Paleoenvironmental and biogeological significance of iron formation for the early history of earth

Paleoenvironmental and biogeological significance of iron formation for the early history of earth

Beukes Nicolas J[1]; Gutzmer Jens[2]
Nicolas J Beukes[1]; Jens Gutzmer[2]

[1] University of Johannesburg; [2] Univ. of Johannesburg
[1] Department of Geology, University of Johannesburg; [2] Dept. of Geology, Univ. of Johannesburg

(continued from Beukes' English abstract)

The distribution of organic matter in iron formation successions strongly suggest that the precipitation of iron oxides was decoupled from primary production of biomass (Klein and Beukes, 1989). Oxide facies iron formation apparently accumulated in areas of very low organic carbon supply or primary productivity. In areas of higher organic carbon supply, iron oxides were transformed to siderite most probably through microbial ferric iron respiration. Certain Archean iron formations occur in close association with manganese carbonates and it is quite possible that these carbonates were derived from microbial respiration of earlier Mn4+ - oxyhydroxides. The presence of Mn4+ - oxyhydroxides requires free oxygen, which would support the notion that at least some oxygen was available in shallow ocean water in the early Precambrian. Oxygenic photosynthesis is the most likely source of free oxygen, which implies that this metabolic pathway was present very early on in earth history.

Iron formations are known to be directly associated with glacial deposits in the Mesoarchean, Paleoproterozoic and Neoproterozoic. All of these iron formations appear to have been deposited either during interglacial periods, or at the end of glacial episodes associated with post-glacial flooding events. It is most unlikely that a permanently stratified ocean could have been maintained in the presence of polar ice caps even as far back in time as the Mesoarchean. Stratification of oceans in the Precambrian may thus have been episodic and could have been controlled by interplay of global climatic change and hydrothermal (tectonic) activity.

References

Cairns-Smith, A.G., 1978. Precambrian solution photochemistry, inverse segregation, and banded iron formations. Nature, 276, 807-808.

Cloud, P., 1973. Paleoecological significance of the banded iron-formation. Econ. Geol., 68, 1135-1143.

Dymek, R.F. and Klein, C., 1988. Chamistry, petrology and origin of banded iron- formation lithologies from the 3 800 Ma Isua supracrustal belt, West Greenland. Precambr. Res., 39, 247-302.

Gole, M.J. and Klein, C., 1981. Banded iron-formations through much of Precambrian time. J. Geol., 89, 169-183.

Isley, A.E. and Abbott, D.H., 1999. Plume-related mafic volcanism and the depositon of banded iron-formation. J. Geoph. Res., 104, 15461-15477.

Klein, C. and Beukes, N.J., 1989. Geochemistry and sedimentology of a facies transition from limestone to iron-formation deposition in the early Proterozoic Transvaal Supergroup, South Africa. Econ. Geol., 84, 1733-1774.

Konhauser, K.O., Hamade, T., Raiswell, R., Morris, R.C., Ferris, F.G., Southam, G. and Canfield, D.E., 2002. Could bacteria have formed the Precambrian banded iron formations. Geology, 30, 1079-1082.