PETROGRAPHY AND CHEMISTRY OF LUNAR DIABASIC METEORITE NORTHWEST AFRICA 10656. S. N. Valencia[1], R. L. Korotev[1], B. L. Jolliff[1], and A. J. Irving[2]. [1]Department of Earth and Planetary Sciences, Washington University, St. Louis, Missouri, 63130, USA (svalencia@levee.wustl.edu). [2]Department of Earth and Planetary Sciences, University of Washington, Seattle, WA 98195, USA.

Introduction: NWA (Northwest Africa) 10656 is a 262.5g lunar meteorite, found in Western Algeria in January, 2016. Initial analysis shows that NWA 10656 is a diabase with an affinity to the NWA 773 clan [1]. Here, we describe the petrography and chemistry of NWA 10656.

The NWA 773 clan is a group of twelve meteorites that are chemically and mineralogically related. These meteorites are variably composed of 5 lithologies (olivine phyric basalt, olivine gabbro, gabbro, anorthositic gabbro, and ferroan gabbro) and a fragmental or regolith breccia [e.g., 2-6]. Together, the various lithologies may represent products of a single magmatic-volcanic system on the Moon [e.g., 3,6].

Methods: In this work, a 13×22 mm polished thin section was used for petrographic descriptions and electron probe microanalysis. Mineral chemistry and x-ray maps were obtained using a JEOL-8200 equipped with 5 WDS spectrometers at Washington University in St. Louis. Using x-ray maps, lithologic mapping was done using ENVI^{TM} for mineralogical classification [e.g., 7]. A mass of 19.5 mg of powdered rock material was analyzed by INAA (instrumental neutron activation analysis) for trace elements.

Petrography and Mineral Chemistry: The sawn face of NWA 10656 shows that the meteorite is monolithologic. This stone is mostly composed of phaneritic olivine, pyroxene, and plagioclase. Our thin section of NWA 10656, which is broadly uniform in both mineral assemblage and texture, comprises 16 vol% olivine, 55 vol.% pyroxene, 26 vol.% plagioclase, and 3 vol.% minor and trace phases (see below).

Olivine occurs as subhedral grains ~85×100 μm to 1770×800 μm in size. In transmitted light, olivine is stained brown, particularly along microfractures, indicating terrestrial alteration (Fig. 1a). Compositions range from Fo_{67} to Fo_{54}, with some Fe-Mg zoning occurring within individual grains. Inclusions are common within olivine. Some inclusions are mulitiphase; composed of sub-rounded pyroxene, plagioclase and/or trace minerals.

Pyroxene occurs as large, lath-like crystals (up to ~2040×550 μm in size). In transmitted light, pyroxene crystals are tan in color. Most pyroxene grains are zoned in Ca, generally from core-rim, where high-Ca pyroxene rims large cores of low-Ca pyroxene (Fig. 1b,c). Pyroxene compositions average $Wo_{14}En_{60}Fs_{26}$ for the low-Ca pyroxene (Mg/(Mg+Fe) averages 0.69) and $Wo_{29}En_{52}Fs_{19}$ for the high-Ca pyroxene (Mg/(Mg+Fe) averages 0.73).

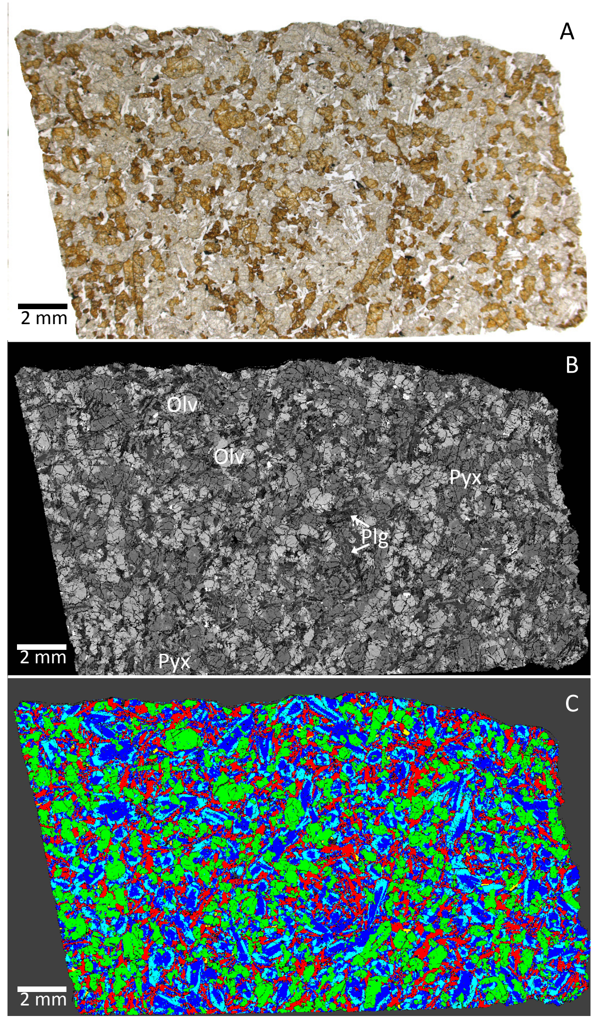

Figure 1. Lunar meteorite NWA 10656. A. Transmitted light. Olivine appears brown in color, pyroxene, tan, and plagioclase, white. B. Backscatter electron image of NWA 10656, where plagioclase is the darkest gray, pyroxene, medium gray, olivine, light gray, and accessory minerals, white. C. Classification image, where olivine is represented by green, plagioclase by red, ilmenite by yellow, low-Ca pyroxene by blue, and high-Ca pyroxene by cyan. This classification diagram highlights the zoning in pyroxene, where high-Ca pyroxene rims large low-Ca pyroxene cores.

