Differences in the triple-oxygen isotope composition of the Earth and Moon

E.J. CANO[1], Z.D. SHARP[1], C.K. SHEARER[2]

[1] Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM [ejcano@unm.edu]
[2] Institute of Meteoritics, University of New Mexico, Albuquerque, NM

Measurements of the triple-oxygen isotopes in mineral separates from lunar and terrestrial basalts reveal that the average $\Delta'^{17}O$ for the Earth and Moon display a statistically significant difference of about 0.01‰ (λ=0.528). Measurements were performed on plagioclase-pyroxene (olivine) mineral separate pairs from both lunar and terrestrial basalts as well as pyroxene and olivine separates from terrestrial peridotites. Empirical measurements of the fractionation exponent (θ) for plagioclase-pyroxene (olivine) pairs in some lunar and terrestrial samples yield values between 0.477 and 0.496, far lower than the expected range predicted for high-temperature equilibrium oxygen fractionation. However, in lunar whole rock analyses the distinction between the $\Delta'^{17}O$ values of terrestrial and lunar basalts is less clear. Lunar basalt whole rock $\Delta'^{17}O$ values range from -0.040‰ to -0.057‰ (λ=0.528), placing them in a range more similar to Earth values as defined by the terrestrial separates. The whole rock samples often yield $\Delta'^{17}O$ values lower than what would be expected from mixing between the pyroxene and plagioclase values, which are the two most abundant mineral phases. These data suggest that another phase, possibly ilmenite, may draw down the $\Delta'^{17}O$ values of the basalt when it is measured in bulk. This tentative conclusion is supported by a positive correlation between $\Delta'^{17}O$ and titanium concentration, and the analysis of ilmenite separates from high-Ti lunar basalts will help determine if this scenario is plausible. Alternatively, it is possible that the observed variation is caused by another process, including degassing or contamination by terrestrial or extralunar materials, which has affected the basaltic bulk material but not the larger mineral grains from which the separates were picked. While pyroxene and olivine separates are likely a better representation of the oxygen composition found in the Earth and Moon's interiors, this variation in whole rock values may explain why it has previously been concluded that the two bodies are identical with respect to $\Delta'^{17}O$.