An intrinsic volatility scale relevant to the Earth and Moon

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The notion of a dry Moon has recently been challenged by the discovery of high water contents in lunar apatites and in melt inclusions within olivine crystals from the two pyroclastic glasses 15426 and 74220. However, these water contents were determined on lithologies that are rare on the lunar surface. To obtain a more representative constraint on the volatile content of the lunar interior, we measured the Zn content, a highly volatile element, of mineral and rock fragments in Apollo mission lunar soils, which average over the surface of the Moon. We show here that the Moon is significantly more depleted in Zn than the Earth. Combining Zn with existing K and Rb data on similar rocks allows us to anchor a new volatility scale based on the bond energy of elements in their condensed phases. Extrapolating the volatility curve to H shows that the bulk of the lunar interior must be dry (≤1 ppm). This contrasts with the water content of the mantle sources of pyroclastic glasses, inferred to contain up to ~40 ppm water based on H_2O/Ce ratios. These observations are best reconciled if the pyroclastic glasses derive from localized water-rich heterogeneities in a dominantly dry lunar interior. Although late addition of 0.015% of a chondritic veneer to the Moon is required to explain the abundance of platinum-group elements, the volatile content of the added material was clearly heterogeneous.