Forming continental crust: Density filtering of underthrust material at the arc Moho

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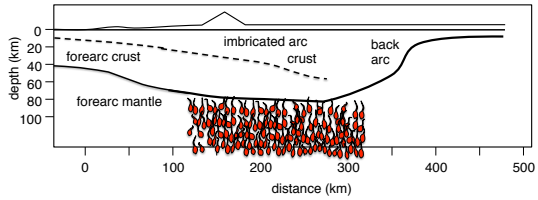
Together with others, we've emphasized the role of density sorting in forming felsic continental crust from mafic arc crust via "delamination" or "foundering" of dense material near the arc Moho [e.g., 1-3], and "relamination" of buoyant, subducted material via diapirs, ascent up a subduction channel, and underthrusting of forearc material during subduction erosion [e.g., 4-8]. Relamination is a good explanation for the widespread occurrence of metasediments (and small lenses of mantle peridotite) in lower crust, and – compared with previous estimates – yields more SiO_2-rich bulk compositions for lower and bulk continental crust, which remain consistent with geophysical constraints.

Here we revisit the possibility that underthrusting of forearc material is an important process in continental genesis and evolution. We consider that in the early Earth, forearc and trench sediments were derived mainly from erosion of arc magmatic rocks. We calculate densities for the same suite of arc rocks as [8], but at arc Moho (800°C, 1 GPa, 900°C, 1.2 GPa) rather than subduction zone conditions (700°C, 3 GPa). Compared to residual peridotite, less dense material is assumed to remain in the crust, while denser material founders into the mantle. These calculations yield bulk compositions consistent with granulite facies terrains and geophysical constraints. Obviously they omit the complexity of processes over 4 Gyr but, like [8], they yield a quantitative benchmark for comparison with other hypotheses.



[1] Herzberg et al Contrib Mineral Petrol 1983 [2] Jull & Kelemen JGR 2001 [3] Behn & Kelemen JGR 2006 [4] Quick et al Geology 1995 [5] Behn et al Nature Geosci 2011 [6] Hacker et al EPSL 2011 [7] Hacker et al AREPS 2015 [8] Kelemen & Behn Nature Geosci 2016