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Petrogenesis of Chang'E-5 mare basalts: Clues from the trace elements in plagioclase

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Abstract

This study focuses on using the chemical compositions of plagioclase to further investigate the petrogenesis of Chang'E-5 young mare basalts and constrain its parental melt composition. Together with previously published data, our results show that the plagioclase in mare basalts overall displays large variations in major and trace element concentrations. Inversion of the plagioclase data indicates that the melt compositions parental to Chang'E-5 basalts have high rare earth elements (REE) concentrations similar to the high-K KREEP rocks (potassium, rare earth elements, and phosphorus). Such a signature is unlikely to result from the assimilation of KREEP components, because the estimated melt Sr shows positive correlations with other trace elements (e.g., Ba, La), which are far from the KREEP end-member. Instead, the nearly parallel REE distributions and a high degree of trace element enrichment in plagioclase indicate an extensive fractional crystallization process. Furthermore, the estimated melt REE concentrations from plagioclase are slightly higher than those from clinopyroxene, consistent with its relatively later crystallization. Using the Ti partition coefficient between plagioclase and melt, we estimated the parental melt TiO_2 content from the earliest crystallized plagioclase to be ~3.3 ± 0.4 wt%, thus providing robust evidence for a low-Ti and non-KREEP origin for the Chang'E-5 young basalts in the Procellarum KREEP terrane.

Keywords: Plagioclase, clinopyroxene, basalt, low-Ti, rare earth element, KREEP