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Geochemical consequences of the crystallization of a basal magma ocean

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Partial melting at the base of the Earth's mantle has been proposed to explain the presence of ultra low velocity zones. The cooling of the core necessary to have mantained the geodynamo for the last 3.2 Gy implies that the present-day melt pockets are the remnants of a crystallizing basal magma ocean formed very early. The slow cooling of the overlying solid mantle allowed a fractional crystallization. As a consequence, the melt consititutes a hidden reservoir containing a large fraction of incompatible elements that explains the Sm-Nd difference between Earth samples and chondrites.

Using a cooling and crystallization model, we show that the crystals formed out of the basal magma ocean were mixed back in the mantle early on, letting geochemical fingerprints in archean rocks. Between 3.5 and 2.7 Gy, the crystals became dense enough to form piles overlying the melt. These piles are depleted and contain the primitive-like signature observed in mantle plumes today.