Multiple sulfur isotope implications for the genesis of Algoma-type BIF, marine metal cycling, and exploration

D Diekrup[1], SJ Ginley[1] ,MD Hannington[1]

[1]Earth Sciences, University of Ottawa, Ottawa ON

The Sherman Mine produced iron ore from the 2.72 Ga Algoma-type banded iron formation (BIF) in open pits north of Temagami, ON. Sulfur in this Algoma-type iron formation occurs as finely disseminated sulfide grains in magnetite, jasper and chert layers. Sulfides were extracted from whole rock samples with concentrations as low as 10 ppm using wet chemical techniques and prepared for isotope measurements. Atmospheric sulfur was identified as primary source, contrasting with earlier interpretations of a juvenile source as an explanation for sulfide-$\delta^{34}S$ values in the Temagami BIF (varying around 0‰). Multiple sulfur isotope results for BIF argue against hydrothermally recycled marine sulfate as the dominant sulfur source, in contrast to Archean VMS deposits of similar age that indicate input of recycled, mass-independently fractionated (MIF) seawater sulfate in the sulfur budget of the hydrothermal system. These findings confirm the variable, but limited role of sulfur entering the water column from seafloor vents responsible for BIF and the likelihood of iron deposition. The current sampling suggests a mixing of hydrothermal and atmospheric sulfur in the sub-basin containing the Temagami BIF, allowing the identification of vent-proximal BIFs. Vent-proximal BIFs captured a MIF-S signal reflecting different sulfur sources; therefore, MIF-S signals should provide an indicator of proximity to a hydrothermal vent source. This has important implications for exploration in Archean greenstone belts, where Algoma-type BIFs are common hosts for, or laterally equivalent to, exhalative mineralization. The multiple sulfur isotope results also inform the oxidation pathways for Fe^{2+} to Fe^{3+}, thought to be fundamental in BIF formation. For example, the abiogenic oxidation of Fe^{2+} by molecular oxygen would also lead to the oxidation of reduced sulfur, causing a mixture of the sulfur species in the water column and, hence, a loss of the MIF-S signal. Algoma-type BIF in general, and individual Temagami BIF deposits in particular, occur in laterally restricted basins typically less than 1 km in strike length. This could reflect preservation but, considering the sulfur isotope results, more likley reflects the very localized sub-basins where bacterially mediated deposition of iron was possible. The involvement of bacteria using molecular oxygen to oxidize reduced iron in this process would require a low yet steady oxygen concentration close to the hydrothermal vent site; a setting that is not supported by the MIF-S data. Alternatively, anoxygenic photoferrotrophs could have been involved in a shallow water vent setting, close to or reaching into the anoxic photic zone.