CHONDRULES AND ISOLATED GRAINS IN THE FOUNTAIN HILLS BENCUBBINITE. A. R. La Blue[1], D. S. Lauretta[1], and M. Killgore[2]. [1]Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, AZ 85721, USA, arlablue@lpl.arizona.edu, lauretta@lpl.arizona.edu. [2]Southwest Meteorite Laboratory, Payson, AZ 85547, USA.

Introduction: The Fountain Hills (FH) meteorite was recently classified as a Bencubbin-like (CB_a) chondrite, which are part of the CR clan [1]. The FH O-isotopic composition is indistinguishable from CB_a chondrites. Metal and silicate compositions are consistent with the CB_a classification. Significant differences between FH and the other CB_a chondrites were noted. These include abundant porphyritic chondrules and complete lack of sulfide minerals. We are furthering this investigation by analyzing silicate chondrules and isolated grains in FH to determine more about its composition, thermal history, and implications for chondrule formation in the early solar system.

Analytical Techniques: A petrographic thin section of the FH chondrite was surveyed with optical microscopy and BSE imaging. Mineral compositions were determined using electron microprobe analysis.

Results: Chondrule diameters range from 250 to 3,500 µm, averaging 1,200 µm. Porphyritic and barred-olivine chondrules are abundant. A few small granular chondrules are present. Representative porphyritic (Fig. 4), barred (Fig. 5), and granular (Fig. 6) chondrules are described. The porphyritic chondrule contains large phenocrysts of olivine (Fo_{96-97} with 0.2 wt.% CaO, 0.1 wt.% Al_2O_3, and 0.5 wt.% Cr_2O_3). Pyroxene ($En_{77}Wo_{19}$ with 3.7 wt.% Al_2O_3, 0.8 wt.% TiO_2, and 1.0 wt.% Cr_2O_3) is concentrated in the outer portion of the chondrule. Mesostasis is recrystallized anorthite containing 0.1 wt.% Na_2O, 0.2 wt.% FeO, and 1.0 wt.% MgO. The barred chondrule contains parallel laths of olivine (Fo_{96-97}) with interstitial anorthite. Low-Ca pyroxene ($En_{93}Wo_3$ with 1.4 wt.% Al_2O_3, 0.3 wt.% TiO_2, and 0.8 wt.% Cr_2O_3) occurs on the outer edge. The granular chondrule is composed predominantly of low-Ca pyroxene with variable composition (En_{91-95} with 0 – 0.5 wt.% Na_2O, 0 – 0.1 wt.% K_2O, 1.3 – 2.9 wt.% CaO, 0.9 – 3.0 wt.% Al_2O_3, 0.1 – 0.3 wt.% TiO_2, and 0.8 – 1.0 wt.% Cr_2O_3). Minor amounts of olivine (Fo_{96-97}) are present.

An isolated chromian spinel grain (Fig. 1 and 2) was characterized. The spinel has a uniform Mg# = 94. However, it is zoned in Cr and Al with Cr contents increasing from core to rim (Fig. 3). The grain is rimmed by anorthite and the rim is 50 µm thick. Olivine with composition Fo_{97} occurs in contact with this grain. Application of the olivine-spinel geothermometer developed by Sack and Ghiorso [2] yields 878 °C using the composition of the spinel closest to the olivine. Cr-Al interdiffusion data for a spinel of composition $(Mg_{0.51}Fe_{0.49})(Al_{0.73}Cr_{0.27})_2O_4$ have recently been measured at 21.4 kb and 1125 °C [3]. These data suggest that D_{Cr-Al} is ~$0.04*D_{Fe-Mg}$. Using this relationship and the Arrhenius relation for D_{Fe-Mg} in spinel [4] we estimate D_{Cr-Al} in spinel at 878 °C. A reasonable fit to the data was obtained by treating the system as an isothermal diffusion problem. This analysis suggests a heating duration of ~40,000 years to establish the Cr-Al zoning profiles in the FH spinel grain.

