 205–208.

A perspective on nanominerals and their roles in microbial ecosystesms

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There are fundamental and profoundly important connections between microbial metabolism and the mineralogy of the Earth's surface. Minerals serve as electron donors and acceptors and can precipitate or dissolve as direct and indirect consequences of microbial activity. Over the past two decades we have learned how microbial polysaccharides dissolve as well as template the precipitation of minerals, how microorganisms affect environmental mineralogy through the oxidation of iron and reduction of sulfate or uranium, and how precipitation reactions under certain conditions lead to the formation of tiny particles whose structure, properties and reactivity are impacted by size. Through the the study of synthetic nanophases such as titania (TiO_2) and sphalerite (ZnS), and using a combination of laboratory and field experiments, simulation, and state-of-the-art characterization methods, we have acquired insight into some of the relationships among nanoparticle structure, interfacial energetics, solvation and reactivity, aggregation, and other properties relevant to the behavior of nanoparticles in the natural environment. For example, adsorption of ions (including inorganic molecules) as well as particle aggregation can dictate internal order, an effect that may be of great importance in determining the behavior of nanomaterials in cellular environments. Less well understood are the ways in which size, internal structure, and surface energetics impact electron transfer reactions, including those that connect subsurface mineralogy and microbial growth. Natural mineral heterogeneity (e.g. in phase, particle size, and surface-adsorbed species) that can alter both redox properties and redox kinetics may be paralleled by variation at the biological level. Community genomic studies have demonstrated that natural bacterial and archaeal populations are internally diverse and that fine-scale sequence variation can have functional significance. Current studies focus on documenting the form and significance of such sequence variation to test the hypothesis that nanomineralogy plays a role in ecological fine tuning.