Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 763

An Upper Mantle Source for Plumes and Dupal; Result of Processes and History that have Shaped the Earth's Interior and Chemistry from Core to Crust

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Most geochemists recognise that the lower mantle must be far less depleted. Heat generation in the early earth makes it certain that there was whole-mantle convection; so when and how, was and is that segregation established and maintained, particularly in view of what seismologists are saying about subduction? For an answer we must first go back to formation of the core. The percolation model is non-viable for two principal reasons. (1) The mantle has preserved a chondritic ~20:1 Ni:Co and it hasn't changed since 3.8 Ga. (2) The Moon was formed in orbit during the supposed percolation interval yet has certainly not experienced the post-percolation 'late veneer' of water and siderophiles that is a corollary of that model. Instead, I propose that the proto-earth's nebular atmosphere reduced surface-erupted magmatic FeO which was then 'subducted' to form the core. This makes S and C the preferred core dilutants. The water produced gave the early earth a wet mantle, lowering its viscosity so that rapid convection could easily dispose of the heating. Komatiites exhibit -Nb anomalies and the counterpart is seen today as +Nb in the upper mantle. That depletion was mainly accomplished by subduction of primitive crust to form D", which sealed the CMB from about 4480 Ma onwards, prior to which major depletion of Pb and siderophiles took place across it. This sealing function of D" denies that plumes can start from the CMB.

Archaean continental crustal addition involved flat-slab subduction of hot and buoyant plates. Whenever subduction was halted, this heat soaked upward, melting the interface oceanic crust and generating widespread TTG in the upper plate. This process advected, into the upper plate, subducting-plate heat that would have been returned to the mantle heat budget. In the context of a waning mantle heat supply this explains the Late Archaean accelerated repetition of this process. A well-linked variety of global geological evidence shows that (upper) mantle overturn ceased for the 2.49-2.22 Ga interval. When it restarted what was its form?

Upper mantle epsilon Nd tripled its rate of rise at about 2.2 Ga, and has continued thus ever since, yet continental crust production clearly did not. In the circumstances it is also unlikely that there was an accelerated rate of subducting mantle depletion products to add to D". The alternative is that there was a major reduction in the volume of mantle being depleted by these processes. I conclude that mantle convection restarted in a two-layer mode, but with still-somewhat-hydrous subducted oceanic crust continuing being dumped into the lower mantle. Thus the accelerated depletion of the upper mantle was also the means of drying it out.

To reconcile this conclusion with the presence of enhanced seismic velocity traces extending far beyond the 660 km discontinuity into the lower mantle I propose that at lower-TZ depths the crustal material acquires a high density, high seismic velocity property (involving stishovite?) and that it breaks up into bodies ('plums') which are able to 'shower' through the 660 and create the observed traces. Examples of this interpretation will be given. The high seismic velocity of the same material, now constituting D", has puzzled investigators (Wysession et al. 1998). Meanwhile, the mantle part of the slab recycles within the upper mantle. This separative action at the 660 km level is seen as the mechanism whereby the lower and upper mantle evolved separately after 2.2 Ga.

To balance the crustal volume entering the lower mantle, but yet maintain the 660 km discontinuity, lower mantle material must migrate upward through the 660 km phase change at a global rate currently ~5 cm/century, creating a 'seepage zone' of lower mantle-derived composition within the TZ. I propose that this is the source of non-OIB 'plume' and Dupal signatures. Access to it occurs in two ways. One is that seismological evidence now suggests that Archaean tectospheres extend beyond 500 km depth; when these are tectonically split the seepage zone material is drawn up between them. The other (W Pacific/E Asia) is that ponding subducted slabs may disturb the material.

The Dupal signature is superimposed on OIB and MORB alike. Magmatic process models presented elsewhere (Osmaston, 1995; 1999a; 1999b; 2000a; 2000b) offer to derive both MORB and the variable signature and characteristic alk-thol-alk-neph sequence of OIB from similar (~DM) upper mantle.

Wysession ME, Lay T, Revenaugh J, Williams Q, Garnero EJ, Jeanloz R & Kellogg LH, *In: The Core-Mantle Boundary Region (Gurnis M, Wysession ME, Knittle E & Buffett BA, eds)*, **AGU Geodynamics v.28**, 273-297, (1998).

Osmaston MF, *XXI Gen. Assy. IUGG, Boulder, Colorado.*, **Abstracts**, A472, (1995).

Osmaston MF, *J. Conf. Abs.*, **4 (1)**, 348, (1999a).

Osmaston MF, *XXII Gen. Assy IUGG, Birmingham, UK*, **Abstract Vol.B**, 113, (1999b).

Osmaston MF, *Geol. Soc./Min. Soc. Volcanic & Magmatic Studies Group Annual Meeting (VMSG2000)*, **Meeting Abstracts**, (2000a).

Osmaston MF, *31st Intl. Geol. Congr., Rio de Janeiro. Gen Symp 4.1: Geologic Processes in Mid-Ocean Ridges.*, **Accepted.**, (2000b).