Discussion: FH is similar to CB chondrites. However, it is distinct from the other members of this group in several ways. Bencubbinites contain 60-70 vol.% metal whereas ~25 vol.% of FH is metal. It is not present in chondrules in bencubbinites and we have located metal phases inside silicate chondrules from FH. The metal inclusions are small (< 1 µm) but visible in reflected light. There is no report of CAIs in Bencubbinites. Spinel is rare but noticeable in FH (Figs. 1 and 7). FH $\delta^{15}N$ data [1] also does not match other Bencubbinites. Lastly, porphyritic chondrules are absent in CB chondrites but abundant in FH. These factors indicate that FH is a unique CB chondrite.

FH also shares some characterisitics with CR chondrites. Both have abundant Fe-Ni metal but metal is concentrated in chondrules in CRs instead of in the matrix as seen in Fountain Hills. CR chondrites contain a variety of chondrule textural types including porphyritic and barred as does FH. $\delta^{15}N$ data for FH is much closer to the CRs than to the CBs. Since the mineral composition of FH does not fully categorize it as either a CB or a CR, we suggest that FH may be transitionary between the CB and the CR chondrites, thus reinforcing the link between these chondrite groups.

The formation of porphyritic chondrules requires preservation of nucleation sites in chondrule melts. The presence of abundant porphyritic chondrules in FH suggests that these chondrules formed either by: (1) incomplete melting of solid precursors or (2) melt formation in the presence of abundant dust grains. The complete lack of fine-grained matrix in FH seems to rule out (2). The lack of sulfide minerals and low alkali abundances are consistent with FH chondrule formation in a high-temperature region of the solar nebula. However, direct condensation of chondrule melts is inconsistent with observed chondrule textures. FH chondrules may have formed by processing of an earlier generation of CB chondrules as suggested by [5] for other CB_a chondrites.

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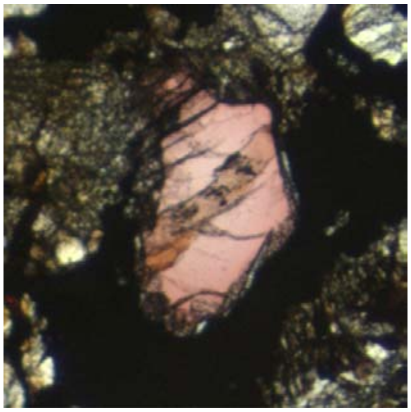

Figure 1. Plane-pol. optical image of spinel grain. FOV=900 μm.

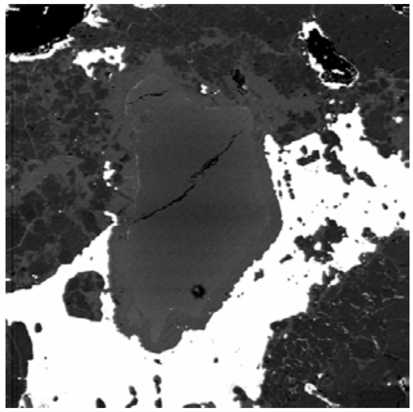

Fig. 2. BSE image of spinel grain in Fig. 1. FOV = 900 μm

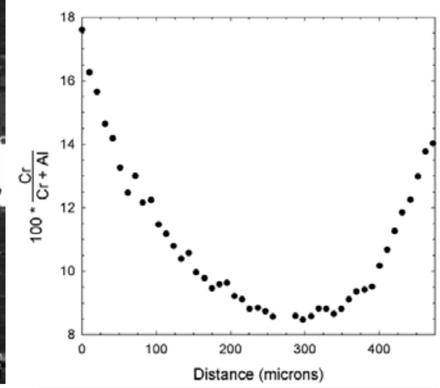

Fig. 3. Compositional variation of spinel (from bottom to top as shown in Fig. 2)

