

CORRELATION BETWEEN TEXTURE AND OXYGEN ISOTOPIC SYSTEMATICS IN CAIS FROM ACFER 094. T. J. Fagan¹, A. N. Krot², S. Kobayashi³, and H. Yurimoto³. ¹Dept. Earth Sciences, Waseda University, 1-6-1 Nishiwaseda, Shinjuku, Tokyo 169-8050, Japan (fagan@waseda.jp), ²Hawai'i Institute of Geophysics and Planetology, SOEST, University of Hawai'i at Manoa, Honolulu, HI 96822, USA. ³Department of Natural History Sciences, Hokkaido University, Sapporo 060-0810, Japan.

Introduction: Ca-Al-rich inclusions (CAIs) in chondritic meteorites are associated with ¹⁶O-rich oxygen isotopic compositions near -40‰ in both δ¹⁸O and δ¹⁷O [1-3]. In spite of this general association, there are significant variations toward isotopically heavier compositions both on the scale of minerals in CAIs and whole CAIs. Petrogenetic causes of these isotopic fluctuations and implications for nebular and chondritic parent body histories remain outstanding issues, in part because of the difficulty of disentangling parent-body from nebular effects. CAIs from the ungrouped carbonaceous chondrite Acfer 094 are ideally suited for evaluating pre-parent-body isotopic variations because of the unequilibrated pristine nature of this meteorite [4,5].

In this study, we present petrologic and isotopic evidence that some of the CAIs in Acfer 094 experienced a change in isotopic setting from the ¹⁶O-rich compositions associated with CAIs to the ¹⁶O-poor compositions associated with other chondrite components. Diopside rims formed on some of the Acfer 094 CAIs in a ¹⁶O-poor setting prior to assembly of the Acfer 094 parent body. However, other CAIs in Acfer 094 did not undergo such rim formation, confirming the inference that CAIs in Acfer 094 were drawn from diverse populations with distinct thermal histories [6,7].

Analytical Methods: CAIs in one thin section of Acfer 094 (provided by A. Greshake) were identified by elemental X-ray mapping using the Cameca SX-50 electron microprobe at University of Hawai'i at Manoa (UHM). Additional characterization of the CAIs was conducted using scanning electron microscopes outfitted with BSE and EDS detectors at UHM, Tokyo Institute of Technology (TiTech) and Hokkaido University (Hokudai). Major element compositions of CAI minerals were determined by electron microprobe (Cameca SX-50) analyses at UHM using oxide and silicate standards. Detailed BSE imaging and elemental mapping of one CAI with a ¹⁶O-poor diopside rim were collected using a field emission SEM at Hokudai.

Oxygen isotopic data were collected using the Cameca ims-1270 SIMS system that was formerly located at TiTech. This SIMS has subsequently been moved to Hokudai. Point analyses were collected at TiTech using conditions described previously [2]. Oxygen isotopic ratio mapping was conducted at Hokudai using the ims-1270 + SCAPS [8].

Results: Of 132 Acfer 094 CAIs identified by [6]: one is a pyroxene-hibonite (pyx-hib) spherule; one is rich in corundum; two are rich in hibonite (hib); 16 in grossite (gro); 17 in pyx+anorthite (an); and 95 in spinel+melilite (sp+mel). The CAIs have not been affected by Fe-alkali metasomatism. Most of the CAIs are zoned, with more refractory minerals in cores and less refractory rims. (An exception to the refractory core/less refractory rim pattern is the occurrence of spinel in cores and melilite in rims. This texture for spinel and melilite is widely reported and yet unexplained [e.g., 9]).

There are differences in the core-to-rim textures though: many of the melilite rims appear to drape continuously around core minerals (Fig. 1 A,B), whereas diopside rims tend to form a discontinuous break with the more refractory cores (Fig. 1 C,D). In many cases, a thin layer of anorthite ±melilite intervenes between diopside rim and refractory core (Fig. 1D).

Point oxygen isotopic analyses indicate that most CAI minerals are relatively ¹⁶O-rich, but one analysis of rim diopside around a grossite-rich, spinel+hibonite-bearing CAI yields a ¹⁶O-poor value (Fig. 2). The refractory core of this CAI is separated from the diopside rim by a layer of anorthite that replaced melilite (Fig. 1D). Grossite and spinel of this CAI are ¹⁶O-depleted compared to other CAIs (Fig. 2). The two-dimensional oxygen isotopic distribution determined by SCAPS verifies the isotopic composition of the diopside rim (Fig. 3), indicating that the rim formed in a ¹⁶O-poor setting. The sharp break in isotopic composition between CAI core and rim indicates that the diopside formed during a short-lived thermal event. These results combined with the primitive nature of Acfer 094 indicate that the set of CAIs in this meteorite experienced diverse thermal histories in distinct oxygen isotopic settings prior to assembly on the Acfer 094 parent body.

References: [1] Clayton R.N. et al. (1973) *Science*, 182, 485-488. [2] Yurimoto H. et al. (1998) *Science*, 282, 1874-1877. [3] MacPherson G.J. (2003) in *Meteorites, Comets and Planets* (ed. A.M. Davis) vol. 1, *Treatise on Geochemistry* (eds. H.D. Holland and K.K. Turekian), pp. 201-246. [4] Newton J. et al. (1995) *Meteoritics*, 30, 47-56. [5] Greshake A. (1997) *GCA*, 61, 437-452. [6] Krot A.N. et al. (2004) *GCA*, 68, 2167-2184. [7] Fagan T.J. et al. (2003) *LPS XXXIV*, Abstract #1274. [8] Yurimoto H. et al. (2003) *Appl. Surf. Sci.*, 203-204, 793-797. [9] Krot A.N. et al. (2004) *MaPS.*, 39, 1517-1553.

