UNIQUE ANGRITE-LIKE FRAGMENTS IN A CH3 CHONDRITE REVEAL A NEW BASALTIC PLANETESIMAL.

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Introduction: Meteorites are believed to be chips from planetesimals. Planetesimals are the building blocks of our planetary system. They can be used to constrain the chemical evolution and dynamic history of the early Solar System. Angrites are a group of volcanic and plutonic meteorites that have unique chemical feature and mineral assemblage [1]. Here, we report the discovery of angrite-like material enclosed in a primitive CH3 chondrite Sayh al Uhaymir (SaU) 290 and discuss its significance for understanding the dynamic evolution of the early Solar System.

Results: Petrography and mineralogy of SaU 290 have been reported in our previous investigations [2–3]. In this study, two oval-shaped fragments (ALF-1 and ALF-2) are observed consisting mainly of Ca,Fe-rich olivine and Al,Ti-rich augite with minor other phases. The olivine grains in the two fragments are Ca,Fe-enriched to various degrees but their Ca-Mg-Fe variation trends are similar to that of olivine in volcanic angrites [4]. The fragment ALF-1 has a Mn,Cr-rich zone along the margin (>20 μm). However, the interior olivine in ALF-1 and olivine in ALF-2 have Fe/Mn values consistent with that of olivine in angrites. In the interior of ALF-1, the Al,Ti-rich augite grains have two groups of compositions in FeO, MgO, and Al_2O_3. Both fragments contain chromite and spinel and the chormite grains in ALF-2 show irregular micro-scale heterogeneity in BSE images. The fragment ALF-1 has a thin rim (~2 μm in width) composed of low-Ca pyroxene with minor high-Ca pyroxene and FeNi metal. High-precision SIMS measurements reveal that the olivine in the two fragments is ^{16}O-poor with an average Δ^{17}O value of 0.91 ±0.18‰ (2σ).

Discussion: The presence of Ca,Fe-rich olivine and Al,Ti-rich augite in the two fragments is the key feature similar to those in angrites [1]. The Fe/Mn values of olivine are largely consistent with that of olivine in angrites [5]. These two features indicate that the parent body of the fragments may have major-element bulk composition, oxygen fugacity, and differentiation similar to that of volcanic angrites. However, the oxygen isotope compositions of the fragments in this study are distinctly different from that of angrites [5], indicating they have been derived from different parent bodies.

Although the chemical composition of olivine can be interpreted with simple fractional crystallization, many of other textural and composition features in the two fragments imply that the fragments have experienced complex thermal events after their initial crystallization. They include (1) absence of igneous texture; (2) coexistence of two groups of augite; (3) Mn,Cr-rich zone along the margin; (4) a rim of pyroxene + FeNi metal; and coexistence of spinel and chromite. Among these features, the Mn,Cr-rich zone along the margin and the rim of pyroxene +FeNi metal can be best, if not uniquely, explained with thermal events in nebular settings, probably similar to chondrule-forming environments. This implies that the parent body of the two fragments might have formed prior to the complete dissipation of the solar nebular gas. Given the Fe/Mn value in basaltic meteorites as a proxy of heliocentric distance [4], the parent bodies of the two fragments and angrites represent two generations of differentiated planetesimals at similar heliocentric distances. The parent body of the two fragments was formed within the solar nebula; whereas the angrite parent body was formed afterwards. Following the hypothesis and classification scheme of meteorites of Warren [6], angrites and CH chondrites belong to non-carbonaceous and carbonaceous meteorites and were formed in the inner solar system and the outer solar system, respectively. Thus, the presence of the two fragments enclosed in the SaU 290 CH chondrite indicates a large-scale migration and mixing between the inner and the outer solar system materials.

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