A New Equilibrated Ordinary Chondrite from North West Africa. G. J. Archer, D. W. Reeves, L. A. Taylor, and H. Y. McSween, Planetary Geoscience Institute and Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996-1410 (garcher2@utk.edu) (dreeves@utk.edu)

Figure 1: Photograph of NWA-6104 ordinary chondrite from North West Africa.

Introduction: Chondritic meteorites formed early in the history of our solar system and still retain their original chemical compositons. Those chondrites that are highly metamorphosed provide constraints on the thermal evolution of planetesimals that escaped melting and differentiation. Here we describe a newly recovered L5/6 ordinary chondrite from North West Africa (Fig. 1).

Methods: Two polished thin sections were prepared and examined by a petrographic microscope in both reflected and transmitted light. Digital photographs of the sections were taken at different magnifications. A Cameca SX100 fully automated electron microprobe was utilized for all chemical analysis.

Overall Description: The meteorite consists mostly of chondrules and chondrule fragments, and is classified as a low iron (L) chondrite, with close to 9% native iron. The average olivine composition is Fa_{24}, and the average Co content of kamacite is 0.8 wt. %, corresponding to the L chondrite classification [1] (Fig. 2). With glass absent and feldspar grains ranging in size from 1 to ~50 µm, and some readily delineated chondrules, it is a petrologic type 5/6 [2,3].

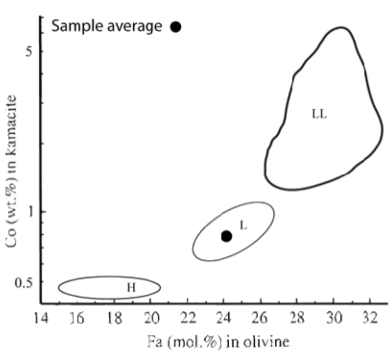

Figure 2: Plot of average Fa (mol%) in olivine versus average cobalt (wt.%) in kamacite.

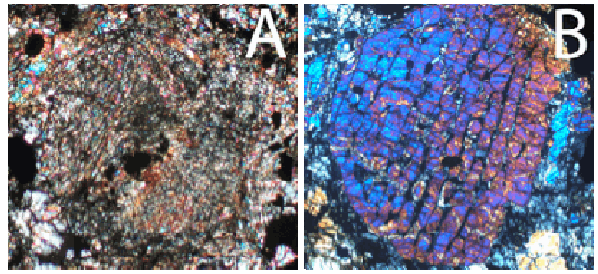

Figure 3: Chondrules showing different degrees of textural integration with matrix.

Chondrules: Recognizable chondrules of two types (barred olivine and radial pyroxene) are present. Well-defined chondrules comprise about 15% of one of the samples, and the overwhelming majority have a barred texture, although some porphyritic chondrules are recognizable. Most identifiable chondrules within the sample are composed predominantly of olivine, and the rest are dominantly orthopyroxene. Minor phases within the chondrules include clinopyroxene, Fe-Ni metals, chromite, and troilite. The matrices of the chondrules are fully devitrified, with feldspar grains ranging from <1 µm to ~50 µm. In the other sample, chondrules are not as distinct (Fig. 3).

Matrix: Chondrules are set in a matrix that consists mostly of olivine, orthopyroxene, and iron-nickel metal. Iron-nickel metal grains range in size from 10 µm to > 500 µm. Minor minerals within the matrix include the following in order of abundance: feldspar, clinopyroxene, troilite, chromite, and Cl-apatite.

Mineral Chemistry: The compositions of olivine grains in both samples range from Fo_{74} to Fo_{78}, with an average of Fo_{76}, except where grains are in close proximity to chromite, in which case the composition has an average of Fo_{78}. Orthopyroxenes are the dominant form of pyroxene, with a range of compositions from $En_{72}Wo_2$ to $En_{78}Wo_1$ and an average of $En_{77}Wo_2$. High-Ca clinopyroxenes occur in small amounts. Within the matrices of the chondrules, feldspar compositions range from $Ab_{77}Or_{10}$ to $Ab_{87}Or_{03}$, with $Ab_{83}Or_{06}$ as the average.

Iron-nickel metal occurs as kamacite and taenite. Grains of kamacite have low, homogeneous nickel concentrations of 6.3% on average. Taenite grains have nickel concentrations that vary from 26% to 45% throughout the grain.

