

HOMOGENEITY OF MATRIX AND CHONDRULE OLIVINE IN THE UNEQUILIBRATED CK CHONDRITES

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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 [1,2]. 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 others [6]. In this study, we analyze matrix and chondrule olivine in seven unequilibrated and two equilibrated (type 4) CK chondrites to better characterize the extent of metamorphism experienced by the unequilibrated CK chondrites.

Methodology: We analyzed olivine in unequilibrated CK chondrites DaG 431, NWA 1559, NWA 2043, NWA 4423, NWA 4425, NWA 5343, NWA 5956, and CK4 chondrites Dhofar 015 and NWA 4422. Compositions of matrix and chondrule olivine in all samples except Dhofar 015 were determined using a JEOL JXA 8200 electron microprobe at Washington University or a CAMECA SX 100 at the American Museum of Natural History. Olivine in Dhofar 015 was analyzed using an SX-50 at the University of Tennessee [7]. Operating conditions for all samples include 15 kv potential, 20-25 nA beam current (depending on the machine used), and 2 μ m beam size.

Olivine Compositions: Homogeneity of olivine is one of the most useful indicators of metamorphic grade, particularly in unequilibrated samples [8-10]. Fa content olivine becomes increasing uniform with increasing petrologic type, eventually converging on equilibrated values. As expected, matrix and chondrule olivine is equilibrated in CK4 chondrites Dhofar 015 (Fa₃₂) and NWA 4422 (Fa_{30.5}). This is consistent with CK 4-6 chondrites measured in previous studies [1,11,12], in which olivine is equilibrated at values near Fa₃₁. However, the unequilibrated CK chondrites in this study exhibit varying degrees of homogeneity, with NWA 5343 being the least homogeneous. In NWA 5343, average matrix and chondrule olivine compositions (Fa_{36.2} and Fa_{16.1}, respectively) indicate that equilibrium has not yet been achieved. Both populations of olivine are heterogeneous: matrix olivine (n=15) in NWA 5343 ranges from Fa_{34.9}-Fa_{37.9}, while chondrule olivine (n=115) ranges from Fa_{0.3}-Fa_{43.4}. When compared to the ordinary chondrites, this degree of heterogeneity and disequilibrium is more consistent with that of petrologic type 3.6 or 3.7 [13]. The heterogeneity of matrix olivine (Fa_{33.2}-Fa_{38.9}; n=64) and chondrule olivine (Fa_{0.3}-Fa_{36.2}; n=104) in NWA 1559 also suggests that it may be < type 3.8. Olivine homogeneity in the remaining samples is consistent with petrologic types 3.8 or 3.9. These results are important when attempting to answer questions regarding the thermal history of the CK chondrite parent body and the relationship between the CV and CK chondrites.

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