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Geochemical and numerical approach to Neoarchean plate tectonics

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According to a shared view, the major part of the Earth's earliest granitic crust of TTG (tonalite-trondhjemite-granodiorite) composition was formed during a long period (4.0 Ga-2.7 Ga) of melting of basalts that constitute oceanic crust and plateaus. However, the site of melting is controversial and the opinions vary from the subducting slab to the lower part of thick basaltic crust. The former assumes that subduction initiated early in the Earth's history, whereas the latter requires an accumulation of thick basaltic piles. The long period of extraction of TTGs from basaltic crust (2.85-2.75 Ga in the Karelian Craton) was followed by an abrupt pulse of mantle magmatism (2.74-2.72 Ga in the same region) that formed granitoids known as sanukitoids.

In the Karelian and Kola cratons of the Fennoscandian Shield, the crust-forming magmatism can be divided into three geochemical groups: (1) low-HREE (heavy rare earth elements) TTGs, (2) high-HREE TTGs, and (3) high Mg-Ba-Sr sanukitoids (Halla et al., 2009). The first two TTG groups differ mainly in their contrasting pressure-sensitive trace element contents, indicating a similar source but different conditions for melting. The enrichment of Mg in sanukitoids points to a mantle source, high Ba and Sr indicate source metasomatism, and a crustal isotope signature requires recycling of continental material into the mantle (Heilimo et al., in press). Their pressure-sensitive element concentrations point to variable conditions between the high- and low-pressure regimes of TTGs.

We propose a possible tectonic scenario of an incipient hot subduction underneath a thick oceanic plateau/protocrust, which would enable simultaneous melting in deep and shallow sources. High-pressure melting in the lower eclogitic part of a thick basaltic pile could produce low-HREE TTGs, whereas low-pressure melting of shallow subducting slab (with possible interactions with the mantle wedge) would be capable of generating high-HREE TTGs. Numerical models predict that the weakness of and tensile stresses of the subducting plate could result in a slab break-off and (local) termination of the subduction process (van Hunen and van den Berg, 2008). Potential mantle upwelling from this effect, and the subsequent development of a new thermal state are likely to provide a situation in which partial melting and metasomatism of the enriched mantle wedge lead to the formation of sanukitoid magmas.

References:

Halla, J., van Hunen, J., Heilimo, E. & Höltta, P. 2009. Geochemical and numerical constraints on Neoarchean plate tectonics. Precambrian Research 174, 155-162.

Heilimo, E., Halla, J. & Hölttä, P. Discrimination and origin of the sanukitoid series: Geochemical constraints from the Neoarchean western Karelian Province (Finland), Lithos (in press).

van Hunen, J., & van den Berg, A.P. 2008. Plate tectonics on the early Earth: limitations imposed by strength and buoyancy of subducted lithosphere. Lithos 103, 217-235.