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A cannon ball impact model of Moon formation and the nature of the earliest meteorites

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We have analyzed the triple oxygen isotope composition of a set of NASA Apollo lunar samples with an improved analytical setup. The $\Delta'^{17}O$ of the (pristine) Moon is within 0.2 ± 0.8 ppm identical to that of the Earth mantle. No intrinsic oxygen isotope heterogeneity is resolved for the major lunar lithologies. We suggest that the proto-Earth was hit by a "cannon ball" impactor that had lost its silicate mantle by space erosion. A silicate-free impactor well-resolves the "isotope crisis" of Moon formation.

We have also identified that the earliest generation of meteorites that struck the lunar surface were likely carbonaceous-chondrite like, with $\Delta'^{17}O$ lower than Earth (and Moon). This generation of meteorites also hit the Hadean and Archean Earth surface and hence may have contributed to the formation of life on Earth > 3.5 Ga ago.

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