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Lunar magnesian-suite volcanism and ancient crust building 4.25 billion years ago

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The crystallization age of the Apollo 17 picritic basalt sample 73002,1017C (thick section 73002,455) has been determined by Pb-Pb SIMS to be 4.25 billion years [1]. The geochemistry and age of the sample link it directly to the lunar Mg-suite, an ancient lithology important to early crustal building processes known previously to only comprise intrusive rocks. Indirectly linked to the Mg-suite, a volcanic glass bead from the same double-drive tube 73001/73002 has the same composition as 73002,1017C after olivine subtraction. Two other clasts in 73001/73002—73001,1122A (thick section 73001,568) and one in continuous thin section 73001,6019 have been identified as potential Mg-suite extrusives. Their bulk compositions are similar to that of 73002,1017C, with all showing evidence of excess olivine (crystal accumulation). 73001,1122A contains 'pink' Mg-spinel whereas the other two do not. A similar lithology was also identified in the 0.5-1 mm size fraction polished grain mounts of 73001 [2].

We used the Magma Chamber Simulator [3,4] to test hypotheses for the petrogenesis of these Mg-suite extrusive rocks. We find that the composition of 73002,1017C after olivine subtraction can be successfully recreated (RMSE < 1) with lunar crustal-pressure assimilation-fractional crystallization between LPUMi (adiabatic partial melt of lunar magma ocean cumulate pile) and a ferroan anorthosite (representing the primary lunar crust) such as 60215, with minor contributions from ilmenite-bearing cumulates and urKREEP. The composition can also be similarly recreated with a high-temperature low pressure melt of the lunar magma ocean cumulate pile instead of LPUMi. The existences of Mg-suite extrusive, volcanic samples provide a better-constrained parent melt composition of the Mg-suite, and reaffirm the idea that the Mg-suite formed by interactions between early lunar magma ocean cumulate sources over 4.1-4.4 billion years ago [5].

[1] Yen et al., (2023) *Goldschmidt Conference*

[2] Simon et al., (2024) *55th Lunar and Planetary Science Conference*

[3] Bohrson et al., (2014) *Journal of Petrology*

[4] Bohrson et al., (2020) *Contributions to Mineralogy and Petrology*

[5] Shearer et al., (2015) *American Mineralogist*