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The Eurekan compression and related motions of Greenland: tectonic product of Arctic opening in the circumstances of a two-layer mantle and deep cratonic tectospheres

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Many-faceted study (>25 yrs) of the subduction process has shown that, contrary to the standard perception, the oceanic plate arriving for subduction must actually have thermal buoyancy, especially when it is <70 Ma old. Two lines of evidence for this (see accompanying contribution) are (a) the mechanical development of extensive 'flat-slab' interface profiles by removal of upper-plate material, and (b) occurrences of wide belts of silicic/granitoid post-subduction magmatism (PSM) when young-plate subduction ceased. Associated with (a), progressive foreland-directed thrusting is widely observed, demanding that MOR ridge-push be substantial.

So a redesign of the MOR process was undertaken to incorporate the deeper, interstitially melted, LVZ material as a physically integral part of the plate (Osmaston 2000, IGC). This model not only generates much more ridge push, as required, but has been very successful in relation to MOR structures (straightness, orthogonal segmentation, etc). Importantly, its axial diapir develops 'suction' at its base. The heat content lies in a superadiabatic temperature gradient in the now-stiff LVZ, partially trapped by the much (>30%) lower thermal conductivity resulting from its (say 3%) interstitial melt until subduction pressure refreezes it.

Perhaps surprisingly, and hitherto unnoted by seismologists, this incorporated ocean-plate-heat is indeed evident as slab reheating during active subduction. Examples from among numerous circum-Pacific tomographic transects, kindly provided by E.R. Engdahl, all show that the 'slab' high-Vp signature peters out (reheating?) at between 200 and 350 km (plate age-dependent and even at 130 Ma) and a second high-Vp signature then begins close to the top of the transition zone (TZ) and goes on into the lower mantle. This latter signature must be mineralogical, not thermal, and arguably is not mantle but, on experimental evidence, is only a stream of dense stishovitic lumps residual from partial melting of subducted oceanic crust at TZ pressures. Thus, for mantle material, we have a two-layer system, but with a slow upwards 'seepage' (<2.5 mm/cy globally) of lower mantle composition across the 660 km discontinuity to offset the crustal volume input.

Recognition of greater plate thickness now extends all the way to cratons, whose tectospheric keels are now seen seismologically (A. Dziewonski) to reach to near the 660 km base of the upper mantle. In that case where does the mantle come from to put under oceans forming between separating cratons? For the Atlantic the flows through the Caribbean and Scotia gaps were the clear result. In the N Atlantic, cratonic separation drew on TZ seepage zone material (Iceland 'plume'). For the Arctic Eurasian basin the mantle needed was 'sucked' up the N Atlantic at depth, dragging Greenland's keel, causing the Eocene Eurekan folding from Svalbard to Ellesmere Island, after early motion on Nares Strait.

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