

ASU-NWA-180 (K460)

Fabien Kuntz

TKW 1247g

History:

Fabien Kuntz purchased 28 stones (ranging 4.8-338g) in Guelmim, Morocco in 2019.

Physical characteristics: Sample has an irregular ovoid shape, is dark brown in color. Chondrules and brecciated texture are visible on the surface.



Fig. 1 and 2. Sample K460 prior to cutting (F. Kuntz photo); Overview of thin section viewed in plane polarized light.

Petrography: Description and classification: (A. Love, App): Sample has a brecciated texture composed of orange-colored, rounded to angular-shaped—mm-sized equilibrated chondritic clasts set within dark-colored, host of unequilibrated and equilibrated chondrules and fragments. Clasts have equilibrated chondritic textures. Many chondrules within host are poorly equilibrated and have an average apparent diameter of $523\mu\text{m}$ ($n=56$). Host and some clasts contain rare zoned olivine and abundant clinostatite. Host contains poorly equilibrated chondrules. Chondrules and clasts define a weakly elongated orientation.

Sample contains a 1mm long xenolithic clast that contains textural and mineralogical similarities to CM chondrite breccias. Clast is composed of sparse, $\sim 160\mu\text{m}$ Mg-rich chondrules, forsterite fragments and CAI's, some of which are coated in fine-grained dust mantles set within a matrix composed of high-contrast objects similar to tochilinite-cronstedite intergrowths and fine-grained dust. Clast contains abundant calcite.

Shock: Sample is a breccia. The sample contains sub-parallel opaque, glassy shock veins. The host and one clast shows ovoid subparallel chondrules. Host and clasts contain olivine that shows planar fractures and undulatory extinction. Some olivine has been stained yellow from shock. Additionally, the sample contains polycrystalline troilite some mixed metal assemblages, rare metallic copper, fizzed troilite and plagioclase chromite assemblages.

Weathering: FeOH minerals stain interstices between grains. FeNi metals show very thin rims of oxidized Fe and sulfides appear unaltered.

