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Heterogeneity In Chang'e-5 Lunar Basalts

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The size of basalt fragments in Chang'e-5 (CE-5) regolith are small (<6 mm^2), resulting in large variation on the estimated bulk composition of CE-5 basalt, which are critical for investigating the crystallization sequence and formation mechanism of the young lunar basalt (~2.0 Ga) [1, 2]. We present petrologic and geochemical analysis of some CE-5 basalt fragments as well as integrate experimental studies to explore the formation mechanism of CE-5 basalt. Equilibrium experiment results show that olivine is the liquidus phase at relatively lower pressure (<0.5 GPa) and followed by plagioclase crystallization. High-Ca pyroxene joins the sequence as the second phase crystallized from the silicate liquid at high pressure condition (>0.7 GPa). Neither of these two cases can produce the lithologies of CE-5 basalt. On the other hand, the relatively high-Ti concentration in pyroxenes (~2.0 wt%) indicates that the parental magma of CE-5 basalt has experienced fast cooling process, which is reproduced by controlled cooling experiments (12-18℃/hour). However, pyroxenes in some basalt fragments show very high-Ti concentrations (>6 wt%) and high Al-concentration (> 8 wt%) should have been formed from high-Ti source region. These new experimental results suggest that the source magma of CE-5 basalt could be analogous to those of Apollo high-Ti basalt and have experienced two-stage crystallization processes. The source magma resides in a staging magma chamber at depth 100 km until the temperature dropped by approximately 40 ℃ below the liquids after which the magma migrated upward to the surface of the Moon. Combined with our research progresses on impact breccia found in CE-5 sampling area, we propose that the magmatism around PKT is related with the formation of Imbrium basin.

1. Li et al. (2021), Nature, 600, 54-58.
2. Che et al. (2021), Science, 374, 887-890.