Norwegian garnet websterites: Analogues for mantle metasomatism?

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In the southern Norwegian Caledonides, garnet websterite forms small bodies enclosed in gneiss, or within layered complexes also comprising peridotite, clinopyroxenite and eclogite, probably originating as crustal, mafic-ultramafic intrusions. Websterites are variably enriched in phlogopite and carbonate and have graphite-bearing fluid inclusions, and are frequently very coarse grained. Calculated pressures of 4-5GPa [1] are consistent with the presence of micro-diamond [3]. Bulk geochemistry suggests an olivine-rich protolith, but subsequent enrichment in Si, C, K, P, other LIL and HFSE. Sr isotopic data for cpx [2] show unsupported, high radiogenic Sr, suggesting an influx of fluids from the enclosing gneisses. Interlayered eclogite is cut by veins of zircon- and apatite-rich glimmerite and coesite-garnetite with depletion haloes of clinopyroxenite. Coarse magnesite is patchily distributed within the websterite. Near Molde [3] microdiamond-bearing garnetite, glimmerite and websterite form veins cutting peridotite, demonstrating fracture-metasomatism of an olivine-rich protolith. The Norwegian external garnet websterites therefore provide rare evidence for metasomatism of ultramafic rocks by siliceous, C-O-H-rich fluids/melts generated in the host gneisses under UHP conditions. Characteristics of the websterites are similar to those of xenoliths attributed to metasomatism of mantle peridotite. Thus, importantly, they provide field-scale examples of metasomatic features not available in mantle xenoliths, and could open new perspectives on mantle metasomatism, diamond genesis and crust-mantle interactions.

[1] Carswell *et al*. (2005) *International Geology Review* **48**-II, 957–977. [2] H K Brueckner (1977) *Contributions to Mineralogy & Petrology* **60**, 1–15. [3] H Vrijmoed *et al*. (2006) *Mineralogy & Petrology* **88**, 381–405

Iron isotopes reveal an abiological origin for a 2.75 Ga BIF from the Yilgarn Craton, Western Australia

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Banded iron formations (BIFs) are important geologic features of the Precambrian Earth, because they provide insights into element cycling in the ancient atmosphere–biosphere–hydrosphere system. Here we report on new Fe isotope data from a 2.75 Ga BIF from the Murchison Supergroup from the Weld Range, Yilgarn Craton, Western Australia. This BIF is interpreted to be part of a collapsed felsic volcanic caldera system and is composed of jaspilitic (hematite-bearing) chert interbedded with secondary magnetite and pyrite grains. The latter two phases formed by movement of Fe-rich fluids, likely of hydrothermal origin, along bedding planes. All three phases were individually microsampled from multiple regions of a diamond drill core and analyzed by MC–ICP–MS.

All three Fe phases studied have positive δ^{56}Fe values that occur over relatively narrow ranges. The low-Fe contents and δ^{56}Fe values of the hematite in the jaspilitic chert layers are consistent with incomplete oxidation of Fe^{2+}_{aq}, followed by Fe oxide precipitation, suggesting the oxidant was limited. Later-formed magnetite has similar, though slightly lower δ^{56}Fe values and much higher Fe contents; such compositions could reflect net addition of Fe^{2+}-rich fluids into the semi-consolidated jaspilitic chert layers. The δ^{56}Fe values for pyrite, which formed after the magnetite, probably reflect interaction between dissolved sulfide and excess Fe^{2+}_{aq}. The average values of each phase increase in the order magnetite–hematite–pyrite, which follows that predicted for Fe isotope equilibrium and suggests formation by entirely abiologic pathways from a major, probably common reservoir of Fe^{2+}_{aq} with a near-zero-δ^{56}Fe value. Collectively, these results suggest that Archean volcanogenic, or ‘Algoma’ type BIFs may form by significantly different pathways than those involved in the large continental shelf-scale ‘Superior’ type BIFs of late Archean and early Proterozoic age, which included a major component of biological Fe cycling.