CHLOROPHAEITE-BEARING NAKHLITE NORTHWEST AFRICA 10153: PETROLOGY, OXYGEN AND HAFNIUM ISOTOPIC COMPOSITION, AND IMPLICATIONS FOR MAGMATIC OR CRUSTAL WATER ON MARS.

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Northwest Africa 10153 is the ninth known specimen in the nakhlite suite of meteorites, which have been interpreted (along with the three known chassignites) to be samples ejected from a single ~1.3 Ga zoned sill or lava flow complex on Mars [1, 2].

Petrography: The specimen has a cumulate igneous texture. Prismatic grains (up to 2.0 mm long) of compositionally zoned augite ($Fs_{23.1-43.5}Wo_{39.6-41.1}$, FeO/MnO = 31-38) and subordinate but larger (2.2-3.0 mm), equant grains of olivine (cores $Fa_{61.3-63.7}$, rims $Fa_{76.2-81.8}$, FeO/MnO = 41-48) are the major constituents, along with interstitial birefringent plagioclase laths ($An_{23.4-25.4}Or_{5.3-3.4}$), chlorapatite, ulvöspinel and exsolved Fe-Ti oxide. Augite grains have prismatic growth twins and polysynthetic shock deformation twins oriented at a high angle to the c-axis.

An unusual feature is the interstitial occurrence of optically and compositionally heterogeneous iron silicate material (red-brown in thin section). The average composition (N = 5, in wt.%) is SiO_2 43.3, Al_2O_3 1.6, Fe_2O_3 36.0, MgO 2.0, CaO 1.0, Na_2O 0.4, K_2O 0.4, with ~15% oxide sum deficiency (presumably as (OH) or H_2O). This is very similar to that reported by [3] for chlorophaeite in hydrously altered terrestrial basalts. TEM studies are in progress to elucidate the nature of this material, which may resemble that found in some other nakhlites [4].

Oxygen Isotopes: Analyses of three acid-washed bulk rock subsamples by laser fluorination gave, respectively: $\delta^{17}O$ 2.677, 2.870, 2.591; $\delta^{18}O$ 4.579, 4.963, 4.446; $\Delta^{17}O$ 0.259, 0.250, 0.244 per mil (for a TFL slope of 0.528).

Bulk Hf and Nd Isotopes: Representative clean bulk cutting dust contains 1.16 ppm Hf and has $^{176}Hf/^{177}Hf$ = 0.282471 ±14 (or εHf of -10.7). If a Lu content as in Nakhla is assumed, this Hf isotopic ratio would lie close to a 1.3 Ga reference isochron. Lu, Hf, Sm and Nd analyses of mineral separates are in progress.

Discussion: NWA 10153 is petrologically similar to Northwest Africa 998 [5], and unlike more rapidly quenched nakhlite specimens such as MIL 03346 [2] and NWA 5790/6814 [1, 6]. Thus it may derive from near the base of the nakhlite-chassignite cumulate pile [1]. Chlorophaeite may have formed at the last stages of igneous crystallization or possibly subsolidus. The Al-poor nature of this interstitial material (in contrast to palagonite [3]) is consistent with crystallization ***after*** plagioclase. Its water content might be of primary igneous origin, extraneous from wallrock or substrate adjacent to a lava flow or sill, or related to post-crystallization hydrothermal alteration of primary glass.

References: [1] Mikouchi T. et al. 2012. *LPS* **XLIII**, #2363 [2] Treiman A.. 2005. *Chemie Erde* **65**, 203-270 [3] Peacock M. and Fuller R. 1928. *Amer. Mineral.* **13**, 360-383 [4] Hicks L. et al. 2014. *GCA* **136**, 194-210 [5] Treiman A. and Irving A. 2008. *MaP*S **43**, 829-854 [6] Jambon A. et al. 2010. *LPS* **XLI**, #1696; Tomkinson T. et al. 2015. *MaP*S **50**, 287-304.