NORTHWEST AFRICA (NWA) 11607: A CK CHONDRITE METAMORPHIC BRECCIA (CK3-6)

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Introduction: The CK chondrites are a group of highly-oxidized carbonaceous chondrites characterized by the presence of magnetite, Ni-bearing sulfides, and NiO-rich olivine [1]. They are also the only group of carbonaceous chondrites to exhibit the full range of thermal metamorphism, from petrologic type 3 to type 6 [1]. Similarities between the CK and CV chondrites, such as oxygen isotopes and bulk rock compositions, led [2] to suggest that both groups were derived from a single, thermally-stratified parent body, much like the onion-shell model for the ordinary chondrites [3,4]. In this model, the less altered CV chondrite material resides on the surface the parent asteroid, while the more metamorphosed CK material is located within the interior [2]. Though alternative models have been proposed [5,6], we contend that a thermally-stratified asteroid is a plausible model for a single CV-CK chondrite parent body.

If the CV and CK chondrites originated from a single parent body, then meteorites containing both CV and CK lithologies should exist. However, creation of a meteorite with both lithologies would require mixing of the deeper, more metamorphosed CK material with CV material near the surface. This is not at all unlikely, as the physical evolution of asteroids is driven by multiple episodes of collisional processes, such as excavation of materials, mixing, and reaccretion [e.g., 7]. Brecciated meteorites and meteorites containing xenolithic clasts provide evidence of these dynamic impact-dominated histories. Though the number of meteorites containing foreign clasts is not well constrained, brecciation is common among many groups of meteorites (e.g., CI, CM, and CV carbonaceous chondrites, aubrites, mesosiderites, and HEDs) [7]. In fact, a recent study by [8] suggests that 27% of ordinary chondrites - the largest group of meteorites - are breccias.

Though meteorites containing both CV and CK lithologies have so far been elusive, three meteorites have recently been classified as CK3-6 breccias: Northwest Africa 11607, Northwest Africa 13357, and Miller Range 13136. These metamorphic breccias could conceivably contain CV material. Recently, we purchased several slices of Northwest Africa (NWA) 11607 (CK3-6). Here, we characterize the texture and mineralogy of this sample in effort to identify any potential CV chondrite lithologies and provide insight into the thermal and physical evolution of the CK (or CV-CK) chondrite parent asteroid.

Petrography: NWA 11607 is a chondrite breccia composed of mm to cm-sized angular clasts in an unequilibrated matrix [9]. It was classified as a CK chondrite based primarily on the presence of abundant Ni-rich olivine and Cr-bearing magnetite. In its initial classification, clasts of all petrologic types (3-6) were discovered, leading to the classification as a CK3-6 metamorphic breccia [9].

Our meteorite collection includes four slices (~ 3 x 6.5 cm; ~10 g each) of NWA 11607. Each slice contains numerous clasts, most of which are mm-sized and sub-rounded to angular. Some cm-sized clasts are also present; the largest is ~2.3 cm in diameter. Interestingly, all of the largest cm-sized clasts are angular. We examined two thin sections from a single slice of NWA 11607 using Back-Scattered Electron (BSE) imagining, and we have identified 22 unique clasts so far. The largest clast in this slice is the ~2.3 cm clast referenced above. The extent of recrystallization in the matrix and the clasts varies, though most areas of the sample appear well equilibrated (i.e., few chondrules are apparent). The sample is highly fractured, as expected in a breccia.

BSE images indicate that the sample is dominated by olivine with subordinate amounts of pyroxene, oxides, and sulfides. In BSE images, the clasts are difficult to distinguish from the matrix, suggesting that the composition of the sample is relatively homogenous. Mineral phase chemistry of all phases in the matrix and the clasts will be determined using Electronprobe Microanalyses (EPMA) prior to the conference. This data, along with textural descriptions, will allow us to quantify the extent of metamorphism in the sample and identify any possible CV chondrite material. The results will provide insight into the thermal and physical evolution of the CK (or CV-CK) parent body.

References: [1] Kallemeyn G.W. et al. (1991) *Geochimica et Cosmochimica Acta*, 55:881-892. [2] Greenwood R.C. et al. (2010) *Geochimica et Cosmochimica Acta* 74:1684-1705. [3] Wood J.A (2003) *Nature* 422:479-481. [4] Trieloff M. et al. (2003) *Nature* 422:502-506. [5] Chaumard et al. (2012) *Icarus* 220:65-73. [6] Wasson J.T. et al. (2013) *Geochimica et Cosmochimica Acta* 108:45-62. [7] Bischoff A. et al. (2006) In MESS II, pp.679-712. [8] Bischoff A. et al. (2018) *Geochim. Cosmochim. Acta*, 238:516-541. [9] Gattacceca J. et al. (2020) *The Meteoritical Bulletin*, No. 107.