HETEROGENEOUS DISTRIBUTION OF ^{26}AL AT BIRTH OF THE SOLAR SYSTEM

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Uniform distribution of ^{26}Al with the canonical (^{26}Al/^{27}Al)$_0$ of ~5×10^{-5}, at least in the inner part of the solar system (SS), has been confirmed by high-precision Mg-isotope measurements of whole-rock CAIs, chondrites, Mars, Earth and the Moon [1]. It is also consistent with measured or estimated initial ^{26}Mg/^{24}Mg ratios in chondrules [2] and CAIs [3]. These observations support an external, stellar origin of ^{26}Al; Asymptotic Giant Branch (AGB) stars, Supernovae (SN), and Wolf-Rayet (WR) stars are discussed as possible sources [4–8]. An AGB source of ^{26}Al is unlikely because of the low probability of an encounter between an AGB star and a star-forming molecular cloud (MC) [9]. Although massive stars are commonly associated with star-forming regions [10], the probability of injection of sufficient ^{26}Al into the protosolar MC or PPD from a nearby SN is also low [11,12]. Alternatively, the Sun may have been a second-generation star in a MC polluted by a single or multiple SN several Ma before formation of the SS [13]. According to this model, ^{60}Fe and possibly ^{26}Al were inherited from the ISM. This model is also invoked to explain the enrichment of the SS in ^{18}O relative to the GCE trend [14]. However, the correlated occurrences of ^{26}Al and ^{41}Ca ($t_{1/2}$ = 0.1 Ma) in CAIs, suggesting the same stellar source for ^{26}Al and ^{41}Ca [15], make the SN model of [13,14] unlikely, at least for ^{26}Al. Instead, ^{26}Al could have been delivered to the protosolar MC by a WR star that escaped from its parent cluster [7,8].

The overwhelming majority of CAIs in primitive chondrites have the canonical (^{26}Al/^{27}Al)$_0$ and are believed to have formed in ^{16}O-rich gas of solar composition (Δ^{17}O ~ −25‰), in regions with high ambient temperature ($\geq T_{cond}$ of forsterite), possibly within <1–2 AU, during first 0.1 Myr of the Sun’s formation [1,16–18]. CAIs with low (^{26}Al/^{27}Al)$_0$ (e.g., FUN CAIs and PLACs) are generally very rare and interpreted as a result of either formation prior to homogenization of ^{26}Al in the PPD [15] or preferential volatilization of a hypothetical, volatile carrier of ^{26}Al from precursors of these CAI [19].

Corundum is predicted to be the first condensate from a gas of solar composition [20]. We recently reported the O- and ^{26}Al-^{26}Mg isotope systematics of µm-size corundum grains from acid-resistant residues of UOCs and primitive CCs [21]. The corundum grains have ^{16}O-rich compositions (Δ^{17}O = −23±8‰), similar to that of the solar wind returned by *Genesis* [22], consistent with a condensation origin. They exhibit a bi-modal distribution of (^{26}Al/^{27}Al)$_0$: (3.5–6.5)×10^{-5} and <3×10^{-6}; the ^{26}Al-poor grains are dominant (55% *vs*. 40%); 5% of grains have intermediate values. A similar distribution of ^{26}Al is also found among ^{16}O-rich CH CAIs [23]. We infer the solar corundum grains and CH CAIs recorded an initial heterogeneity in the distribution of ^{26}Al at the birth of the SS. The canonical (^{26}Al/^{27}Al)$_0$ found in the overwhelming majority of CAIs, the oldest SS solids dated, was produced subsequently, possibly within <<0.1 Ma. Heterogeneity of ^{26}Al among earliest condensates could arise from injection of ^{26}Al contemporaneously with the collapse of the protosolar cloud. Absence of a resolvable difference in O-isotope composition between ^{26}Al-rich and ^{26}Al-poor corundum condensates (and CH CAIs) suggest injection of ^{26}Al by a massive (>40$_\odot$) star. ^{60}Fe-^{60}Ni measurements in ^{26}Al-poor, ^{16}O-rich refractory inclusions may discriminate between SN and WR sources.

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