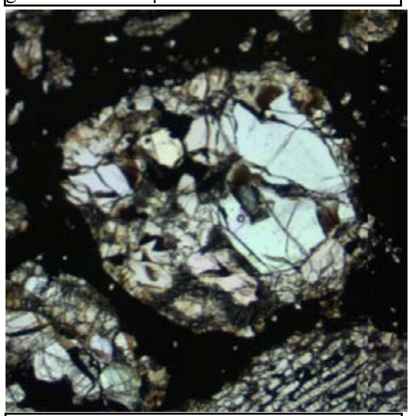

Fig. 4. Plane-pol. optical image of porphyritic chondrule. Dia = 1,035 μm

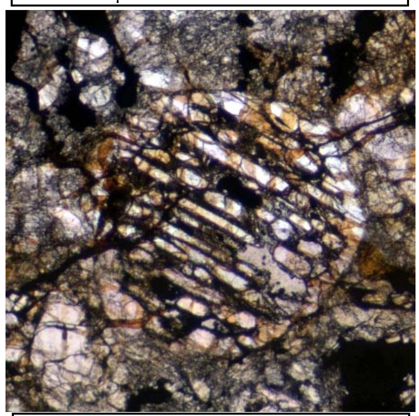

Fig. 5. Plane-pol. optical image of barred chondrule. Diameter = 1,070 μm

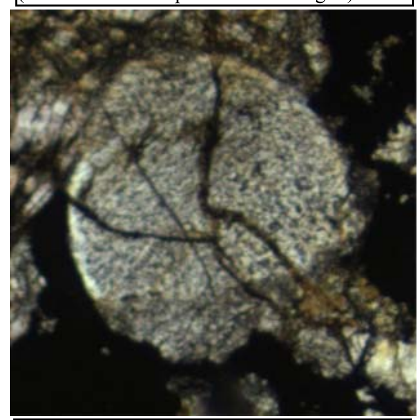

Fig. 6. Plane-pol. optical image of granular chondrule. Diameter = 930 μm

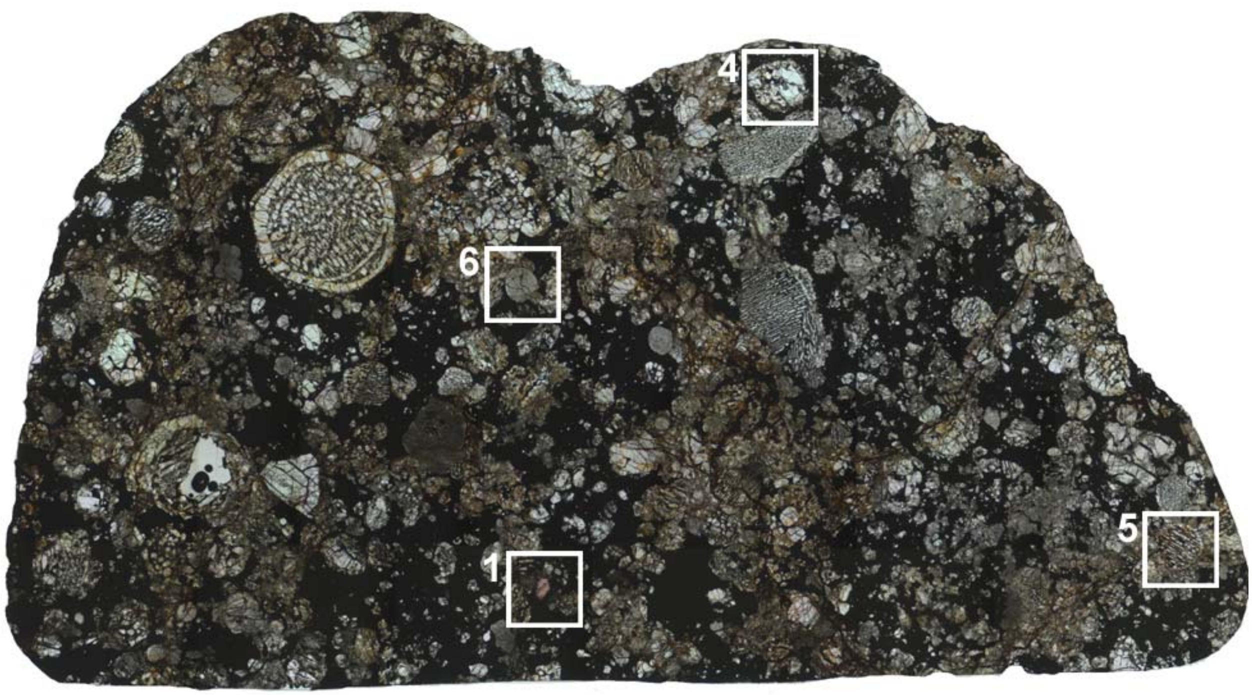

Fig. 7. Plain polarized map of Fountain Hills in thin section. Location of chondrules and spinel grains in Figs. 1, 4-6 are indicated. FOV = 3.5 cm