LUNAR FELDSPATHIC BRECCIA NORTHWEST AFRICA (NWA) 11421: CLASTS IN THE CORNERS

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Introduction: Meteorite NWA 11421 is one of the "Algerian Megafind" group of highland regolith breccias [1,2], paired with NWA 8046. Their clast population is dominated by anorthosite, with common troctolitic granulite [3], and a range of other materials [3,4,5]; here, we document several more types.

Method: Our earlier work focused on a cm-sized dunite clast in NWA 11421 [4,6], applying X-ray computed tomography, SEM X-ray maps and EMP chemical analyses. The maps' corners include matrix material and small clasts – these maps are the basis for this work (as we have been unable to obtain additional data).

Dunite: The dunite clast [4] is a unique find among NWA 8046 pairs. It consists of granular olivine (Mg*=83.5), plagioclase (An96.5), enstatite, augite, and chromite [4]. It contains no phosphates or Ti- or Zr-bearing phases. Chromite occurs as intergrowths with augite, possibly from a metasomatic event [7]. Thermochemical modeling on its mineral compositions with Perple_X implies equilibration at ~950°C and ~0.4 GPa [4], within the lunar mantle.

Other Lithic Clasts: Around the dunite clast are many others, mm-sized or smaller. The most abundant clasts are anorthosites, both as angular crystalline fragments and as ellipsoidal melt droplets. One anorthosite clast contains stringers of silica. Impact melt fragments, aphantic and crystalline, are common. Troctolitic granulite [3,8.9] is not common. The area also includes two types of clasts that could represent basalts. One has plagioclase laths surrounded by low-Ca pyroxene, which encloses rounded olivines – a texture typical of ophitic or sub-ophitic basalt. The other has augite, olivine and plagioclase in a granular texture. Neither basaltic type contains Ti-rich minerals.

The area contains two unusual, fine-grained clasts. First is rich in igneous incompatible elements (ITE) – K, Ti, & P – and silica (Fig. 1). It's mineralogy is not evident. The clast could be related to KREEP or granite; bulk NWA 8046 contains little ITE [2]. Second is a rounded fragment rich in anorthite and augite, with a few grains of olivine and Fe-metal. It contains Na in excess of that in any other fragment or matrix area, and the Na is concentrated along grain boundaries (Fig. 2). The clast contains minimal K. P, Ti, or Cr. It could be related to the low-Ca anorthosite of [8] and/or sodic troctolite of [9].

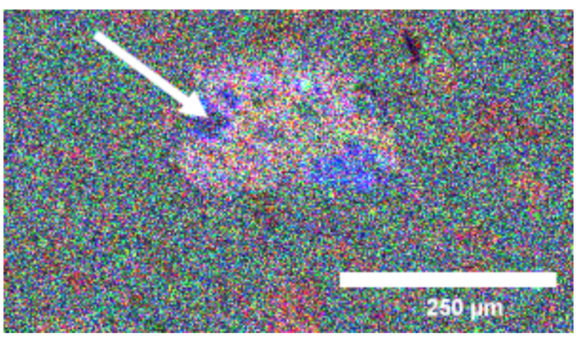

Figure 1. EDS X-ray map if ITE-rich clast. Red=Ti; green=P; blue=K. Arrow indicates a grain of silica. Surrounding material is anorthite, olivine, and pyroxenes (red).

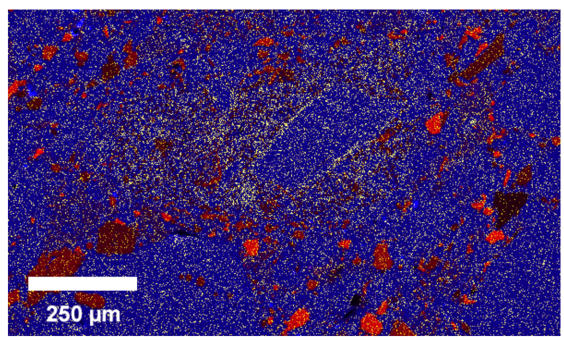

Figure 2. EDS X-ray map of Na-bearing clast. Na=yellow; red=Mg; blue=Al. Minerals are plagioclase (blue), olivine (red), pyroxenes (dull red).

Mineral Grains: Nearly all isolated mineral grain in our study area can be ascribed to one of the clast lithologies above. There is one grain of Mg-Al spinel, such as occur in spinel troctolites [10]. And there are several grains of exolved pyroxenes, augite in opx and vis versa, such as might have come from a slowly cooled gabbro.

Implications: NWA 11421 contains a wide variety of lunar rock types, from mantle to impact melt, mare to highlands, and ITE-depleted through enriched. Given our small study area, this clast inventory is not comprehensive; even with this limited sample, we find several lithologies not noted in other meteorites paired with NWA 8046. Who know what treasures await in a broader survey?

References: [1] Korotev R. (2021) https://sites.wustl.edu/meteoritesite/items/lm_nwa_08046_clan/ [2] Korotev R. & Irving A.J. (2021) *Meteoritics & Planetary Sciences* 56, 206-240. [3] Fagan A. L. & Gross J. (2020) *LPSC* 51st, Abstr. #2904. [4] Treiman A.H. & Semprich J.J. (2019) *LPSC* 50th, Abstr. #1225. [5] Lunning N. & Gross J. (2021) *LPSC* 52nd, Abstr. #2225. [6] Treiman A.H. & Coleff D. (2019) *Meteoritics & Planetary Sciences* 53, Abstr. #6329. [7] Elardo S.M. et al. (2012) *Geochimica et Cosmochimica Acta* 87, 154-177. [8] Li Y. et al. (2020) *LPSC* 51st, Abstr. #1652. [9] Cao H.J. et al. (2019) *LPSC* 50th, Abstr. #2359. [10] Prissel T.C. et al. (2021) *Earth and Planetary Science Letters* 551, 116531.