^{16}O-POOR WATER ICE IN THE ACFER 094 PARENT BODY

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The ungrouped carbonaceous chondrite Acfer 094 is the only meteorite known to contain cosmic symplectite (COS), a fine-grained aggregate of magnetite and pentlandite with an extremely ^{16}O-poor composition. COS may have sampled isotopically heavy water reservoir, preserved in the outer Solar System, thought to arise from CO self-shielding in the solar nebula or parent molecular cloud. Understanding the formation environment of COS, either in the solar nebular or on the parent body of Acfer 094, is necessary to constrain the distribution of this heavy water reservoir in the early Solar System.

To distinguish between these two scenarios, we: 1) performed petrographic observations of COS in a thin section of Acfer 094 (USNM 72337) using backscattered electron imaging and energy-dispersive X-ray analyses in a field-emission scanning electron microscope, and 2) measured Acfer 094 matrix for O isotopes and Fe-Mg-Al content (using the Cameca ims 1280 ion microprobe at the University of Hawaiʻi at Mānoa) and O isotopes of COS grains (using the Cameca NanoSIMS 50 at Washington University in St. Louis).

We identified COS grains 5-20 μm in size. Their oxygen isotopic compositions were $\delta^{17,18}$O=160-210‰, consistent with previous measurements [1]. They are found in or near fractures and are occasionally rimmed with fibrous sulfides. Textures of COS grains are similar to fracture-filling veins of carbonates and sulfides previously reported in aqueously altered CM chondrites and CM1-like clasts from the Kaidun meteorite. Matrix grains show O-isotope compositions that vary along a slope≅1 line, where more Fe-rich grains have higher $\delta^{17,18}$O compositions than Mg-rich grains. This line is consistent with mixing between anhydrous silicates and a COS-like water reservoir, and differs from the slope≅0.7 mixing line for CO-CM matrix material [2]. Our measurements imply that Acfer 094 matrix grains interacted with the same ^{16}O-poor water reservoir from which COS formed. We propose that the parent body of Acfer 094 accreted ^{16}O-poor ice in the outer Solar System, which subsequently melted to form COS and Fe-rich, ^{16}O-poor matrix grains.

[1] Sakamoto N. et al. (2007) *Science 317,* 231–233

[2] Marrocchi Y. et al. (2018) *EPSL* 482, 23−32