The short-lived ^{53}Mn-^{53}Cr chronology and its application in the origin of angrite parent body.

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Abstract: Chromium (Cr) isotopes is probably one of the best suited system to study the timing and genetic relationships. The short-lived nuclide ^{53}Mn, with a half-life of 3.7 ± 0.2 Myrs, decays to ^{53}Cr (radiogenic origin) and therefore the ^{53}Mn-^{53}Cr decay system is a useful chronometer to date early Solar System events. On the other hand, the variation of $^{54}Cr/^{52}Cr$ ratios (nucleosynthetic origin) can be a good tracer to track the kinship of Solar System materials.

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. Here, we show that the $^{54}Cr/^{52}Cr$ ratio is homogeneously distributed among angrite meteorites within 13 parts per million, indicating that precursor materials must have experienced a global-scale melting such as a magma ocean. The $^{53}Cr/^{52}Cr$ and Mn/Cr ratios are correlated which is evidence for an initial $^{53}Mn/^{55}Mn$ ratio of $(3.17 \pm 0.21) \times 10^{-6}$. When anchored to the U-corrected Pb-Pb age for the D'Orbigny angrite, this initial $^{53}Mn/^{55}Mn$ corresponds to an absolute age of 4563.3 ± 0.4 Ma, i.e. 4.0 ± 0.4 Ma after CAI-formation. This age is distinct from the one of the volatile depletion events dated by the $^{87}Sr/^{86}Sr$ initial ratio and therefore must correspond to the age of crystallization of the magma ocean and crust formation of angrite parent body (APB), which can also constrain a bigger size of APB than that of Vesta. Furthermore, this age is similar to those obtained from internal isochrons of the oldest volcanic angrites that cooled rapidly at the surface of the parent body (with ages of 4564 ~ 4563 Ma), while older than those obtained from plutonic angrites (4561 ~ 4556 Ma) that cooled down slowly, located deeper within the parent body. This implies that cooling of the angrite parent body took at least ~8 Myrs after its formation.

Key words: Geo and cosmochemistry, Sun and Solar system.