Asymmetric Early Post-Magma Ocean Crust Building on the Moon's Nearside

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The Moon's crust is hemispherically asymmetric in terms of crustal thickness, the composition of the primary lunar magma ocean- (LMO) derived anorthosite, and in the distribution of both geochemically incompatible elements (including the radioactive elements K, U, and Th) and erupted lavas. The concentration of radioactive elements on the nearside in the Procellarum KREEP Terrane (PKT) is widely thought to have provided heat for mantle melting from ~3.9 Ga to ~1 Ga. However, a link between KREEP and the earliest pulse of post-differentiation crust building, represented by the Mg-suite, is highly debated.

Here we assess whether Mg-suite crust-building magmatism was a global or regional event using high-temperature experiments and thermal evolution calculations. Our high-temperature, 1-atm experiments simulate Mg-suite magma production from a hybridized source region [1] consisting of deep mantle dunites, crustal anorthosite, and variable amounts of KREEP from 0 – 50 wt. %. Our results show that the change in bulk chemical composition due to increasing amounts of KREEP lowers the melting point of the three-component system dramatically. When we consider only experimentally produced melts that match the major and trace element compositions of Mg-suite parental melts estimated from samples, we conclude that there may have been between ~4 – 13 times more Mg-suite melt production in and around the PKT post-LMO relative to the farside.

We also conducted cooling calculations for the Mg-suite source regions of the same compositions to assess the effects of radiogenic heating. Using lower crustal cooling rates of 0.2 – 2.5K/Myr from [2], all Mg-suite source regions containing >25% KREEP increase in temperature regardless of cooling rate. Conversely, all Mg-suite magma sources with <5% KREEP, as would be expected on the farside, cool down with time. The combined effects of KREEP-induced depression of mantle melting temperatures and the heat produced from radioactivity strongly suggest that Mg-suite crust-building was concentrated on the nearside in and around the PKT.

[1] Elardo et al. (2011) *GCA,* **75**, 3024 – 3045
[2] Laneuville et al. (2018) *JGR-P,* **123,** 3144 – 3166