Timing and origin of the angrite parent body inferred from Cr isotopes

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Angrite meteorites are some of the oldest materials in the solar system. They provide important information on the earliest evolution of the solar system and accretion timescales of protoplanets [1]. Previous studies showed the crystallization age of individual angrites (4~11 Ma after CAI) [1], while the formation of the angrite parent body (APB) is still unknown. Mn-Cr chronometry ($t_{1/2}$ = 3.7 Myrs) is robust to date early events happened in the first 10 Ma in the Solar System [2]. Also the ε^{54}Cr systematics can be used to trace the origin of the APB [2,3]. Here, we report the first systematic high-precision mass-independent Cr isotopic data for seven bulk angrites to answer the questions above.

3-step columns were used to purify the Cr, followed by [4] with a total yeild more than 90%. The Cr isotopes were measured on Triton TIMS, followed by the total-evaporation method described in [5]. The seven angrites possess homogeous ε^{54}Cr with average value of -0.42 ± 0.13, and all of them fall on a single isochron with a slope of ^{53}Mn/^{55}Mn = (3.17 ± 0.21) × 10^{-6}.

The ε^{54}Cr values for angrites is similar to that of ordinary chondrites [2], and it is further consistent with the Δ^{17}O and ε^{50}Ti homogenity, supporting a magma ocean model. The ^{53}Mn/^{55}Mn ratio defined by the external isochron corresponds to an age of 4563.3 ± 0.4 Ma (4 Ma after CAI), when anchored to U-corrected Pb-Pb age of D'Orbigny. We show that this age records the mantle-crust differenciation of the APB, rather than core formation or volatile depletion. When compared to this external isochron, internal isochrons obtained through mineral separation of individual angrites with ages from 4563 to 4556 Ma, reflect the cooling history during the evolution of the APB.

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