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Origin and formation conditions of chondrules

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The underlying mechanism(s) of chondrule formation remains a mystery and diverse scenarios are debated in contemporaneous literature. Here we report a method combining high-resolution X-ray maps, electron microprobe analyses, and SIMS oxygen isotope measurements to quantitatively assess for the first time the nature of relict olivine grains in type I chondrules [1]. Our results demonstrate that olivine Ca-Al-Ti concentrations allow the relict and host olivine grains to be distinguished. The Ca-Al-Ti-poor and ¹⁶O-rich nature of most relicts indicate chemical and isotopic similarities with AOAs-like condensates [2]. Chondrules are thus complex nebular objects formed by (i) recycling of a previous generation of solids in all likelihood formed in the solar protoplanetary disk, as demonstrated by relict olivine grains, and (ii) *in situ* host minerals crystallization with significant gas-melt interactions in the chondrule-forming region(s).

[1] Marrocchi, Y. et al. (2018) EPSL 496, 132-141.

[2] Marrocchi, Y. et al. (2019) GCA 247, 121-141.

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Cite abstract as:

Marrocchi, Y, Villeneuve, J, Jacquet, E (2019) Origin and formation conditions of chondrules. Paneth Kolloquium, Nördlingen (Germany), abstract URL: <http://www.paneth.eu/PanethKolloquium/2019/0013.pdf> (abstract #0013).