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Are volatile mantle plumes important for the origin of giant ore bodies?

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Here we present the case that a reduced ore forming fluid arises from the systematic degassing of the Earth with an ultimate origin in the deep mantle or even the core of the Earth. We propose a scenario below where the Earth has episodically degassed over its history with the release of H_2 and associated siderophile elements (including gold) into the lithosphere of the Earth. Tomographic analyses now give some first clues as to how and where this may happen. But they also contain some surprises that are still unresolved. A wet sheet-like upwelling impinging on the US Atlantic margin has recently been found by shear wave tomography [1]. This upwelling coincides with the former suture of the Iapetus Ocean (quite possibly the future suture of the Atlantic) and is located directly underneath the present Appalachians. The shear wave velocity anomaly, cannot be explained in terms of a temperature anomaly alone by the temperature derivative and can only be explained by the presence of water. Similarly the low S-wave velocities under the Tornquist–Teisseyre Zone have previously been interpreted as evidence for water injection on the old suture. Both anomalies appear to have followed the plate motion.

We are presenting the hypothesis that wet upper mantle plumes and sheets are attracted and advected by the strong guidance of the top layer, the lithosphere, in much the same way as the hot spots are rooted on the $D^{//}$-layer and held fixed by the lower mantle. In the Archean the young Earth is expected to have been hotter and richer in volatiles. While sheet like upwellings might be linked to the presence of some style of subduction (A), circular plume-like upwellings are a robust feature of plume tectonics (B). The early Earth must thus have gone through a convective fluid mechanical (A) and a plate tectonic solid mechanical mode (B). Self-organization of plate tectonics evolved out of both modes A and B in a critical phase transition. In this paper we examine the implications of this phase transition for the origins of large ore bodies

References

[1] van der Lee, S., High-resolution estimates of lithospheric thickness from Missouri to Massachusetts, USA, *Earth and Planetary Science Letters*, **203** (1) 15-23, 2002

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6.4.P01

Halogen concentrations of banded iron formations – implications for the chemical evolution of Precambrian oceans

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Chlorine and bromine degassed from the upper mantle are strongly partitioned into seawater. Iodine by contrast, is extremely depleted in modern seawater and enriched in marine sediments. Iodine is taken up biologically from seawater but the evolution of this process and the consequent evolution of the halogen composition of seawater remains unknown. Recent fluid inclusion studies of ironstones and pillow lavas have attempted to determine halogen ratios in Precambrian seawater, however the low concentration of iodine and the possibility of later fluid entrapment have hampered the interpretation of these fluids in terms of early oceans [1,2].

Banded iron formations have the potential to record seawater halogen ratios in two ways. Firstly, cherts are well known to trap water during formation therefore silica rich bands may directly sample seawater from the time of formation. Secondly it has been shown that iodate (and to a lesser extent iodide) are strongly adsorbed on to iron oxides at pH <9 [3]. The iodine content of iron rich bands may therefore reflect the iodine content of the seawater from which the oxides were formed.

Halogen ratios reported here are the first measurements of the halogen composition of separated iron rich and silica rich bands in banded iron formations. Noble gas mass spectrometry following irradiation of samples has allowed simultaneous measurement of chlorine, bromine and iodine in these samples despite their low (<ppb) iodine content. Iron rich bands are significantly more enriched in iodine consistent with greater adsorption by iron oxides. This may reflect the concentration of iodine in Precambrian seawater but may also have important implications for the removal of iodine from the early oceans.

References

[1] Channer D.M.D., de Ronde C.E.J. and Spooner, E.T.C., (1997) *EPSL* **150,** 325-335.
[2] Gutzmer J., Banks D.A., Luders V., Hoefs J., Beukes N.J. and von Bezing K.L. (2003) *Chem. Geol.* **201,** 37-53.
[3] Couture R.A. and Seitz M.G. (1983) *Nuclear and chemical waste management* **4,** 301-306.