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Silicon isotopic compositions of chondrule silicates in carbonaceous chondrites and the formation of primordial solids in the accretion disk

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Chondrules are submillimeter-sized silicate spheroids, abundantly observed in primitive meteorites. Despite the relatively simple major mineralogy of chondrules (i.e., olivine, low-Ca pyroxene, and glassy mesostasis ± Fe-Ni metal beads), countless, disparate models have been proposed to describe their formation [1]. This profusion of models stems from the fact that, beneath their relatively innocuous appearance, chondrules are complex objects whose mineralogy, textures, and chemical and isotopic compositions result from multi-step processes involving precursor recycling, melting event(s), and complex gas-melt interactions [2-4].

Here, we determined the silicon isotopic compositions of silicates (olivine and low-Ca pyroxene) in type I and type II chondrules of the carbonaceous chondrites Allende, Kaba, NWA 5958, and MIL 07342 [5]. Type I chondrule olivines show large, mass-dependent Si isotopic fractionations, with δ^{30}Si values ranging from –7‰ to +2.6‰. This is reminiscent of the Si fractionation observed in AOA olivine [6] and likewise suggests kinetic effects during recondensation (in open system). The systematically lighter Si compositions of low-Ca pyroxene may record an acceleration of the cooling (e.g. [7]). The δ^{30}Si values of type II chondrule silicates are close to zero and vary by less than 2‰, except for Mg-rich relict olivine grains whose Si variations are comparable to type I olivine. Our data also suggest that at least some type II chondrules derived from their type I counterparts [7]. Overall, our results show that chondrules are complex objects whose Si isotopic compositions derived from their precursors and SiO-rich gas-melt interactions.

[1] Connolly & Jones, JGRP 121, 1885–1899 (2016). [2] Libourel & Portail, Sci. Adv. 4 (2018) [3] Marrocchi et al., GCA 247, 121–141 (2019). [4] Ebel et al., in: Russell et al. (Eds.), Chondrules: Records of Protoplanetary Disk Processes. Cambridge University Press, pp. 151–174 (2018). [5] Villeneuve et al., EPSL 542, (2020). [6] Marrocchi et al., PNAS, 116:23461-23466 (2019). [7] Villeneuve et al., 160:277-305, GCA (2015).