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The Age of KREEP

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The formation of a magma rich in K, REE, and P (KREEP) marks the end of crystallization of the lunar magma ocean. Its age represents a minimum age for the formation of the Moon, which has been the subject of considerable controversy, with ages proposed spanning ~4.35 to >4.5 Ga [1,2]. KREEP formation was associated with Lu/Hf fractionation, which can be dated using ^{176}Lu-^{176}Hf in lunar zircons [2-4]. The measurements performed so far on lunar zircons demonstrated the old age of KREEP, but improvements are needed to place more definitive constraints on the chronology of lunar formation and differentiation. We carried out a multi-institution coordinated study of Lu-Hf systematics in lunar zircons that involved finding and characterizing the zircons, treating them by chemical abrasion, measuring their U-Pb ages by TIMS, and measuring their Hf isotopic compositions by MC-ICP-MS [4]. Data reduction involves ensuring that chemical abrasion does not disturb Lu-Hf systematics, correcting the zircons for ^{176}Lu-decay, and correcting Hf isotopic ratios for the presence of cosmogenic effects [4]. Despite differences in ages, all zircons analyzed show subchondritic ^{176}Hf/^{177}Hf ratios consistent with crystallization from a chemically uniform KREEP reservoir that was isolated from the lunar magma ocean at a well-defined time. These new data help us constrain the age of KREEP.

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