NORTHWEST AFRICA 6698: A HIGH TEMPERATURE "DIORITIC" ACHONDRITE WITH OXYGEN ISOTOPE COMPOSITION IN THE LL CHONDRITE FIELD.

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Petrography: NWA 6698 is a small (38.4 gram), fresh stone with unusual mineralogical and isotopic characteristics. It is a fine to medium grained (< 2mm) "dioritic" assemblage of relatively sodic plagioclase (69 vol. %), pyroxenes (27 vol.%) and accessory taenite, chromite (*cr#* = 90), chlorapatite and troilite. Plagioclase displays simple albite and Carlsbad twinning, is mostly equigranular, and contains included pyroxene chadacrysts. Two pyroxenes (augite and *unexsolved* pigeonite) are present as grains of highly variable size (up to 2 mm), and contain included plagioclase chadacrysts. Sparse pockets of brown, glassy late stage residuum with microlites occur between the other phases. Undulatory extinction in plagioclase and some pyroxenes implies mild shock levels.

Silicate Compositions: Most plagioclase ranges in composition from $An_{22.4}Or_{2.0}$ to $An_{36}Or_{2.2}$; a few zoned grains have cores of $An_{52-56}Or_{2.1}$ and rims of $An_{36}Or_{2.1}$, and albite in residuum pockets is $An_{10}Or_{5.7}$. Both augite ($Fs_{18.5–27.0}Wo_{36.7–41.2}$; FeO/MnO = 14-17, Al_2O_3 = 2.2 wt. %, Na_2O = 1.2 wt %; TiO_2 = 1.2 wt. %; Cr_2O_3 = 1.6 wt. %) and pigeonite ($Fs_{34.4-39.7}Wo_{8.6-14.5}$; FeO/MnO = 20, Al_2O_3 up to 3.2 wt. %) are notably aluminous. Residuum glass contains (in wt. %): SiO_2 70, Al_2O_3 13.8, FeO 2.8, CaO 2.1, Na_2O 9.4 and K_2O 2.9.

Oxygen isotopes: Results obtained by laser fluorination of acid-washed material ($\delta^{18}O$ = 4.80, 4.73; $\delta^{17}O$ = 3.72, 3.75; $\Delta^{17}O$ = 1.199, 1.265 per mil, respectively) plot well above the TFL in the field for LL chondrites [1].

Discussion: Several aspects of this achondrite imply that it is a rapidly cooled, high temperature igneous rock. The coexistence of pigeonite and subcalcic augite is possible only at temperatures above 1175°C in Fe-free systems at 1 bar [2], but even in Fe-bearing systems the coexistence of these two pyroxenes would indicate temperatures probably above 900-1000°C, which are consistent also with the elevated aluminum contents of both pyroxenes. The partly glassy intergranular residuum is consistent with rapid quenching of a partly crystallized magmatic liquid. The possibility that NWA 6698 might represent an impact melt rock is not in concert with the overall texture and complete lack of included clasts. Although the oxygen isotopic composition and sodic plagioclase suggest affinities with LL chondrites, the pyroxene compositions and especially their very low FeO/MnO ratios are quite unlike those for pyroxenes in LL chondrites.

References: [1] Clayton R. et al. (1991) *Geochim. Cosmochim. Acta* **55**, 2317-2337 [2] Longhi J. and Bertka C. (1996) *American Mineralogist* **81**, 685-695.