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Seawater composition, BIF deposition, glaciation and the rise of oxygen: major changes linked by a late Archaean/early Proterozoic change in the internal behaviour of the Earth

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The interval 2.45-2.2Ga saw a uniquely vast deposition of BIF (banded iron-formation). It also marks, globally, a still-empty age-gap both for greenstone belts and for orogenic granitoids. What was going on?

During the preceding 500Ma, from about 2.9Ga, there was major acceleration in the rate of crustal addition to cratons. This process (Osmaston, 1999a), involved the widespread intrusion of successive greenstone belts by TTG granitoids, derived from subduction interface melts whenever 'flat-slab' subduction beneath was interrupted. So it advectively deprived the mantle of heat which subduction would otherwise have returned to the mantle budget. This, in turn, rendered subduction even more susceptible to interruption, thus accelerating the repetition (Osmaston, 2000). The increasing depositional water-depth of interpillow sediments on greenstone belts during this time is consistent with declining mantle heat. It is therefore reasonable to attribute the gap in greenstone and granitoid dates to a 'hiatus' in upper mantle convective overturn (Osmaston, 1999b). How did this affect seawater?

Accelerated deposition of oxide-facies BIF, beginning about 2.75Ga, was clearly not due to a sudden increase in Fe++ from MORs, especially if these were declining; it must have been accumulating in solution. The same applies to the even greater amount of silica in the BIF. These requirements, together with studies of Cameroun crater lakes, suggest the following 'specification' for ocean water at ~2.75Ga. Below a chemocline, the fumarole-maintained pH was ~4.5, Fe++ content was over 80ppm and the mean temperature (to the floor) was ~25degC, with an inverted temperature gradient maintained by the Fe++ density gradient.

The following history then emerges. Throughout the Archaean, a low-pH ocean (topped by a shallow oxygenated water layer beneath a dense CO_2+N atmosphere) accumulated Fe++ in solution. At ~2.8Ga the ocean floor began to deepen, exposing the cratons to massive weathering. This lowered CO2, resulting in the Earth's first glaciation at 2.65Ga, followed at 2.35Ga by the major Huronian glaciation during the 4km+ lowering of sea-level during the actual hiatus. During the hiatus the MOR supply of reducing gases was shut off and oxygenic life was at last enabled to win its battle against the Earth's reducing power. BIF deposition was the result. Carbonates with a major positive excursion in delta13C at 2.2Ga mark the florescence of oxgenic life, presented with non-acid shallow seas over planated cratons, as renewed MOR activity raised sea-level. Thus the lowering of atmospheric CO_2, the rise of oxygen and the change in seawater chemistry stem from changes in the Earth's internal behaviour, not from biological innovation.

Osmaston MF Phanerozoic subduction and the TTG-magmatic construction of Archaean continental crust. IUGG99, Birmingham, UK. Abstr.B B.74 (B.75 in Abst.Update CD) 1999a
Osmaston MF Impact of the behaviour of the Earth's interior upon the evolution of the Earth's atmosphere and the rise of oxygen. IUGG99, Internat.Union Geod.Geophys., Birmingham, UK. Abstr.B B.261 1999b
Osmaston MF The magmatic and tectonic construction of Archaean continental crust and why it accelerated. 31st Int.Geol.Congr., Rio de Janeiro. Abstr.CD-ROM Gen.Symp.9-2 2000