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Petrology and geochemistry of lunar granite 12032,366-19 and implications for lunar granite petrogenesis

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Abstract

Apollo 12 sample 12032,366-19 is a 21.3 mg granite fragment that is distinct from any other lunar granite or felsite. It is composed of barian K-feldspar, quartz, sodic plagioclase, hedenbergite, fayalite, and ilmenite, with trace amounts of zirconolite, baddeleyite, apatite, and merrillite. The texture of 12032,366-19 is largely a micrographic intergrowth predominantly of K-feldspar and quartz and, to a lesser extent, plagioclase and quartz. Hedenbergite, fayalite, and ilmenite are present in minor but significant quantities—6.0, 3.1, and 1.7 wt%, respectively—and are scattered throughout the feldspar-quartz intergrowths. Trace amounts of Zr-bearing phases are found including zirconolite (0.6 wt%) and baddeleyite (0.04 wt%). Incompatible trace-element concentrations are high in 12032,366-19, particularly the high-field-strength elements, e.g., Zr, Sm, and Th (1500, 25, and 61 µg/g, respectively). The chondrite-normalized, rare-earth-element concentrations form a "V-pattern" that is characteristic of other lunar granitic material. By modeling 12032,366-19 as a derivative from a KREEP-like parent melt, the composition and mineral assemblage can be obtained by extended fractional crystallization combined with separation of the low-density minerals plus trapped melt components prior to final solidification. However, this model cannot quantitatively account for the relatively sodic composition of the plagioclase ($An_{34–50}$) and requires that the starting melt has Na_2O of 1.2–1.4 wt%, which is higher than most KREEP compositions. Formation of this assemblage by silicate-liquid immiscibility is neither required nor indicated by petrogenetic modeling.

Keywords: Granite, Moon, zirconolite, apatite, felsite, Apollo 12