Geological evidence of microbial dissolution of iron carbonate

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Many exposures of continental sandstones exhibit distinctive patterns of iron-oxide cement (IOC) and iron oxide stain (IOS). These include boxworks consisting of concentric bands of IOC as well as irregular, undulatory bands of IOC. In both cases the more friable sandstone between the bands is stained with IOS. Perhaps the most spectacular example of this type of iron-mineralization is the Kanab Wonderstone. Vertically jointed sandstone bodies in the Shinarump member of the Chinle Formation contain *ca*. 5% Fe_2O_3. Much of this iron occurs as 1 to 5 mm thick, undulatory bands of iron oxide cement (IOC) that cross-cut and obscure sedimentary structures. Iron also occurs as iron oxide stain (IOS). Between each pair of IOC bands are alternating IOS and lightly stained or unstained bands of sand grains that also cross-cut and obscure sedimentary structures. The interior-most portion of the sandstone bed may contain bleached sandstone enclosed by a band of IOC.

Siderite is abundant in the lower portion of the Chinle Formation and locally (e.g. at Temple Mountain) cements large masses of sandstone. We interpret the IOC and IOS to be produced by microbially mediated dissolution of siderite and oxidation of ferrous iron. Iron-oxidizing bacteria colonized the interface between siderite-cemented sand and porous sandstone, oxidizing iron and generating acid that caused dissolution of siderite. Aqueous ferrous iron diffused back to the biofilm where it was oxidized. The bands of IOS are the remains of self-focused reaction fronts that advanced ahead of the biofilm. These features are geological evidence of past microbial activity and evidence of microbial recycling of mineralized carbonate back into the atmosphere.

Banded iron formations from the Eastern Desert of Egypt: A new type of ore?

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Banded iron formations (BIFs) occur in 13 localities in an area approximately 30, 000 km^2 within the eastern desert of Egypt. Iron ore occurs as rhythmically layered bands intercalated with volcanic arc assemblages. In most cases, the BIFs display syn-sedimentary bedding and lamination. The entire sequence is strongly deformed and regionally metamorphosed under greenschist to amphibolite facies conditions.

All deposits consist of an oxide facies with magnetite and hematite, and a silicate facies made of quartz with subordinate amounts of one or more of the minerals: chlorite, greenalite, stilpnomelane, garnet, carbonate, epidote, hornblende, or plagioclase. With the exception of the northernmost jaspilite type deposit of Hadrabia, magnetite is the predominant oxide. Major and trace element data vary from one deposit to another, the most intriguing feature being their high Fe/Si compared to Algoma and Superior types. Two types are identified: a) fresh BIFs with Fe/Si ratio < 2.3 and b) altered BIFs with Fe/Si ratio > 3.0.

The relatively small nature of individual deposits, strong variations in Fe_2O_3 (t) and SiO_2 and high Cr, V and Ni (for most deposits) support a volcanic exhalative origin, leading most scientists to classify them as 'Algoma type BIFs'. However, the lack of sulfides, varve – like nature of some deposits, and lack of a distinct enrichment in Co, Ni, Cu, As, and Sr are at odds with such a classification. On the other hand, their Neoproterozoic age, high Fe and P contents, and presence of diamictites intercalated with at least one of the deposits are features similar to Rapitan type BIFs.

The presence of laminations and absence of wave generated structures in most Egyptian BIFs indicate subaqueous precipitation below wave base. The formation of authegenic primary magnetite, paucity of primary sulfides and siderite suggest distal precipitation under slightly euxinic conditions in basins where S and CO_2 activities are low. Accordingly, Egyptian BIFs formed in the deepest 'shelf – like' environments of fore-arc and back-arc basins.