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Presolar Grains in Asteroid Ryugu

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Chondrites contain tiny and rare presolar grains that formed in dying stars and were part of the original building blocks of the Solar System. They are identified by their highly unusual isotopic compositions and their study allows insights into galactic, stellar, interstellar, and asteroidal evolutionary processes [1]. One of the science goals of JAXA's Hayabusa2 sample-return mission to C-type asteroid (162173) Ryugu is to characterize and ascertain the inventory of preserved presolar grains. As part of the Hayabusa2-initial-analysis chemistry team (Lead: H. Yurimoto), we used the Carnegie NanoSIMS 50L to search for presolar grains in Ryugu thin section A0058-2. We collected $^{12,13}C^-$, $^{16,17,18}O^-$, $^{28}Si^-$ and $^{27}Al^{16}O^-$ ion images for contiguous 10×10 μm^2-sized frames in multi-collection mode with a Cs^+ primary beam (~0.7 pA), and analyzed them via standard methods.

Out of a total mapped area of 26,900 μm^2 we have thus far identified 1 presolar oxide, 7 SiCs and 6 grains that may be SiC or graphite. These refractory phases survived the pervasive aqueous alteration that Ryugu has experienced, whereas presolar silicates were probably destroyed. The Al-rich oxide (Fig. A) is a highly ^{17}O-enriched Group 1 grain of 0.26 μm diameter. Most C-rich grains have $^{12}C/^{13}C$ ratios between 13 and 69 and are probably mainstream SiC grains. Their average diameter is 0.23 μm. We estimated the abundances of presolar grains in Ryugu by dividing their total cross-sectional area by the area of fine-grained material mapped (18,408 μm^2), excluding large mineral grains and holes in the thin section. Based on the single grain, the abundance of presolar oxides is 3+6.9 -2.5 ppm (1σ). The abundance of C-rich grains is estimated to be 34 +11 -8 ppm and virtually identical with previous results from Ryugu samples [2], as well as most primitive carbonaceous chondrites (~30 ppm [3], Fig. B). Further measurements will help to better compare O- and C-anomalous presolar grains in Ryugu samples and carbonaceous chondrites.

[1] Zinner E. (2014) *Treatise on Geochemistry*, 2nd ed., 181–213. [2] Nittler L. R. et al. (2022) 53rd Lunar Planet. Sci. Conf., abstr. #1423. [3] Davidson J. et al. (2014) *GCA* 139:248–266.