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Siderophile volatile element inventory of Apollo 17 high-Ti mare basalts: Assessing the influence of fractional crystallization and magmatic degassing

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The Moon is significantly depleted in volatile elements when compared to Earth. To better understand the magmatic evolution and volatile loss of the Moon, study of its interior composition is essential. Mare basalts provide important insights into the lunar interior as they represent voluminous magmas originating from partial melts of the lunar mantle. Although mare basalts have been studied by NAA in the aftermath of the Apollo missions, data on SVE in high-Ti mare basalts are scarce. In this study, we provide a comprehensive data set for mass fractions of Cu, Se, Ag, S, Te, Cd, In, and Tl in high-Ti mare basalts measured from the same sample aliquot via state-of-the-art isotope dilution-ICP-MS. We studied Apollo 17 type A (n=6) and type B (n=6) samples of variable Mg content. Each type represents a distinct lava flow, which evolved due to fractional crystallization of silicates and Fe-Ti oxides at shallow depths near the effusion level [1]. Type A basalts are considered to be more evolved than those of type B because they show higher incompatible element abundances. CI-normalized SVE abundances of high-Ti basalts show overall similar fractionation patterns to low-Ti basalts but significantly higher abundances of S as well as slightly higher Cd and slightly lower Cu abundances. When plotted against incompatible refractory lithophile elements such as Sm, Cu, Se, and Ag show positive correlations. The same applies to S, but due to slightly larger scatter of the data, the correlations are not as clear. This observation of positive trends indicates that fractional crystallization was the most important controlling process on the budget of less volatile SVE. Fractional crystallization trends of the more volatile elements Te, Cd, In, and Tl are disturbed, most likely due to late-stage magmatic degassing. In order to further assess mantle source characteristics, we will discuss a fractional crystallization model which involves refractory lithophile as well as siderophile volatile elements. The results indicate significantly lower Cu/S and higher S/Se ratios in the initial high-Ti basalt melts, indicating heterogeneity of SVE inventories in mantle sources of low- and high-Ti basalts.

[1] Neal et al., 1990, GCA 54, 1817-1833