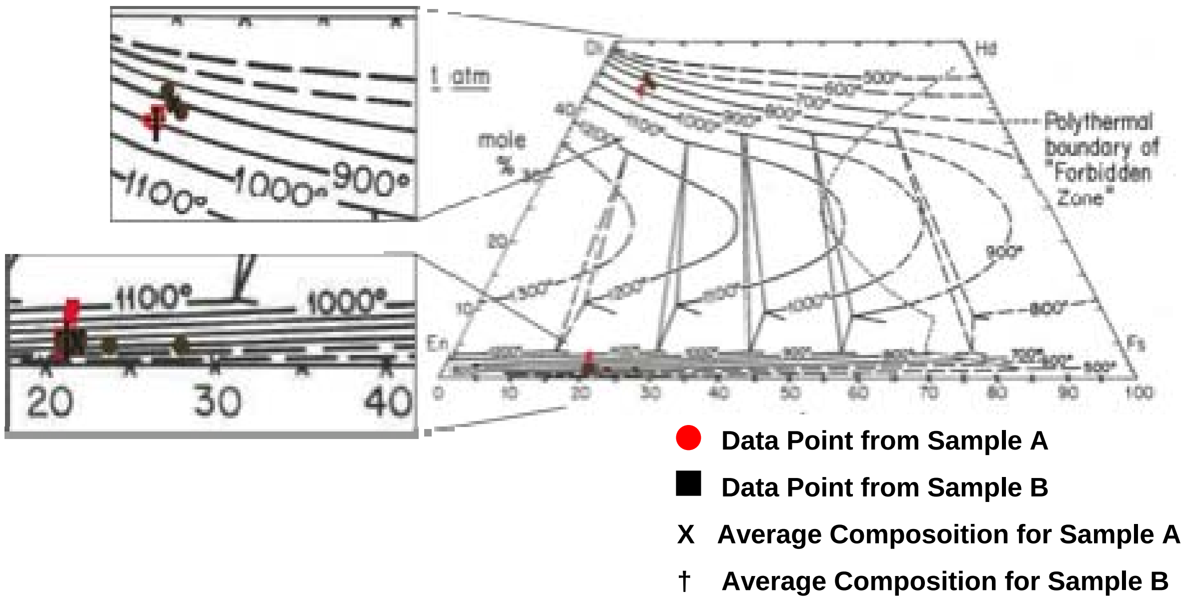

Figure 4: Pyroxene-pyroxene thermometry showing peak metamorphic temperature.

Thermometry: Using the two-pyroxene geothermometer [4], the peak metamorphic temperature was determined to have been 800-900±50 °C (Fig. 4). This is confirmed by both the average orthopyroxene and clinopyroxene compositions. This temperature is consistent with a petrologic type 5/6 classification [3].

Data collected from taenite grains allowed for the use of a cooling-rate speedometer [5]. The wt% nickel in taenite was plotted against distance from the nearest grain edge. Data for both samples plotted on the same curve, corresponding to a cooling rate of approximately 5°C per million years (Fig. 5).

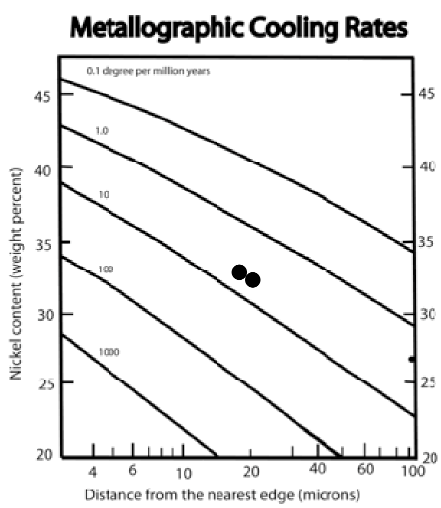

Figure 5: Taenite thermometry showing metallographic cooling rates.

References:

[1] Rubin A. E. (1990) *GCA* 54: 1217-1232.
[2] Van Schmus W. R. and Wood J. A. (1967) *GCA* 31: 747-765.
[3] Sears D. W. G. and Dodd R. T. (1988) *Meteorites and the Early Solar System*, 3-31.
[4] Lindsley D. H. (1983) *Amer. Mineral.* 68: 477-493.
[5] Taylor G. J. et al. (1987) *Icarus* 69: 1-13.