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The magmatic and tectonic construction of Archaean continental crust, why it accelerated, and the construction of its deep tectosphere

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My previous work (e.g. IGC'92, IUGG99) has shown that two major subduction-related processes, STE and PSM, are widely evident in the Phanerozoic. STE (subduction tectonic erosion) shallowly and rapidly undercuts the upper plate, advancing the plate downbend for hundreds of kilometres. The process is confined to young (<70Ma) subducting plates, implying thermal buoyancy provided by some of their low velocity zone (LVZ) mantle being integral with the plate. When subduction stops, LVZ heat thermally expunges the 'slab', melts the interface crustal material and produces widespread silicic/granitoid PSM (post-subduction magmatism) in the upper plate.

STE and PSM seem to have dominated the construction of mid and late Archaean continental crust. Komatiite compositions and co-magmatic felsics imply, not a subduction relationship, but that the early Earth had a wet mantle, inherited from a new mode of core formation, briefly outlined. Greenstone belts are seen as the forearcs of intra-oceanic subduction zones, undercut (thinned) by STE and widened by downbend advance. Interruptions in subduction then resulted in successive wide belts of quasi-coeval TTG-granitoid intrusion.

This mode of crustal construction left in place an ex-oceanic plate below each TTG-intruded area. Thus the ~200km depleted zone from which xenoliths originate was created by the Archaean MOR process. The tectospheric richer mantle below that, to 500km+ (Gu et al. 1998, EPSL 157), may be coeval Archaean mantle and the source for xenolith metasomatism and of kimberlite itself.

The wet mantle's very low viscosity made convection more than able to keep up with the declining heat supply, evident as deepening MOR crests, onset of craton erosion and more frequent interruptions in subduction. PSM advects to the surface LVZ heat that would otherwise return to the mantle heat budget, so interruptions and crustal additions became more frequent. Finally this led to a 2.45-2.22Ga heat budget crisis during which MOR and subduction activity ceased (no greenstone or TTG dates). Dykes and minor rifting events affecting every craton in this interval record the thermal shrinkage of the global lithosphere in the absence of MORs as take-up zones.

Keywords:- Archean crust; plate tectonics; subduction; tectosphere; kimberlite.