Plagioclase occurs as relatively small, anhedral laths, up to ~1240 μm in length, which are intergrown with pyroxene with a subophitic texture. In many regions, plagioclase is unfractured and some regions are isotropic under crossed polarized light, indicating partial conversion to maskelynite. Plagioclase compositions range from $An_{86}Ab_{13}Or_{0.5}$–$An_{93}Ab_{6}Or_{1.8}$ and average $An_{91}Ab_{8}Or_{1.0}$ (Fig. 2).

Minor to trace minerals include ilmenite, K-feldspar chromite, apatite, merrillite, troilite, Fe-Ni-S metal, and baddeleyite. Ilmenite is the largest of the accessory minerals, with anhedral grains reaching ~290×200 µm in size (Fig. 1). Ilmenite has an average composition of $Fe_{0.82}Mg_{0.13}Ti_{1.0}O_{3}$. Chromite has an average composition of $Fe_{0.9}Mg_{0.2}Cr_{1.3}Al_{0.5}Ti_{0.1}O_{4}$.

Bulk Composition: NWA 10656 has a composition intermediate to olivine gabbro, ferroan gabbro, and anorthositic gabbro lithologies of the NWA 773 clan (Fig. 2). Although NWA 10656 is petrographically similar to the olivine gabbro lithology found in several members of the NWA 773 clan, it is compositionally distinct from the main field of olivine gabbros. NWA 10656 has an FeO content (19.7 wt.%) that falls near the average of the bulk of the olivine gabbro lithology (Figs. 2,3). NWA 10656 has greater concentrations of many trace elements, particularly REE, when compared to olivine gabbro samples in the NWA 773 clan (e.g., 7 ppm La in the average olivine gabbro vs. 12 ppm La in NWA 10656).

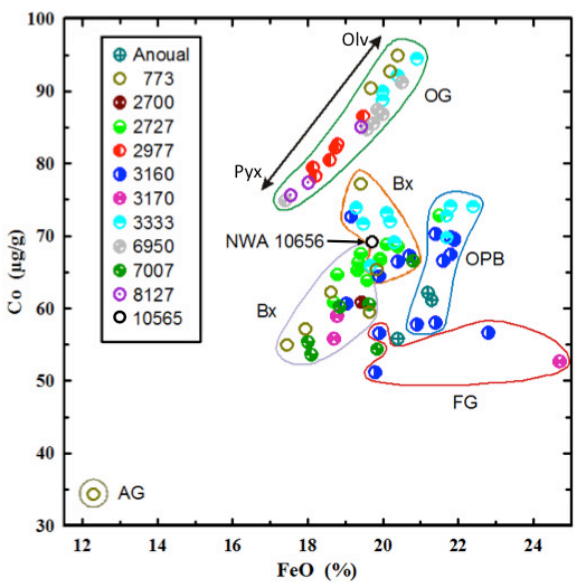

Figure 2. Bulk compositions of the members of the NWA 773 clan. NWA 10656 plots as an intermediate among the olivine gabbro (OG), anorthositic gabbro (AG) and ferroan gabbro (FG) end-members.

Discussion and Conclusions: The various lithologies in the NWA 773 clan appears to represent a magmatic system on the Moon that contains both intrusive and extrusive lithologies. The intrusive lithologies may represent different parts of a shallow magma chamber. The chemical changes of the intrusive lithologies track the evolution of the magma chamber form early, magnesian and olivine-rich lithologies, to late, ferroan, lithologies. The earliest formed lithology

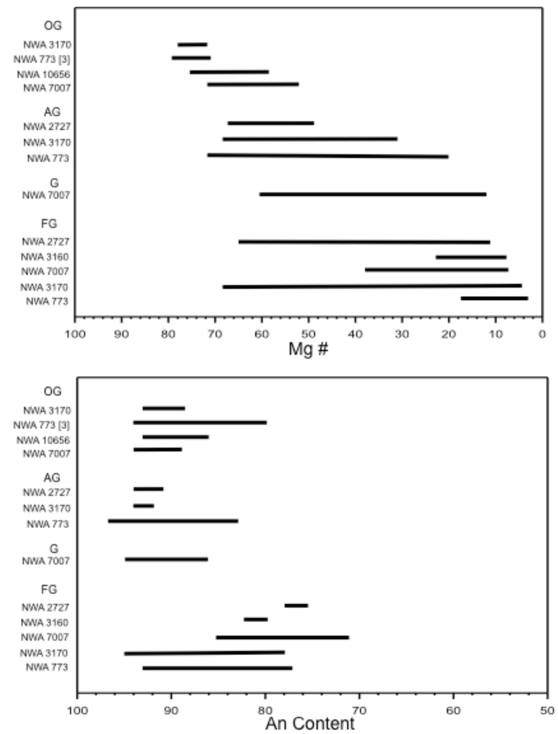

Figure 3. Mg# and An content evolution of the intrusive lithologies of the NWA 773 clan.

is the olivine gabbro, which has relatively magnesian pyroxene compositions (Fig. 3). Following the crystallization of olivine gabbro are the anorthositic gabbro and gabbro lithologies, both of which exhibit extensive Mg-Fe zoning (Fig. 3). Pyroxene reaches the most Fe-rich compositions in the ferroan gabbro lithology, indicating it was last to crystallize (Fig. 3). NWA 10656 has Mg# range shifted toward lower values and elevated incompatible concentrations compared to many other olivine gabbro samples. As such, we infer that NWA 10656 fits into this crystallization sequence somewhat near the end of crystallization of the olivine gabbro lithology, but its different texture resulted from a faster rate of cooling.

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