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NEW EVIDENCE ON THE THERMAL STATE OF SUBDUCTING PLATES AND MECHANICAL STATE OF THE MANTLE WEDGE: SIGNIFICANCE FOR THE ORIGIN OF ARC MAGMAS

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My multifaceted study of the subduction process has indicated that the rapid development of 'flat-slab' interface profiles involves the physical removal of hanging wall material (beit lower crust or mantle) in front of the downbend by basal subduction tectonic erosion (STE). Historically this, and its active seismological manifestation known as seismic coupling, only occurs where the subducting plate was/is <70Ma old. Hence the requisite subducting plate buoyancy must be thermal and slab-pull an unlikely agent for such subduction - a conclusion reinforced by the abundant development of progressive foreland-directed thrusting during the STE process, which intermittently couples ridge push to the upper plate. Lots of ridge push is needed to drive that thrusting and the subduction of such buoyant plates.

Accordingly, a redesign of the MOR process has incorporated the LVZ as a physically integral part of the plate (Osmaston 2000 IGC Rio). This model not only generates much more (but still being quantified) ridge push, as required, but has turned out to be very successful in relation to MOR structures. The heat content takes the form of a superadiabatic gradient in the now-stiff LVZ, and is partially trapped (until subduction) by the much (>30%) lower thermal conductivity resulting from its (say 3%) interstitial melt.

Perhaps surprisingly, this incorporated ocean-plate-heat is indeed evident as slab reheating during active subduction. Examples from among numerous circum-Pacific tomographic transects, kindly provided to me, all show that the 'slab' high-Vp signature peters out at between 175 and 350km (plate age-dependent and even at 130Ma) and a second high-Vp signature then begins close to the top of the TZ and goes on into the lower mantle. This latter signature must be mineralogical, not thermal, and arguably is not mantle but is only a stream of dense stishovitic lumps of residue derived from the partial melting of subducted oceanic crust at TZ pressures. Stishovite, conveniently, is a seismologically preferred constituent of D''.

These results are, in two ways, in serious conflict with the perceptions widely adopted by those modelling arc magmatism. First, the subducting plate is evidently not just the cold slab beloved of subduction modellers but has a major heat content which shows up during active subduction. This means that at the sub-arc point the subducted crust can already be receiving heat for dehydration, and perhaps for limited melting, from within the plate, so the demand for heat from the mantle wedge is much reduced or may even be eliminated. Second, my wide-ranging STE studies tightly link the progress of the downbend to thrusting events in the crust above and to the changing hanging-wall guidance of the plate, strongly suggesting that the mantle wedge is not mobile but has mechanical integrity down to great depths.

Finally, the highly arc-like chemical character of magmas (e.g. the Siluro-Devonian ones of Scotland) that are demonstrably (by their dates) the result of POST-subduction interface reheating and melting suggests that interface reheating may be a much more general route to syn-subduction arc magmatism than the subduction modellers have provided hitherto. [500 words]

Keywords:- Arc magmagenesis, Subduction, Heat sources

Message to convenors:- Bob Engdahl supplied the (>90) tomographic transects and Tibor Gasparik the info on TZ melting.