

Magnetic Characterization of Fe-Oxides concretions from Utah, USA and Czech Republic as terrestrial analogues of Mars

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Terrestrial Fe-oxides (e.g., hematite, goethite, and magnetite) concretions were formed in aqueous diagenetic conditions in sandstones. Magnetism of these concretions from the Jurassic Navajo sandstone, Utah, and from Cretaceous sandstones in Czech Republic were partly characterized, and interpreted for the compositions of hematite, goethite and magnetite with respect to their grain sizes.

At ambient temperature they are the mixtures of superparamagnetic (SP), single domain (SD), and multidomain (MD) magnetic states. For the magnetic signature interpretation, we also collected Navajo sandstone samples that contain primarily goethite or hematite cement and used them as a standard. Concretions from Utah are not capable of reaching saturation magnetization (SIRM), even when using pulse magnetic fields exceeding 10 Tesla. We observed a linear trend during the room-temperature, high-field magnetic acquisition that we interpret as goethite signature. Such linearity was also observed in the goethite-cemented Navajo sandstone. Hematite-cemented sandstone saturated around 3 Tesla. We utilized the linear magnetic acquisition trend of the goethite signature to separate magnetic signature of goethite from hematite in the mixed compositions in the concretions. Because Czech concretions showed identical magnetic behavior as Navajo concretions with occasional magnetite addition, the formation process of the both concretions is unique, and may not be sensitive to geographic location.

The concretions may have formed along transport paths of iron-rich fluids in zones of their mixing with oxygenated meteoric waters. The oxidation of ferrous iron from the aquatic solution initiated the precipitation of goethite/hematite. Fe isotope data reveal some lighter isotopic iron inside the concretions pointing towards biomediated iron precipitation. In their iron and rare earth element compositions, the concretions rather differ from those of the bulk rock. They contain the unusual elements such as Mo, Sn, Ba, La, Pb, Nd, Sm, Gd, Er, which are absent in the bulk sandstone. This suggests the possible association with biological control of the element distribution.