THE DISCOVERY OF HIDALGO, A NEW HIBONITE INCLUSION WITH FUN CHARACTERISTICS, IN DAR AL GANI 027 (CO3).

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Introduction: FUN (Fractionation with Unidentified Nuclear effects) inclusions are peculiar samples among all refractory components in chondritic meteorites. They are generally characterized by strong mass-dependent isotopic fractionations in several elements (e.g., O, Mg, Ca, Ti), large (~5-20‰) enrichments or depletions in neutron-rich isotopes (e.g., ^{48}Ca, ^{50}Ti, ^{54}Cr), and low inferred abundances of ^{26}Al (^{26}Al/^{27}Al < 1×10^{-5}) [1]. Understanding the origins of these features in FUN inclusions can shed light on the astrophysical environment and chemical processes that took place in the early Solar System. A large fraction (slightly less than half) of the ~20 FUN CAIs discovered so far are hibonite-rich (such as HAL, SHAL and DH-H1, collectively called HAL-type inclusions hereafter), and, according to their elemental and isotopic signatures and the results of evaporation experiments, are thought to have formed as a distillation residue [2,3]. However, questions regarding the timing of the formation of HAL-type inclusions relative to those of regular CAIs and the decoupling between the ^{26}Al abundances and nucleosynthetic anomalies remain poorly understood. Here we report preliminary data on mineral chemistry, and O and Mg isotopic compositions of a new HAL-type hibonite inclusion, HIDALGO (Hibonite in Dar al Gani CO3), found in the CO3 chondrite Dar al Gani 027 (DaG027), and discuss its possible formation history.

Mineralogy, oxygen and magnesium isotopic compositions: HIDALGO is a ~300×300 μm, nearly stoichiometrically pure, single hibonite crystal, containing homogeneous CaO = 8.5% and Al_2O_3 = 91% along with trace amounts of TiO_2 = 0.2% and FeO = 0.3%. No MgO could be detected by EPMA. Such mineral chemistry is very similar to all other HAL-type hibonites, except that HIDALGO apperas to be the most Mg-depleted hibonite found so far (^{27}Al/^{24}Mg up to 60,000). The O and Mg isotopic compositions were measured in multicollection and monocollection mode, respectively, on the UCLA CAMECA ims-1290 ion microprobe. Similar to all HAL-type inclusions, HIDALGO is characterized by fractionated oxygen isotopic compositions by 16−19‰/amu and a homogeneous Δ^{17}O value of −13.3±0.4‰ (2σ) (Fig. 1), but lacks discernable mass-dependent Mg isotope fractionations (δ^{25}Mg = 0.1±7‰ (2σ)). The inferred abundance of ^{26}Al incorporated into HIDALGO, ^{26}Al/^{27}Al = $(1.50\pm0.02)\times10^{-5}$, is higher than that in other FUN hibonites (Fig. 2). The initial ^{26}Mg/^{24}Mg ratio (Δ^{26}Mg$^*_0$ = −21±30‰) of HIDALGO is terrestrial within error.

Discussion: HIDALGO shares similar chemical and isotopic (O and Mg) characteristics with other HAL-type hibonites, suggesting that it could belong to the family of FUN inclusions (although we have not yet analyzed it for nucleogenetic anomalies in Ca, Ti, etc.). The nearly pure hibonite stoiochiometry and mass-dependently fractionated O isotopes point to a distillation origin for HIDALGO. Mg appears to have been near-completely lost during evaporation (hence the very high Al/Mg ratios) so that unfractionated δ^{25}Mg most likely was derived from measuring the contaminants having isotopically normal Mg. As a result, the ^{26}Al isochron of HIDALGO in Fig. 2 can be viewed as a mixing line between pure radiogenic ^{26}Mg and a terrestrial/chondritic composition. Although ^{26}Al/^{27}Al in HIDALGO is well-determined, understanding the chronological meaning of this value requires analyses of other isotope systems, such as Ca-Ti, ^{41}Ca and ^{10}Be. We will present the results of these additional analyses in the meeting.

References: [1] Wasserburg et al. 1977, *GRL*, 4:299−302 [2] Ireland et al. 1992, *GCA*, 56:2503−2520 [3] Floss et al. 1996, *GCA*, 60:1975−1997 [4] Lee et al. 1980, *GRL*, 7:493−496 [5] Fahey et al. 1987, *GCA*, 51:329−350.

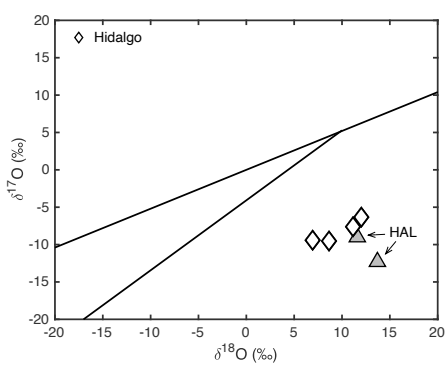

Fig. 1. Oxygen isotopic compositions of HIDALGO. O-isotope data of HAL [4] are plotted for comparison.

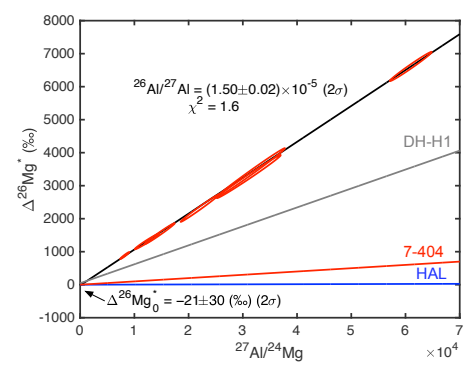

Fig. 2. ^{26}Al isochrons for HIDALGO and other HAL-type inclusions (literature data taken from [2,5]).