NORTHWEST AFRICA (NWA) 10588: AN EQUILIBRATED CV CHONDRITE?

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Introduction: Two groups of carbonaceous chondrites, the CV and CK chondrites, have similar compositions and textures. The CV chondrites are characterized by a fine-grained matrix, abundant chondrules (≈45 vol%), and Fe-rich olivine [1-3]. However, the CK chondrites contain Ni-rich olivine and Cr-rich magnetite [4]**.** Both groups also experience different degrees of metamorphism; while CV chondrites are metamorphosed to types 3.0 - 3.6, CK chondrites are metamorphosed to types 3.7 - 6.0 [5-7]. [8-10] suggest that CV and CK chondrites originate from the same parent body, whereas [11] argue for separate parent bodies due to the two groups' distinct magnetite compositions. The single-parent-body model could be strengthened with evidence of transitional CV-CK material. In its original classification, Northwest Africa (NWA) 10588 (CK3) was described as potentially intermediate between CV and CK chondrites [12]. We investigated the mineralogy and texture of this sample to revisit the classification and determine if it is transitional.

Methodology: Elemental mapping, Energy Dispersive Spectroscopy (EDS), and backscattered electron (BSE) imaging was completed at Bowdoin College using a Tescan Vega3 Scanning Electron Microscope (SEM). Mineral chemistry analyses were obtained using a JEOL JXA 8200 electron microprobe at Washington University in St. Louis, where we analyzed olivine, pyroxene, sulfides, and oxides present within chondrules, chondrule rims, veins, and matrix. We obtained 90 olivine analyses in 13 chondrules, as well as 35 pyroxene analyses in 10 chondrules. Microprobe operating conditions included a 15kV potential, 25.0nA beam current, and 2μm beam size.

Results: The average fayalite (Fa) content of chondrules ranges between Fa_{11}-Fa_{33}; the average is Fa_{22} (n = 90). Olivine consistently contains NiO abundances <0.04 wt%, and average Cr_2O_3 is <0.10wt%. The average ferrosilite (Fs) value for pyroxene is $Fs_{11.83}$ (n = 35). BSE images show that the matrix is fine-grained and not recrystallized. Shock veins and metal grains are present throughout the sample; multiple oxide veins show evidence of replacement by terrestrial limonite ($FeO•nH_2O$). Minimally-altered magnetite grains in the matrix and chondrule rims contain average TiO_2, Cr_2O_3, and NiO abundances of 0.0wt%, 0.02wt%, and 0.13wt%, respectively. Additionally, 2 troilite grains and one chromite grain were identified.

Comparison with CV and CK Chondrites: Characteristics consistent with the CV chondrites include the primitive matrix, NiO content of chondrule olivine, chondrule abundance (65-70 vol%), and abundances of TiO_2 and NiO in magnetite. However, the equilibrated nature of chondrule olivine suggests that the sample has experienced metamorphism consistent with Type 3.7 CK chondrites [13]. An anomalous characteristic that is not consistent with CV nor CK chondrites is the low (<0.1wt%) Cr in magnetite.

Based on these results, we suggest that NWA 10588 is an anomalous CV chondrite. However, the equilibrated chondrule olivine indicates that it experienced a higher degree of metamorphism than recorded in other CV chondrites. In order to better understand the thermal history of the CV parent body, future work will focus on the search for similarly-equilibrated CV chondrites.

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