ON THE PROVENANCE & DISTRIBUTION OF THE LUNAR HIGHLANDS MAGNESIAN-SUITE.

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Introduction: *What is the provenance of the magnesian-suite rocks?* Posed in the first volume of New Views of the Moon [1], this question has motivated several lines of research aimed at advancing our understanding of the ancient, plutonic magnesian-suite samples. Below, I summarize the distribution and petrogenesis of the lunar highlands Mg-suite in light of recent experimental and orbital data.

Pink Spinel Anorthosites (PSA): NASA's M^3 experiment remotely identified a potentially new lunar rock type, PSA [2]. The lithology contains spinel ($MgAl_2O_4$) with no mafic silicate signature observed in the visible to near infrared wavelengths, suggesting a unique origin. This type of spinel is rare among the lunar samples, but most commonly observed within the Mg-suite pink spinel troctolites (PST) [3]. Akin to the plutonic Mg-suite, PSA detections are associated with the central peaks of craters and basin walls, indicative of intrusive lithologies excavated during impacts [4]. [3] experimentally investigated the hypothesis that PSA formed by magma-wallrock interactions within the lunar crust [5,6]. Results indicate PSA is best explained as the reaction product between the Mg-suite parent melt and anorthosite [3]. If true, the chemical connection between PSA and Mg-suite is profound; remote detections of PSA can be used as a new proxy for Mg-suite lithologies on the Moon [3]. Moreover, the presence of PSA (and by extension, Mg-suite) on the lunar farside and regions outside of the Procellarum KREEP terrane [4] may indicate KREEP is not a primary component of Mg-suite petrogenesis [3].

Troctolite Petrogenesis as told by Spinel: Two competing hypotheses suggest melts parental to the lunar troctolites formed **(A)** by partial melting of a hybridized source region (ultramafic cumulates + plagioclase-bearing rocks + KREEP) [7] or **(B)** when magma-wallrock interactions within the anorthositic crust increased the Al-contents of initially plagioclase-undersaturated, MgO-rich melts [8]. However, phase equilibria experiments testing melt compositions from both **(A)** & **(B)** [9,10] yield major and accessory mineral compositions consistent with PST only, and do not produce magmatic chromite ($FeCr_2O_4$) as observed in the remaining troctolites (and dunites) [10]. Instead, experiments and modeling suggest plagioclase undersaturated Mg-suite melts are parental to chromite-bearing troctolites (and dunites), whereas spinel in the PST is an indicator of **(B)** [10]. The process of **(B)** is likely restricted to the magma-wallrock interface due to slow diffusion rates of Al_2O_3 in basaltic melts [11] and thus, spinel-bearing lithologies are expected to represent a volumetrically minor, but perhaps widespread, component of the lunar crust [10]. The conclusions are supported by the paucity of PST among the Mg-suite samples (though possibly not representative) and also the low number (~20) of global PSA detections [4]. New estimates of the plagioclase undersaturated Mg-suite parent are provided by [10].

Buoyancy-driven Mg-suite Magmatism: Finally, the lack of extrusive (and predominance of intrusive) Mg-suite samples is surprising considering that mare basalt flows cover ~18% of the lunar surface [12] and are 200 – 300kg/m^3 greater in density than estimates for Mg-suite parental melts [13]. Motivated by recent measurements of crustal density from GRAIL [14], buoyancy-driven magmatic ascent of Mg-suite melts was investigated [15,16]. Results from [15,16] suggest present day, low-crustal densities measured by GRAIL (due to increased estimates of porosity) are needed to have prevented ancient, low-density Mg-suite parental melts from buoyantly erupting. Because the Mg-suite samples are ancient (> 4.1Ga) and predominantly intrusive, the results imply the primary lunar crust was fractured soon after solidification perhaps creating a porous, low-density barrier to eruption [16]. The Mg-suite parental melt estimated by [10] is consistent with intrusive petrogenetic models, and potential regions of eruption predicted for alternative Mg-suite melts are focused within the nearside southern highlands [16]. The Mg-suite eruptive area in the nearside southern highlands [15,16] is strongly correlated with a number of PSA detections [4] and positive Bouguer anomalies (possibly buried Mg-suite) [17] identified within the region. The findings suggest the nearside southern highlands is the most promising region to explore ancient intrusions and possible volcanic deposits of the lunar highlands Mg-suite [16].

References: [1] Wieczorek, M.A. et al. (2006) Rev. Min. Geochem., 60, 221-364 [2] Pieters, C.M. et al. (2011) JGR 116(E6) [3] Prissel, T.C. et al. (2014) EPSL 403 144-156 [4] Pieters, C.M. et al. (2014) Am. Min. 99, 1893-1910 [5] Gross, J. and Treiman, A.H. (2011) JGR 116(E10) [6] Prissel, T.C. et al. (2012) LPSC 43 #2743 [7] Longhi, J. et al. (2010) GCA 74 784-798 [8] Warren, P.H. (1986) JGR 91 D331-D343 [9] Prissel, T.C. et al. (2014) LPSC 45 #2514 [10] Prissel, T.C. et al. (in press) Am. Min. [11] Morgan, Z. et al. (2006) GCA 70 3477-3491 [12] Whitten, J.L. & Head, J.W. (2015) Icarus 247 150-171 [13] Prissel, T.C. et al. (2013) LPSC 44 #3041 [14] Wieczorek, M.A. et al. (2013) Science 339 671-675 [15] Prissel, T.C. et al. (2015) LPSC 46 #1158 [16] Prissel, T.C. et al. (in review) Icarus [17] Sori, M.M. et al. (in press) Icarus