This is a very preliminary report on a mineralogically extraordinary ureilite, NWA766. The meteorite consists of ~80 vol% olivine, 20% pigeonitic pyroxene, several percent of interstitial black carbon phase(s), and slightly less than 1% Cr-spinel. The olivine is uncommonly ferroan: cores average about Fo76.3, with 0.26 wt% CaO, and molar Fe/Mg, Fe/Mn and Fe/Cr ratios of 0.31, 49 and 52, respectively. These ratios hint at possible deviations from the usual ureilite Fe/Mg-Fe/Mn-Fe/Cr systematics [1] in the same way, albeit less dramatically, as seen in the extremely ferroan and Cr-rich sample LEW88774 [1-3]. Pyroxene generally clusters tightly around En 67.0 Wo 14.5. The overall texture is typical ureilitic, with mafic grains averaging 1 mm across (but up to 4 mm), curved intergranular boundaries, and abundant triple junctions. The rock is moderately weathered, W2 [4].

The Cr-spinel is compositionally similar to that of LEW88774 [2]. In addition, and generally in close proximity to Cr-spinel, there are traces of Cr-rich sulfides, possible carbides, and most interestingly, an association of slender masses of Al, Si-rich glass and a strange Cr-silicate phase. One such Cr-rich region is shown in Fig. 1 (backscattered electron images; lower portion is a magnified view of small box near top portion’s right edge). The glasses average 79.5 wt% SiO2, 13.5 wt% Al2O3, 2.4 wt% CaO, 1.6 wt% Na2O, and 0.5 wt% FeO. Similar glasses have been reported for a few other ureilites [e.g., 5]. Analyses of the associated Cr-rich silicate show a consistent stoichiometry, with atomic Si/O ratio uniform at 0.25±0.004. For the average composition, a simplified chemical formula is (Mg,Ca,Fe,Mn,Na)2.7(Cr,Al)2.0(SiO4)3. The compositions appear to represent a solid solution of the knorringite-uvarovite varieties [Mg3Cr2(SiO4)3 and Ca3Cr2(SiO4)3] of garnet. Shuiskite, Ca4(Mg,Al)(Cr,Al)2(Si2O7)(OH)2·(H2O), can be ruled out because of the consistently good analysis sums. The long, narrow garnets are internally complex. Ca/Mg ratio increases with distance from the glass. The boundary between knorringite with 0-5 wt% CaO and more uvarovitic garnet with up to 14 wt% CaO is sharp. The mg ratio varies from 0.61 (in a knorringite) to 0.94 (at a point with 10.4 wt% CaO). At high magnification (Fig. 1), the garnet, especially the knorringitic portions, appears to have decomposed into a symplectic intergrowth. These intergrowths are far too fine to be resolved by e-probe, and analyses simply reflect their bulk (garnet stoichiometry) compositions. In at least one locale, the garnet is also associated with a sliver of subcalcic (En63Wo29) pyroxene.

Assuming the garnets (or decomposed garnets) formed preterrestrially, their genesis probably involved shock. A huge extrapolation from an experimental dataset tailored for terrestrial Cr-garnets [6] suggests that production of the NWA776 garnets, which have Cr/(Cr+Al) = 92.5±(1-σ)3.7, may have required only about 4 GPa, along with a (locally) high shock temperature, >>1700°C.