ASYMMETRIC POST-MAGMA OCEAN CRUST-BUILDING ON THE LUNAR NEARSIDE.

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Introduction: The Mg-suite is a series of ancient plutonic rocks from the lunar crust with ages and compositions indicating that they represent the first post-differentiation crust-building magmatism [1, 2]. Samples of Mg-suite materials were found at every Apollo landing site except 11 and all exhibit geochemical characteristics indicating the involvement of KREEP in their petrogenesis [3-5]. This has led to the suggestion that the KREEP reservoir under the nearside was responsible for Mg-suite magmatism [e.g., 5, 6]. The lack of readily identifiable Mg-suite rocks in meteoritic regolith breccias sourced from outside the Procellarum KREEP Terrane (PKT) seemingly supports this interpretation.

One attractive aspect of including KREEP as a necessary component of Mg-suite formation models is the high abundance of heat-producing elements in KREEP (e.g., K, Th). The primitive major element compositions of Mg-suite rocks indicate mantle source rocks with high melting temperatures, so KREEP presents a convenient heat source for Mg-suite magmatism inside the PKT [5, 6]. However, given that Mg-suite ages are essentially identical to both FANs and model ages for KREEP and mare basalt sources [7], there may not have been sufficient time for radiogenic heat to accumulate and significantly impact the onset of Mg-suite magmatism. Here, we propose an alternative model by which the presence of KREEP can affect Mg-suite melt production: melting point depression. We have undertaken high-temperature experiments to test the model that KREEP resulted in melting point depression of FAN-early LMO cumulate source materials. Additionally, we are currently performing calculations to test the radiogenic heating model to better constrain the relative contributions of melting point depression and radiogenic heating to Mg-suite melt production

Experimental Design: Six starting materials with 0%, 5%, 10%, 15%, 25%, and 50% of the KREEP mix by weight were prepared by combining a synthetic KREEP composition [8] with a 50:50 mixture of powdered San Carlos olivine and powdered Miyake-jima anorthite, which are compositional analogs for deep mantle dunites and FANs. Experiments were conducted in a Deltech vertical gas mixing furnace at the Geophysical Lab at an fO_2 corresponding to the IW buffer using a CO-CO_2 mixture. Experiments were soaked for 4 – 6 days to ensure a close approach to equilibrium.

Discussion: Our experimental results demonstrate that the addition of KREEP to a mixture of crustal anorthosite and deep mantle dunite, which is the likeliest source rock for the Mg-suite [1, 5], depresses the melting temperature relative to a KREEP-free source. To assess the degree of this effect, we consider only melt-bearing experiments saturated in olivine and plagioclase, but not low-Ca pyroxene. These magmas would produce primitive troctolites. Our experiments show that the addition of 5% - 50% KREEP in the source rocks results in an increase in melt production by a factor of 2x – 13x over a KREEP-free source. The melts are in equilibrium with olivine and plagioclase with An#s and Mg#s similar to Mg-suite troctolites, showing that even with the addition of 50% KREEP, major element constraints are not violated. Trace elements provide additional constraints on our model. We calculated the REE abundances in our experimental melts using trace element partitioning parameterizations for olivine and plagioclase. We also modeled the REE abundances of Mg-suite parental magmas. In all cases, REE contents of our experimental melts are slightly lower than or similar to troctolite parental magmas.

We are currently performing calculations to determine the temperature increases that would be expected in source regions with the same percentages of KREEP as our experiments. The short time intervals between KREEP formation and the onset of Mg-suite magmatism combined with heat loss due to cooling may affect the ability of radiogenic heating to be the driver for Mg-suite magmatism.

These findings strongly suggest that KREEP-induced melting point depression could have had a significant impact on Mg-suite melt production on the nearside vs. farside. Our findings do not preclude the occurrence of Mg-suite magmatism in the farside crust, but demonstrate that models of Mg-suite petrogenesis should predict far more magmatism on the nearside, perhaps by an order of magnitude or more. This conclusion is independent of the effects of any radiogenic heat production from KREEP.

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