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Fluid-induced martitization of magnetite in BIFs from the Dharwar Craton, India.

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Banded iron formations (BIFs) represent the largest iron deposits on Earth, which mainly formed in the Late Archean and Early Proterozoic. The complex geological history of BIFs makes it difficult to reconstruct the primary mineralogy and thus the initial depositional environment. Magnetite and hematite are the most important iron oxide minerals in BIFs. Magnetite ($FeOFe2O_3$) comprising of both ferrous and ferric iron, easily undergoes transformation at low temperature. Hematite (α-$Fe2O_3$) is often a result of the pseudomorphic replacement of magnetite, in the processus called martitisation. Despite the process of martitization having been widely studied, in both synthetic and natural magnetites, the mechanics of the transformation are poorly understood. What is generally agreed is that the transformation from magnetite to hematite occurs via a maghemite (g-$Fe2O_3$) intermediate.

The 2.9 Ga BIF from the Western Dharwar Craton, Southern India (a 500 m thick Archean BIF), is characterized by millimetric to centrimetric alternating white quartz and grey Fe-oxide bands. The Fe-oxide bands consist of martite crystals ($\sim$20μm) which represent the hematitisation of euhedral magnetite. The hematite crystals are in part euhedral, cubic shaped pointing to the replacement of magnetite. The crystals show a trellis pattern. Magnetite patches occur within the hematite. Raman spectroscopy, X-Ray diffraction, Curie balance and magnetic hysteresis analyses and FIB-TEM investigation indicate the presence of maghemite, and the presence of subhedral magnetite and interstitial hematite crystal. The latter are characterized by dislocation with fluid inclusions and high porosity zones. The magnetite grains contain lamellae and the interfaces between magnetite-maghemite and hematite are curved suggesting grain boundary migrations with the growth of hematite at the expense of magnetite and maghemite. It is thus suggested that martite result from low-T exsolutions along cleavage resulting in the formation of maghemite at the interface between magnetite and hematite with the migration of excess Fe3+ through the magnetite crystal lattice to the surface. Martitization is thus due to hydrothermal events associated with grain boundary migration during dynamic recrystallization.