FIRST ROCK FROM THE SUN: A CORUNDUM-HIBONITE CONDENSATE FROM MURCHISON. S. B. Simon[1], L. Grossman[1,2], and R. Elsenheimer[3], [1]Department of Geophysical Sciences, University of Chicago, 5734 S. Ellis Ave., Chicago, IL 60637, USA, [2]Enrico Fermi Institute, University of Chicago, Chicago, IL 60637, USA, [3]Illinois Mathematics and Science Academy, Aurora, IL 60506, USA.

By freeze-thaw disaggregation of Murchison (CM2), we have recovered an interesting and important inclusion: M98-8, which consists of hibonite and corundum. M98-8 (Fig. 1) is rounded and roughly egg-shaped, ~90 × 75 µm, and consists of hibonite laths (89.1 vol%), mostly ~10 µm wide and 30-40 µm long, enclosing rounded, anhedral grains of corundum (9.3%), 5–20 µm across, and smaller grains of perovskite (1.6%). Most of the perovskite occurs at the edge of the inclusion. Hibonite averages 1.8 wt% TiO_2 and 0.9 wt% MgO. Thermodynamic condensation calculations [1] show that, in a solar gas at $P^{tot} = 10^{-3}$ bar, corundum condenses at 1770 K and reacts with the vapor to form hibonite at 1728 K. Perovskite is predicted to begin condensing at 1680 K. The texture of M98-8 is consistent with this sequence and the reaction relationship between corundum and hibonite. In contrast, there are problems with any model that includes a molten stage. For M98-8 to have been *completely* molten would have required temperatures in excess of ~2140 K [2], but no solids or liquids are stable in a solar gas at this temperature and any $P^{tot} \leq 1.5$ atm [3]. For $P^{tot} = 10^{-3}$ atm, enrichment in dust relative to gas by factors of 100 or more can stabilize certain liquids to temperatures in excess of 2200 K [1], but these liquids have higher Ca/Al ratios than bulk M98-8, and grossite + $CaAl_2O_4$, not corundum + hibonite, would crystallize from them [4]. We cannot envision any nebular conditions under which a *completely* molten M98-8 would have been stable. In addition, its texture, like those of BB-5 [5] and F5 [6], corundum-hibonite inclusions from Murchison and Murray, respectively, is not consistent with metastable crystallization of a supercooled droplet [5].

Hibonite melts incongruently to corundum + liquid at 2100 K and 1 atm [4]. In experiments performed in vacuum [7], rapid heating of hibonite to corundum + liquid + vapor followed by rapid cooling yields a residue of corundum + glass, not corundum + hibonite. There is no glass in M98-8, and if liquid formed by melting of hibonite had cooled slowly enough to avoid quenching, it presumably would have undergone more extensive evaporation, forming copious amounts of a Ca-Al phase, with an Al/Ca ratio greater than that of hibonite, which is not observed. In a solar gas at low pressures, hibonite would begin evaporating at temperatures below its melting point (e. g., 1728 K at $P^{tot} = 10^{-3}$ and 1480 K at $P^{tot} = 10^{-6}$ [1]). Evidence of what occurs when hibonite undergoes partial melting and evaporation in a nebular setting might be found in GR-1, a corundum-bearing inclusion from Murchison that appears to contain two generations of hibonite [8,9]. In GR-1, hibonite in the interior is enclosed in corundum, which, in turn, is partially enclosed in hibonite. It is possible that the corundum formed during incomplete melting of the primary (interior) hibonite accompanied by total evaporation of Ca from that liquid, and that the outer hibonite in GR-1 formed by reaction of the corundum with the nebular gas upon cooling [9]. While GR-1 has hibonite enclosed in corundum, and probably a somewhat complex history, samples BB-5, F5, and M98-8 contain corundum enclosed in hibonite and may be direct nebular condensates.

Conclusions. The texture of M98-8 does not indicate that hibonite was evaporating. Hibonite appears to have been stable; it occurs as well-formed crystals, and corundum is evenly distributed throughout the inclusion rather than concentrated in a vaporization rind on the exterior of the inclusion. Gas-solid condensation is the most straightforward way to account for the features of M98-8, making this sample a likely primary corundum-hibonite condensate from the early solar nebula.

References. [1] Ebel D. S. and Grossman L. (2000) *GCA, 64,* 339. [2] Berman R. G. (1983) Ph. D. Thesis, Univ. B.C. [3] Yoneda S. and Grossman L. (1995) *GCA, 59,* 3413. [4] Nurse R. W. et al. (1965) Trans. *Brit. Ceram. Soc., 64,* 409. [5] Bar-Matthews M. et al. (1982) *GCA, 46,* 31. [6] Fahey. A. J. (1988) Ph. D. Thesis, Wash. U. [7] Floss C. et al. (1998) *MAPS, 33,* 191. [8] MacPherson G. J. et al. (1984) *Proc. LPSC 15th,* in *JGR,* C299. [9] Hinton R. W. et al. (1988) *GCA, 52,* 2573.

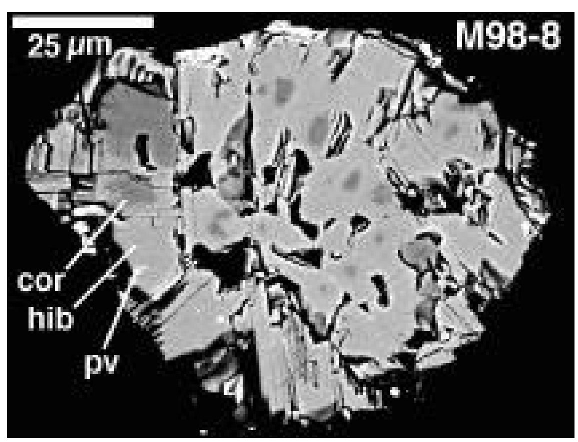

Fig.1. Backscattered electron image of M98-8. cor: corundum; hib: hibonite; pv: perovskite.