meetabst\EUG11mc.sam/lwp EUG XI, Strasbourg. 8-12 April 2001.
Symposium MS01: Geochemistry, structure and dynamics of the Earth's mantle. J.Conf.Abstr. 6 (1) 417 (2001)

Two-layer convection of the mantle. How is it possible? When did it change? What are its geochemical and plate tectonic implications?

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Based on elemental abundances in meteorites, geochemists recognize a need for a major enriched reservoir, commonly identified as the lower mantle; recent developments of the plume concept make use of this view. Yet seismologists claim to observe the traces of subducting 'slabs' penetrating far into the lower mantle, making dubious the long-term retention of a lower mantle reservoir.

To resolve this conflict, we reconsider the subduction process and what is actually being subducted. To achieve tectonic undercutting and development of 'flat-slab' profiles (Osmaston, 1995; 1999a), subducting plates must possess thermal buoyancy (Osmaston, 1999b); so a new model of the MOR process has been devised which treats LVZ material as integral with the plate and provides much more ridge-push to drive subduction (Osmaston, 2000a). During subductive descent the LVZ heat starts to conduct towards the interface. The high energy-release of deep (350-660km) earthquakes is a problem which near-melting interface conditions may resolve; melts there are denser, so imply input of overburden compressional energy which propagates the melting. This partial melting of the subducted crust will produce low-silica melt very rich in Fe, with a possibly stishovite-rich residue, so that *both* components could be denser than the original, showering slowly as dense high-seismic-velocity lumps into the lower mantle, with stishovite matching the properties of D".

Tomographic traces will be interpreted in these terms; sloping traces imply westward motion of the Americas; significantly, these traces greatly widen vertically with increasing depth, consistent with different sinkage velocities for different-sized lumps. Meanwhile the mantle part of the subducted plate recycles within the upper mantle. High heat generation in the early earth made whole-mantle convection inevitable. But huge changes in geological processes during the 2.5-2.2Ga interval suggest this was the time of changeover to separate upper mantle convection. Since then, depletion has been confined to the upper mantle, much of its differentiates being dumped into the lower mantle, and is evident in the much-accelerated rise in depletion indicators like epsilon Nd (Osmaston, 2000b).

Beneath Archaean cratons, the 410km and 520km discontinuities appear weak or absent, suggesting that less-depleted tectospheres extend to beyond that. If cratons have keels extending to the base of the upper mantle there are interesting consequences for plate tectonics. As the Atlantic opened, where did the mantle below it come from if it cannot come from the lower mantle? Are the eastward motions of the Caribbean and Scotia areas the result? Likewise, did the Cenozoic opening of the Arctic Ocean drag Greenland's keel northwards, causing the widespread folding along its northern margin and in western Svalbard?

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