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 ± $\delta^{18}$O ± 10 ‰, mean 6.8 ‰) and 11 shale samples (10.8 ± $\delta^{18}$O ± 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 ± $\delta^{18}$O ± 7.3 ‰) and feldspar (3.8 ± $\delta^{18}$O ± 11.8 ‰) from 23 lava samples also exhibit variability analogous 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 ≤ $\delta^2$H ≤ -59‰, except for two values of -94.3 and -114.6‰) and 10 shale samples (-92 ≤ $\delta^2$H ≤ -51‰, except for one value of -138‰), exist within the Phanerozoic $\delta^2$H ranges of similar samples. 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 Phanerozoic 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.