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

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Iron formation is an enigmatic rock type, abundant in Precambrian sedimentary successions and scarce to absent in the Phanerozoic. Certain iron formations contain interbeds of sedimentary manganese ores. There is very little consensus about the origin of these rocks, largely because of a lack of modern analogues, except perhaps for iron and manganese-bearing sediments associated with present day deep sea hydrothermal vents. In spite of this, detailed sedimentological studies of iron formation may provide us clues about biological activity and depositional-diagenetic environments in ancient oceans.

Iron formations typically represent starved shelf deposits formed during major transgressions. Their abundance as a rock type through time is thus perhaps best defined by the frequency with which they occur along transgressive surfaces in rock successions of different ages. Defined as such they appear perhaps more abundant in Archean than in Paleoproterozoic successions. The so-called peak of iron formation deposition at ~2,45 Ga, based on size (Gole and Klein, 1981), may merely be an artifact of preservation and of deposition of iron formation of the Transvaal and Hamersley Provinces in one large unique sedimentary basin. Contrary to popular belief it is thus unlikely to represent a global event of iron formation deposition and to be related to the rise of oxygen in the atmosphere (Cloud, 1973). In both the Transvaal and Hamersley successions, a carbonate depositional basin was replaced by an iron-precipitating basin, with retention of the whole spectrum of depositional environments from deep basin to shallow shelf. This is best explained by increased hydrothermal plume activity bringing iron and silica into a basin on a shallow shelf and replacing the water from which carbonates were initially deposited. Hydrothermal plume activity may thus have been a major controlling factor on the distribution of iron formations through time (Isley and Abbott, 1999). Scarcity of iron formations in rock successions younger than 1,9 Ga, could thus also be an artifact of preservation as a result of decreased plume activity and restriction of hydrothermal plumes to off-shelf, deep oceanic environments.

Facies relationships between iron formation and associated rock types, especially stromatolitic carbonate and black carbonaceaous chert, indicate that iron formations were most commonly deposited from a stratified ocean in which the shallow (less than 200 m depth) surface layer, including the entire photic zone, was depleted in dissolved iron. It is thus highly unlikely that photochemical oxidation of ferrous to ferric iron (Cairns-Smith, 1978) and/or anaerobic photosynthetic iron-oxidizing bacteria (Konhauser et al., 2002) could have been responsible for the precipitation of oxide-facies iron formations in the absence of free oxygen in the Archean. In turn, this implies that free oxygen must have been available in the upper layer of a stratified ocean for the deposition of oxide-facies iron formations in the Archean. Such iron formations occur as far back as 3,8 Ga at Isua in Greenland (Dymek and Klein, 1988).

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