NORITIC DIOGENITES AND FELDSPATHIC DIOGENITES: EVOLVED ANCIENT CUMULATES POTENTIALLY RELATED TO MESOSIDERITES AND NOT TO ANY EUCRITES.

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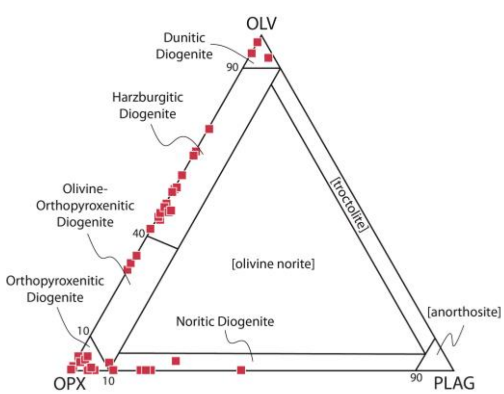
Introduction: We previously suggested [1] that the close similarities between diogenites in general (and plagioclase-rich diogenites in particular) and mesosiderites may imply a genetic connection between them. We have also suggested [2] that the metal component in mesosiderites derives from an exotic impactor that collided with a noritic diogenite parent body very early in the history of the Solar System.

This hypothesis is supported not only by the closely similar silicate mineral compositions for diogenites and mesosiderites, but by their similar very ancient formation ages (within 1-2 Myr after condensation of the solar nebula began). In a magnesium isotope study of diogenites by Schiller et al. [3], one of the analyzed specimens (NWA 5312 -- originally misidentified as a diogenite) is actually a heterogeneous mesosiderite [2], yet it is equally ancient and formed during the lifetime of the short-lived radionuclide ^{26}Al.

Here we describe two noritic diogenites (NWA 10268, NWA 10388) and one feldspathic orthopyroxenitic diogenite (NWA 8744), which serve to further characterize igneous cumulus processes (potentially in magma oceans) on one or more ancient diogenite parent bodies. These proposed bodies may have no relation whatsoever with any of the bodies (at least ***five*** so far) yielding different sorts of eucrites, and this begs the question of whether the popular acronym "HED" is prejudicial and even hindering our true understanding about the origins of all of these achondrites.

Nomenclature: Figure 1 shows a logical nomenclature scheme for diogenites [4] based on the IUGS scheme for analogous terrestrial igneous rocks; modes for specimens discussed here are plotted.



Noritic Diogenite Northwest Africa 10388: This very fresh specimen is composed predominantly of interleaved, bladed grains of orthopyroxene (72.2 vol.%) and calcic plagioclase (25.1 vol.%) exhibiting strong crystal lattice preferred orientation (Figs. 2, 3).

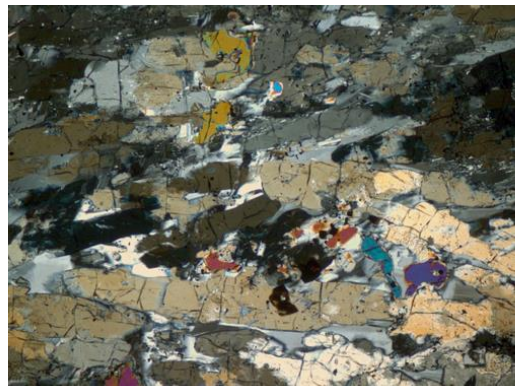


Figure 2. *Cross-polarized light image of NWA 10388. Opx (beige), plagioclase (gray), olivine (colors).*

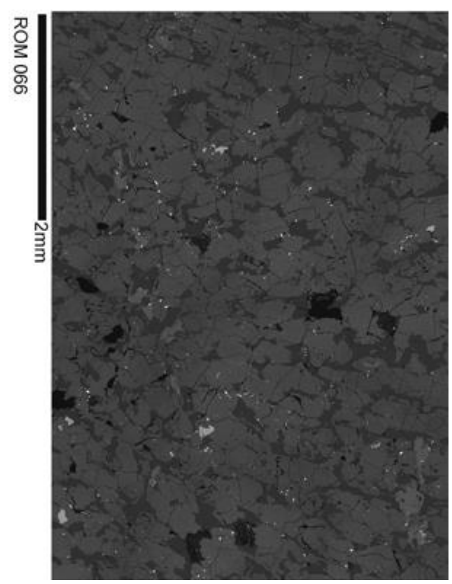


Figure 3. *BSE image of NWA 10388. Orthopyroxene (medium gray), plagioclase (darker gray and black holes), olivine and chromite (lighter gray).*

Also present are some larger (up to 4 mm), equant grains of orthopyroxene. Accessory minerals are olivine ($Fa_{33.7-37.0}$, FeO/MnO = 43-47), chromite (both Ti-bearing and Ti-free, Al-bearing), rare silica polymorph and troilite. Orthopyroxene grains are zoned (cores $Fs_{22.3-24.9}Wo_{1.8-3.0}$; rims $Fs_{30.9-34.9}Wo_{4.1-3.2}$; FeO/MnO = 29-33) and plagioclase is bytownite ($An_{85.9-88.0}Or_{0.1-0.3}$).

