

## COMPOSITION AND METAMORPHISM OF MATRIX MATERIAL IN UNEQUILIBRATED CK CHONDRITE NORTHWEST AFRICA 5343.

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**Introduction:** The CK chondrites are a group of highly-oxidized carbonaceous chondrites characterized by magnetite, Ni-bearing sulfides, and Ni-rich olivine [1,2]. The CK chondrites are also the only carbonaceous chondrite group to exhibit the full range of thermal metamorphism (from petrologic type 3 to type 6) [1]. Though the majority of CK chondrites are equilibrated (types 4-6), twenty-five unequilibrated CK chondrites have been discovered since 1990. Unequilibrated CK chondrites are thought to be metamorphosed to conditions associated with petrologic subtype 3.7 or higher [3-5]. However, our previous work suggests that some unequilibrated CK chondrites may not be as metamorphosed as previously thought [6]. Based on heterogeneity of matrix and chondrule olivine, [6] argued that Northwest Africa (NWA) 5343 is petrologic subtype ~3.6 – 3.7. In this study, we analyze the matrix of NWA 5343 to characterize the composition of, and extent of equilibration in, the least metamorphosed CK chondrites.

**Methodology:** We selected five 1 x 1 mm regions of NWA 5343 for X-ray mapping. These regions were chosen because they consisted entirely of fine-grained matrix material. Using these X-ray maps, we selected 2 – 5 areas (50 x 50  $\mu\text{m}$ ) within each region for bulk chemical analysis. These smaller matrix-grid areas were selected based on the absence of large grains and enrichment in Mg and S, as Mg is the primary element in matrix olivine and S is the best tracer for interchondrule matrix [7]. Bulk composition was determined by analyzing 49 points in each 50 x 50  $\mu\text{m}$  grid. Points with totals < 85 wt% were discarded. X-ray maps and bulk chemical analyses were acquired using the JEOL 8200 electron microprobe at Rutgers University. Operating conditions included 15 kv potential, 15 nA beam current (to minimize alkali loss), and variable beam size (1  $\mu\text{m}$  for X-ray mapping and 3  $\mu\text{m}$  for bulk analyses).

**Results:** Compositions of matrix grid-areas are similar within each region and between regions, suggesting that the matrix of NWA 5343 has experienced some degree of equilibration. The matrix is dominated by  $\text{SiO}_2$ , MgO, and FeO, which corresponds with silicate minerals, olivine and high-Ca pyroxene. CaO abundances are bimodal, with some regions having high CaO (~20 – 32 wt%) and other having low CaO (< 1 wt%). Regions with higher CaO are dominated by pyroxene rather than olivine.  $\text{Al}_2\text{O}_3$  is present at abundances < 6 wt%.  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  are mostly below detectable levels. Sulfur, NiO, and  $\text{Cr}_2\text{O}_3$  are also present at detectable levels.

We described the texture of each matrix grid-area and distinguished three distinct textures. Areas with a “porous texture” consist of anhedral to subhedral grains of olivine surrounded by mostly empty interstitial space. Sometimes this interstitial space is filled with finer-grained (1 – 2  $\mu\text{m}$ ) sulfides and silicates. The amount of interstitial space that is occupied varies. We also identified two types of textures in which the space between grains is filled with a glassy mesostasis. We distinguished these two glassy textures based on the shape and composition of the primary crystals. The dominant mineral is high-Ca pyroxene in “euhedral glassy” areas and olivine in “anhedral glassy” areas.

In general, porous and anhedral glassy matrix-grid areas have very similar compositions, particularly in FeO, MgO, and  $\text{SiO}_2$ , confirming that both textures are dominated by olivine. The euhedral glassy areas are richer in CaO and  $\text{Na}_2\text{O}$  than both the anhedral glassy and porous regions, due to the presence of Ca-pyroxene and glass. Other compositional differences between the porous and anhedral glassy regions and the euhedral glassy region can be explained by additional differences in mineralogy (e.g., the absence of sulfides from the euhedral glassy regions).

**Extent of Metamorphism:** Matrix material in type 3 chondrites, which is opaque in transmitted light, becomes more translucent as grain size increases during recrystallization [8,9]. Compared with ordinary chondrites of known petrologic types [8,10], the amount of recrystallized matrix in NWA 5343 suggests that it has been metamorphosed to petrologic type 3.4 – 3.6 conditions. The presence of glass is also a useful indicator of petrologic type. Glass begins to devitrify into Na-plagioclase at petrologic type ~3.5 and is rare above petrologic types 3.6 [11]. Large grains of plagioclase (~ 50 – 70  $\mu\text{m}$ ) were observed in the areas adjacent to the euhedral glassy regions, narrowing down the petrologic subtype to 3.5 – 3.6.

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