Apollo 15 Green Glass: Compositional Distribution and Petrogenesis

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ABSTRACT

We have characterized a comprehensive suite of individual, green-glass beads from Apollo 15 soil to determine interelement behavior and to constrain petrogenetic relationships. We analyzed 365 particles for trace elements by instrumental neutron activation analysis, and have analyzed 52 of those covering the compositional ranges observed for trace elements for major elements by electron microprobe analysis. We confirm the observation of Delano (1979) that the beads comprise discrete compositional groups, although two groups he defined are further split on the basis of trace-element compositions. Each of the resulting seven groups has distinct average rare-earth abundances. The coherence between major- and trace-element data was masked in previous studies by imprecision, correlated error, and nonrepresentative sampling of the different groups. Most of the compositional characteristics of the green glasses can be explained by a model for batch equilibrium melting of a nearly homogeneous, ultramafic source region, when the complicating effects of high pressure and low oxygen fugacity are taken into account. The previously puzzling behavior of Ni and Co as apparently incompatible elements may arise from partial reduction of those elements to the zero oxidation state, with substantial melt solubility and low partition coefficients. The model also offers explanation for why the green glasses form boomerang trends on many two-element variation diagrams and why certain compositions (Groups A and D) are more abundant than glasses with other compositions.