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Textural and mineral chemical evidence for the cumulate origin and evolution of high-titanium basalt fragment 71597

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Abstract

Basalt fragment 71597 is the sole high-titanium mare basalt showing evidence for olivine accumulation during formation. The petrogenesis of this unique sample was investigated using quantitative textural analysis and major- and trace-element mineral geochemistry. Crystal size distribution analysis identified two size populations of olivine, which we separate into cumulate and matrix olivine. The spatial distribution of olivine also supports clustering of olivine crystals, likely during accumulation. Observed mineral chemistry was consistent with an origin through olivine accumulation, although where this occurred cannot be discerned (e.g., in ponded melts at the base of or in the lunar crust, or within a thick high-Ti basalt flow). Attempts to place 71597 within a geochemical group were inconclusive both using subtraction of cumulate olivine from bulk composition, and by modal recombination of major phases. However, equilibrium liquid compositions of augite and plagioclase are determined to be consistent with an origin by fractionation from the Type B2 chemical suite of Apollo 17 high-Ti basalts. This method of classification has potential for placing other Type U ("Unclassified") basalts into chemical suites.

Keywords: Mare basalts, cumulates, crystal size distributions, LA-ICP-MS