Noritic Diogenite Northwest Africa 10268: NWA 10268 is relatively coarse grained and moderately shocked, consisting predominantly of interlocking grains of orthopyroxene (up to 8 mm) with ~10 vol.% calcic plagioclase ($An_{83.5-85.2}Or_{0.5-0.9}$) plus accessory chromite and troilite. Both pyroxene and plagioclase exhibit marked undulose extinction, and sparse thin shock veinlets crosscut the fresh specimen. Orthopyroxene is notably ferroan ($Fs_{34.9-36.9}Wo_{2.6-2.5}$, FeO/MnO = 29-31) and has very fine exsolution lamellae of clinopyroxene ($Fs_{13.7-15.1}Wo_{43.4-43.1}$, FeO/MnO = 25).

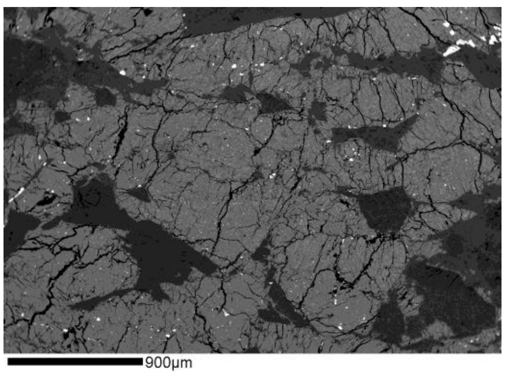


Figure 4. *BSE image of NWA 10268. Pyroxene (gray), plagioclase (black), chromite and troilite (bright).*

Northwest Africa 8744 – A Shock-Melted Feldspathic Diogenite: This large (12.57 kg) specimen is a melt-matrix breccia consisting of clasts (~30 vol.%) of orthopyroxenitic diogenite, feldspathic diogenite and noritic diogenite plus related crystalline debris within a predominant, very fine grained, vesicular matrix (see Figure 5). Orthopyroxene is turbid, pale clove brown in thin section and notably ferroan ($Fs_{35.4-37.0}Wo_{6.5-4.3}$, FeO/MnO = 29-31); anorthitic plagioclase ($An_{93.5-985.6}Or_{0.2-0.1}$) is polycrystalline. Some orthopyroxene contains irregular "patches" of pigeonitic clinopyroxene ($Fs_{26.4-38.0}Wo_{6.4-10.8}$, FeO/MnO = 29-30). Accessory phases are chromite, olivine ($Fa_{48.9}$, FeO/MnO = 44) and minor troilite blebs in orthopyroxene. Pigeonite in the vesicular matrix is more ferroan ($Fs_{42.5}Wo_{13.4}$, FeO/MnO = 27) than in clasts. Although some clasts contain up to 40 vol.% plagioclase (see Figure 4a), the overall plagioclase content is <10 vol.%.

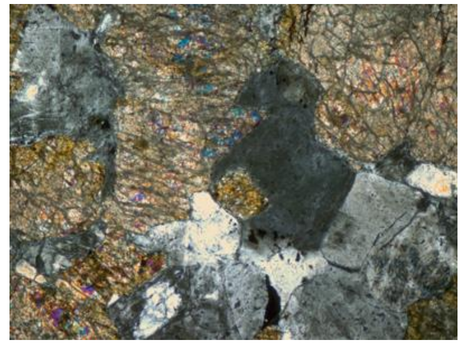
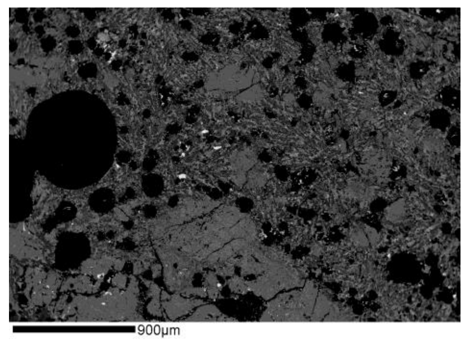


Figure 5. *Features of NWA 8744* ***(above)*** *Cross-polarized light image of noritic diogenite clast (with ~40 vol.% plagioclase). Width 2.37 mm.* ***(below)*** *BSE image showing the vesicular quenched matrix.*



Observations and Conclusions: The specimens described here and by [1] belong to a category of diogenites much richer in calcic plagioclase than most previously studied examples. The fabric exhibited by NWA 10388 appears to be consistent with crystal settling within a magma reservoir or magma ocean. These plagioclase-rich diogenites contain orthopyroxene that is notably more ferroan (Fs_{35-38}) than in plagioclase-free diogenites (or even some plagioclase-bearing diogenites), and the zoned orthopyroxenes in NWA 10388 bridge this compositional range. The presence of diogenite clasts in howardites should not be taken as unequivocal evidence for a common parent body for eucrites and diogenites – the diogenitic material (like the common CM2 chondrite clasts) could very well be exotic to any of the eucrite parent bodies. Thus we suggest that the acronym "HED" be abandoned as being prejudicial.

Acknowledgements – We are very grateful to Dr. David Gregory, Gary Fujihara, Rachid Chaoui, Greg Hupé and Darryl Pitt for their astute observations, which were pivotal in making these stones available for scientific study.

References: [1] Irving A. et al. 2014 *77th Meteorit. Soc. Mtg.*, #5199 [2] Bunch T. et al. 2014 *Lunar Planet. Sci.* **XLV** #2554 [3] Schiller M. et al. 2011 *Ap. J. Lett.* **740**, L22 [4] Wittke J. et al. 2011 *74th Meteorit. Soc. Mtg.*, #5223.