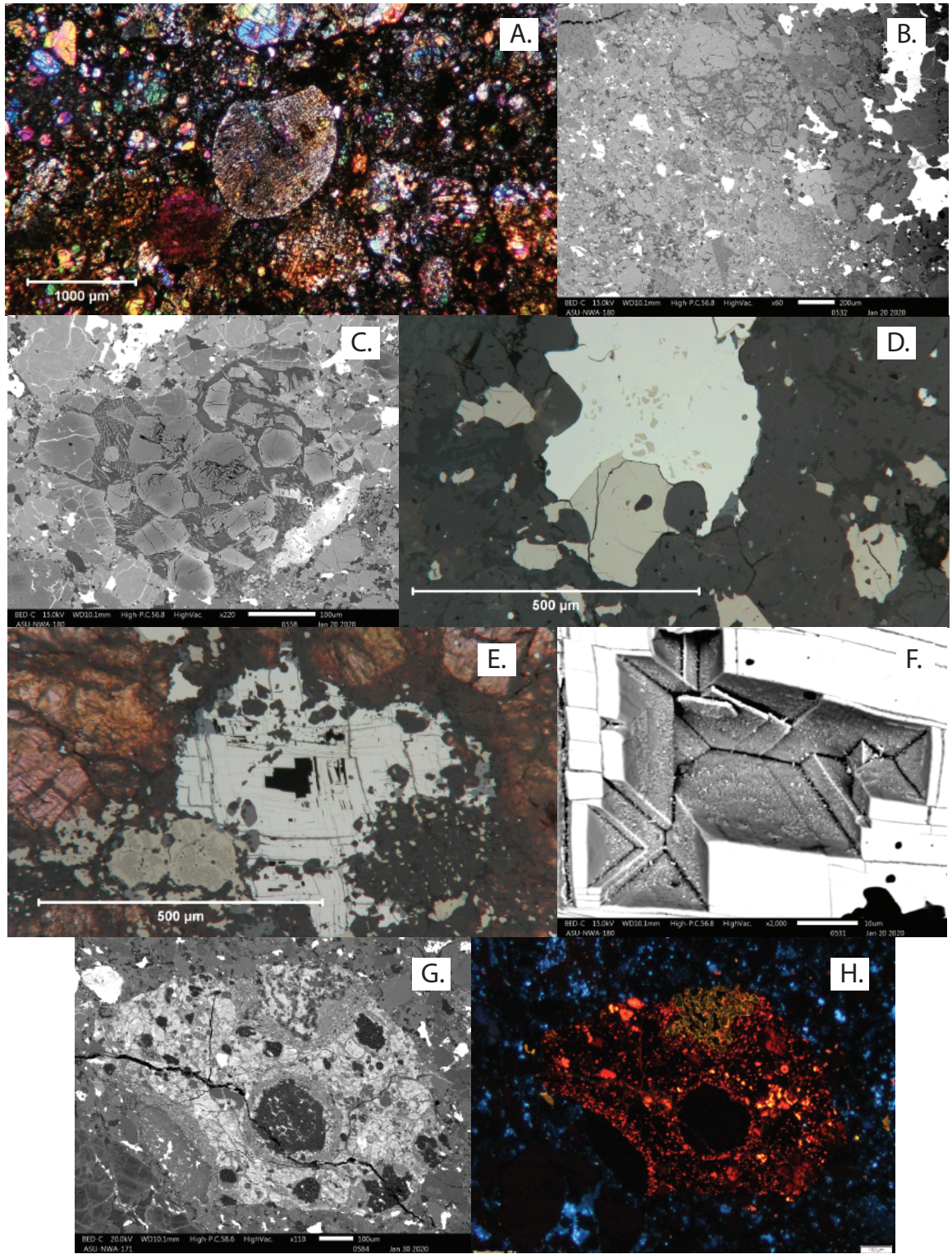


Fig. 3: A) Cross polarized light view of chondritic host with chondrules and fragments in a sulfide-rich, recrystallized matrix; B) Backscattered electron image showing boundary between

Fig 3 cont.: recrystallized equilibrated clast (upper right) and host region (lower left); C) Backscattered electron image showing unequilibrated porphyritic olivine chondrule with normally-zoned olivines; D) Reflected light image showing FeNi+FeS grain with metallic copper (when present always visible in FeNi near boundary with FeS); E) FeNi grain with plucked tip of octahedral crystal(no reflection due to surface defect) viewed under cross polarized light; F) Backscattered electron image showing plucked crystal from octahedral kamacite metal grain; G) Backscattered electron image showing CM2 clast; H) Cathodoluminescence image showing same region (notice yellow-green CAI – Spinel-diopside anorthite in upper portion of clast). Red color is forsterite. Clast contains non-luminescent calcite.

Cathodoluminescence Microscopy

CL was observed using the CL Olympus BX-51 with a Reliotron CL control and stage housed within the Department of Geology at Appalachian State University. Observations were made at 8 KV.

Sample shows distinctive luminescence that highlights the distinctions between the unequilibrated host and equilibrated clasts and xenolithic clasts. The host contains olivine chondrules some of which show dark-red CL (present in unequilibrated chondrites), limited magenta CL common in FeO-poor pyroxene chondrules (unequilibrated chondrites) and characteristic blue CL seen in growth of secondary feldspar.