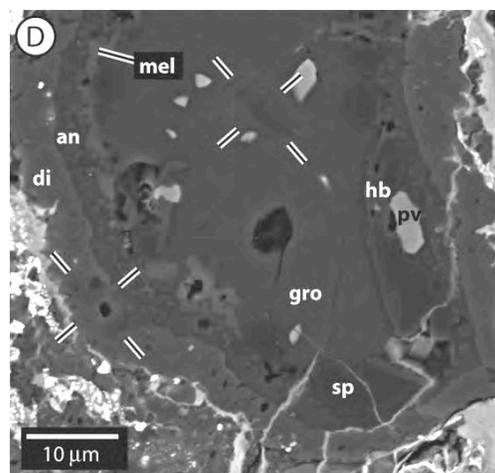
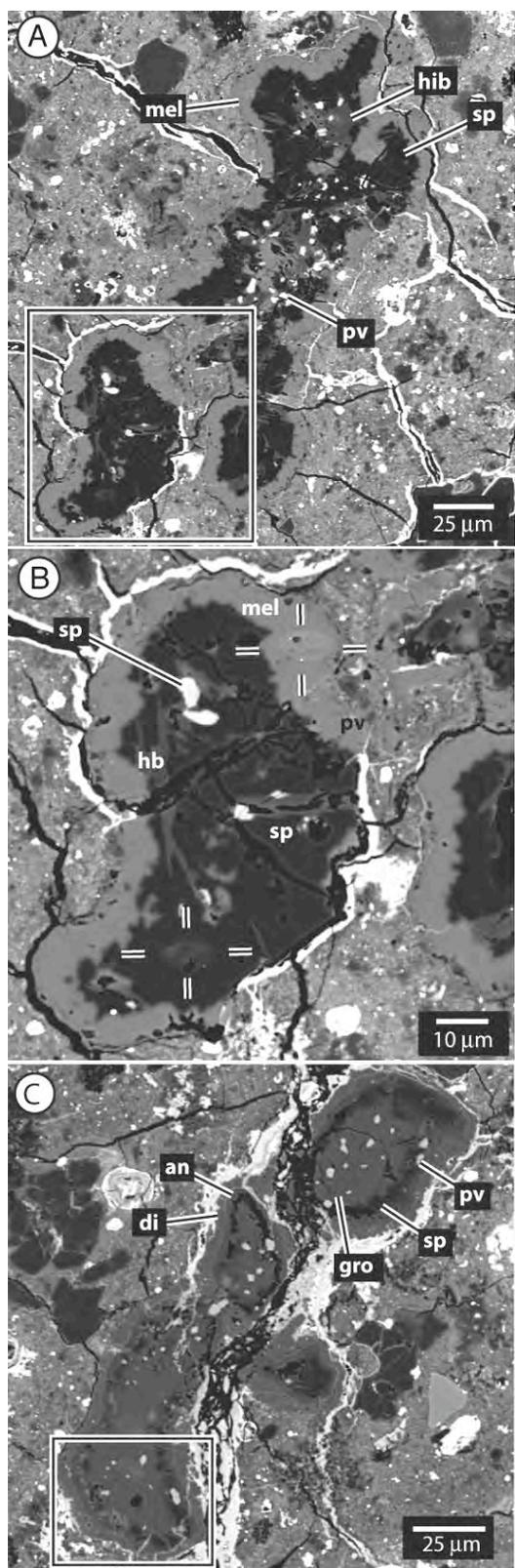


Fig. 1. BSE images of CAIs RO-89 (A,B) and RO-64 (C,D). Pits excavated by SIMS highlighted (B,D). an = anorthite; di = diopside; gro = grossite; hb = hibonite; mel = melilite; pv = perovskite; sp = spinel

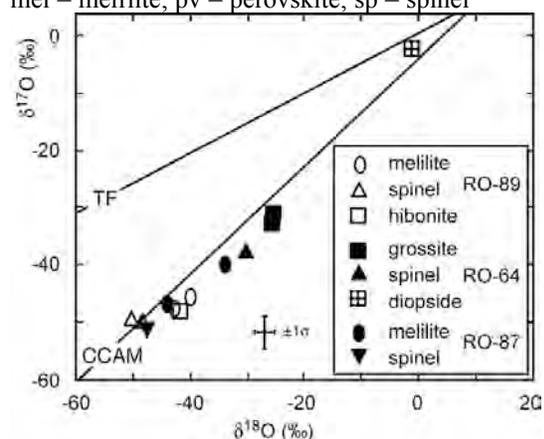


Fig. 2. Point analyses for oxygen isotopes.

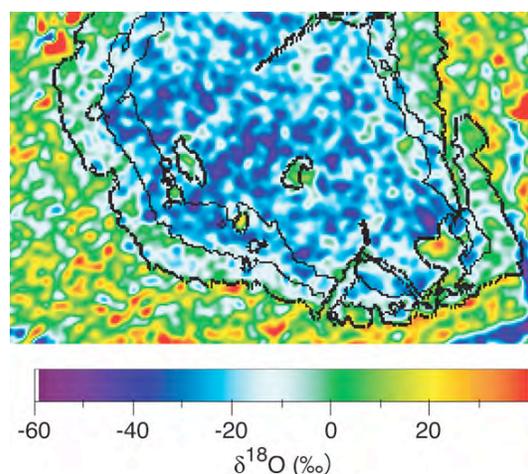


Fig. 3. SCAPS isotopography showing ¹⁶O-poor diopside rim of RO-64. Compare with 1D.