

A Highly Enriched Parental Melt Composition of Apollo 17 Mg-suite Samples

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The lunar Mg-suite rocks are characterized for their simultaneous enrichment in Mg, Al, REE and other trace elements. Their origin can be traced to lower mantle cumulates, the crust and KREEP, a highly enriched mantle source resulting from the last part of the magma ocean to crystallize. But these are cumulate rocks with unknown parental melts, which we must approximate through experimental and modeling approaches. We have obtained trace element compositions of plagioclase, pyroxenes and olivine, through LA-ICP-MS for several Apollo 17 samples. We used these trace elements to approximate the parental melts for each sample through partition coefficient inversions. An analysis of re-equilibration was performed to ensure that the compositions accurately represent magmatic compositions. Only samples with visible pyroxene exsolution appeared to present significant re-equilibration, and most of them show very little or no subsolidus re-equilibration. Through the parental melt approximation, most samples were found to be related to each other by linear behavior of Eu, Nd, La, Sr, Ba and others, with trends that could be approximated by fractional crystallization of the most depleted samples. These trends are consistent with the lithological evolution associated to the Mg-suite: the transition from troctolite-norite-gabbro-norite. This is also consistent with the liquid line of descent modeled from the composition of a melt inclusion found in an olivine crystal.

The most depleted samples have a REE concentration of around 30% that of KREEP (10^2 - 10^3 times chondritic values). In contrast, the most evolved gabbro-noritic samples are indicative of melts enriched over an order of magnitude above the troctolites and are modeled as over 90% fractional crystallization of the same parental melt. At this stage, elements like Zr, Ba and REE have concentrations that can add up between 1-3 wt.%. This implies the existence of highly enriched crustal manifestations which result from this fractional crystallization process. The abundance of similarly enriched rhyolitic melts found within Mg-suite rocks in norite and gabbro-norite stages could be related to the origin of granitic formations in the lunar crust.