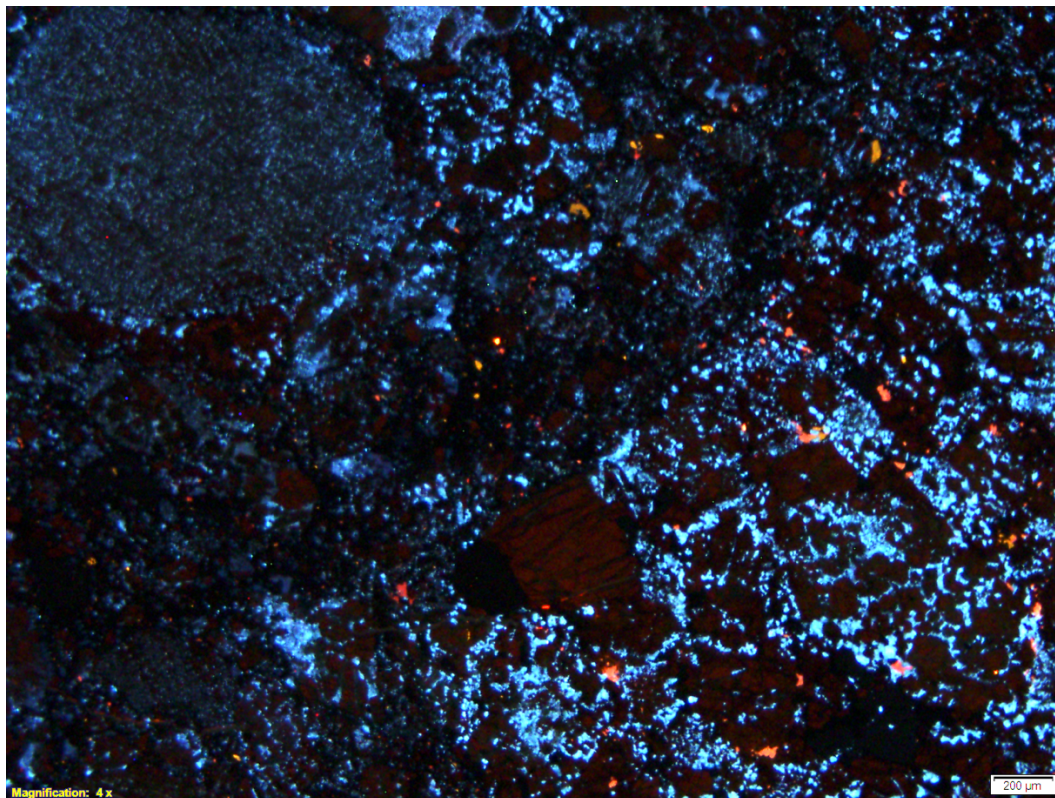


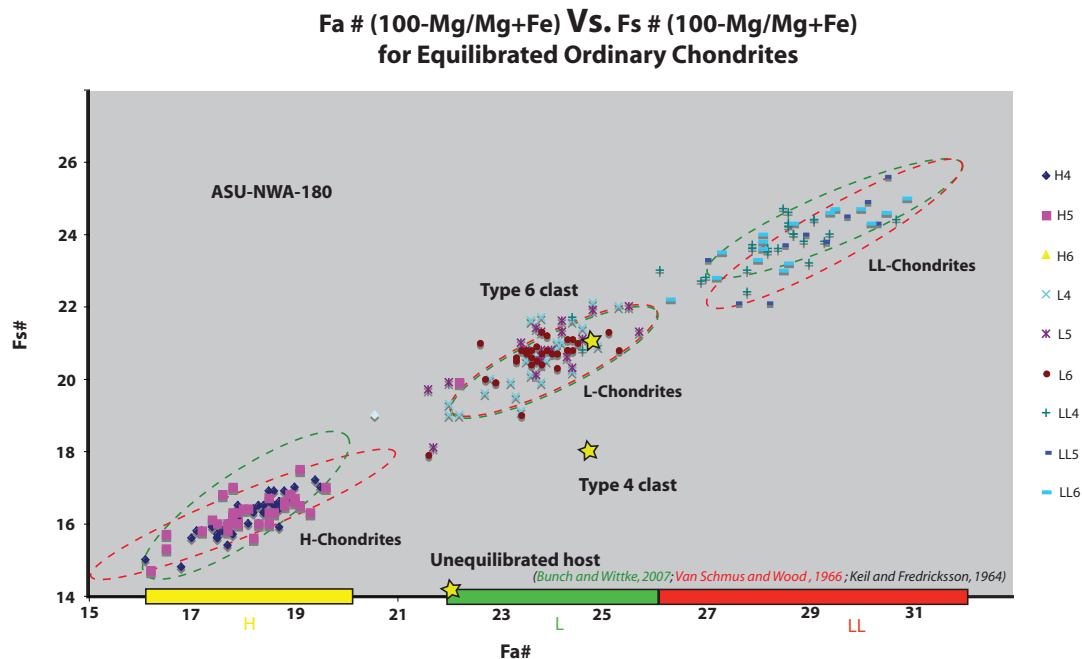
Fig. 4. High-contrast cathodoluminescence photo showing dark red CL of FeO-poor olivine and blue CL of secondary feldspar. Yellow and orange grains are secondary phosphates.

Equilibrated clasts show only blue CL as the FeO-content (>5 wt% FeO quenches CL) of olivine and pyroxene has equilibrated to ~22 and 14 wt% respectively. The CM2 clasts shows bright red luminescence characteristic of forsteritic olivine and dark green CL of spinel and yellow CL of diopside within one of the CAI's

Magnetic Susceptibility: Mass magnetic susceptibility was measured using a ZH Instruments SM-30 pocket MS meter. Quadruplicate measurements of two samples produced $\log \chi \times 10^{-9} \text{ m}^3/\text{kg} = 4.69$. This $\log \chi$ value falls within the range defined for L ordinary chondrites (Rochette et al., 2003).

Geochemistry: (A. Love, App) Geochemistry was measured using the JEOL ITS3000 SEM with EDAX EDS in the Dewel Microscopy Lab at Appalachian State University. An accelerating voltage of 20kV was used to analyze 3 spots per grain. Host is poorly equilibrated while clasts show a range of poorly equilibrated to equilibrated compositions.

Host: Olivine (Fa22.66+/-3.39, (Fa15.64-27.19), PMD=11.10, Fe/Mn=46.77+/-3.54 n=11); low Ca pyroxene (Fs14.78+/-7.00Wo 1.42+/-2.04 (Fs6.87-22.92Wo0.13-4.93), n=5); Equilibrated clasts: Olivine (Fa24.74+/-0.74, Fe/Mn=47.76+/-4.44, n=7); low Ca pyroxene (Type 4 Fs18.08+/-7.21Wo2.68+/-4.41, n=5; Type 6 Fs21.45+/-0.65Wo1.74+/-0.18, n=5) Xenolithic clast: Olivine (Fa2.78+/-2.20, Fe/Mn=16.24+/-16.45, n=3); low Ca-pyroxene (Fs2.71Wo2.00, n=1).



Classification: Ordinary chondrite (L3-6 xenolithic breccia, C-S3 W1). Based on the textures, mineral compositions, magnetic susceptibility and chondrule diameters, this is an L 3-6 chondrite breccia. The xenolith has textures and compositions similar to CM2 carbonaceous chondrites. This sample is likely a regolith breccia.

Specimens: The main masses are held by Fabien Kuntz. An endcut and slice weighing 28.75g and a polished thin section are on deposit at App.

References: Rochette, P., Sagnotti, L., Bourot-Denise, M., Consolmagno, G., Folco, L., Gattacceca, J., Osete, M. L. and Pesonen, L., 2003. Magnetic classification of stony meteorites: 1. Ordinary chondrites. MAPS 38, N.5, pp. 251-268.