NORTHWEST AFRICA 8632- RECORDING YOUNG LUNAR VOLCANISM. A.L. Fagan[1], J. Gross[2], S. Ramsey[1], and B. Turrin[2], [1]Geosciences and Natural Resources Dept., Western Carolina University, Cullowhee, NC 28723 (alfagan@wcu.edu), [2]Dept. of Earth and Planetary Sciences, Rutgers University, Piscataway, NJ 08854.

Introduction: Northwest Africa (NWA) 8632 is a porphyritic, low-Ti, low-Al, low-K lunar basalt [1,2] composed predominantly of large olivine phenocrysts (up to ~2 mm in length) with skeletal pyroxene and olivine microphenocrysts set in a fine-grained, glassy matrix (Fig. 1). Some olivine phenocrysts contain melt inclusions and euhedral spinel grains. Small (~25-30 μm long) ilmenite grains are found in the matrix, and isolated patches of yellow glass and glassy veins are likely impact melt glass [1].

Fig. 1. Plane-polarized photomicrograph of NWA 8632 showing porphyritic texture of olivine (Ol) phenocrysts, pyroxene (Px), and glass (G) in the fine-grained, dark matrix. White box denotes the area of the Phosphorus map in Fig. 2.

The bulk composition of NWA 8632 has some similarities (e.g., TiO_2, Sc [1]) to Northwest Africa (NWA) 032/479, but they are not considered paired due to other minor compositional differences (e.g., Sm [1]). NWA 8632 also has some textural similarities to NWA 032, particularly with regards to the shape and slope of the olivine crystal size distribution [3]. In addition, NWA 8632 has *some* compositional similarities with some Apollo 12 pigeonite basalts, as well as Northwest Africa 4734 [1]. Co, however, is much lower than in the Apollo basalts and instead is similar to that found in the Mg-suite [4]. Although NWA 8632 has some similarities to a variety of lunar basalts, these similarities are not consistent for all compositional groups, modal mineralogy, or textures. NWA 8632 has the most similarities to NWA 032, which is one of the youngest lunar basalts (2931 ± 92 Ma [4]) and contains unique oscillatory zoning in its olivine phenocrysts. In this study, we examine the olivine composition and provide the first geochronology of NWA 8632 to better understand its potential relationship to NWA 032.

Methods: Major and minor elemental abundances of olivine were characterized using electron probe microanalysis (EPMA) via the Cameca SX 100 at the Univ. of Tennessee; instrument settings were: 15 kV, 30nA, and on-peak count times of 30 sec, with the exception of Ca (40 sec) and P (150 sec). The detection limit for P (3 σ above background) is ~80 ppm. P elemental maps (e.g., Fig. 2), which were used to guide the selection of EPMA analyses, were generated with the JEOL-8200 superprobe at Rutgers Univ. with pixel spacing of 2 μm, 300 nA, 15 kV, and 500 ms dwell time.

$^{40}Ar/^{39}Ar$ geochronology analyses were conducted at the University of Rutgers. Small (few μg) aliquots were taken from a thin-section of NWA 8632 using a micro-core drill [e.g., 5,6]. Samples and reference standards, Fish Canyon sanidine (28.201 Ma; [7]) and Hb3Gr hornblende (1080 Ma; [8]), were irradiated in a controlled geometry to facilitate the correction of any measurable gradients in the neutron-flux. Neutron irradiation was carried out at the US Geological Survey TRIGA reactor for 77 hrs without Cd-shielding. Argon isotopes were then measured using a Mass Analyzer Products (MAP) 215–50 noble gas mass spectrometer. Samples were placed on a Ta-platform in the extraction system, in vacuo; heating (5-min. heating times) of the samples was by indirect laser heating of the tantalum substrate [9]. For a ten-minute extraction (including heating), typical static system blanks were (1018 mol): ^{40}Ar = 714 ± 30; ^{39}Ar = 13.3 ± 1.0; ^{38}Ar=1.1±0.5; ^{37}Ar=24±0.2; ^{36}Ar=3.6±0.14; we have determined that the blanks are independent of temperature. All errors are quoted at the 1-sigma level of uncertainty.

Olivine Composition: Olivine phenocrysts (0.3 to 2 mm) are compositionally zoned (avg. Fo_{68} cores to avg. Fo_{51} rims). In contrast, the microphenocrysts (0.05 to 0.3 mm) have avg. cores of Fo_{55} and avg. rims of Fo_{46}. Some of the olivine phenocrysts display P zoning (Figs. 2, 3) similar to NWA 032 [10]. Low P areas (blue, Fig. 2) are below the detection limit (~80 ppm), but enriched areas (green, Fig. 2) have up to 349 ppm P (0.08 wt% P_2O_5). The high P regions oscilate (Figs. 2, 3) within an individual grain, but are more concentrated near the center and around melt-inclusions (Fig. 2) as in [11].

P-bearing olivine have been previously identified in lunar samples such as Luna 16 [12] and 20 [13]; Dhofar 025, 961, and 287 [12]; as well as NWA 032 [14], with some grains containing up to 0.5 wt% P_2O_5. The P-rich regions within the olivine in this study are similar to those of NWA 032 (0.07 wt% P_2O_5 [10]). Because P diffuses slowly in olivine [e.g., 15], the individual grains retain remnant P zoning more efficiently than with other elements, leading P to be a useful indicator of magmatic processes. The oscillatory P zoning in NWA 032 has been hypothesized to form due to convection processes within the magma chamber [14] or solute trapping during olivine growth [14, 16], which could also be the case here.

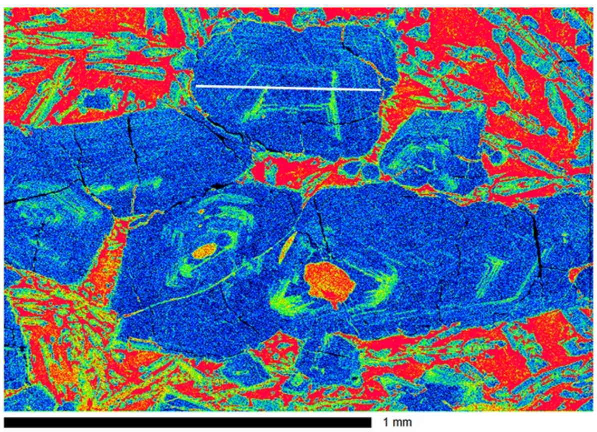

Fig. 2. Phosphorus zoning X-ray map. Red indicates the highest P abundance (corresponds to the matrix), green is intermediate, and blue is the lowest (below detection limit of EPMA). White line indicates the location of P data in Fig. 3.

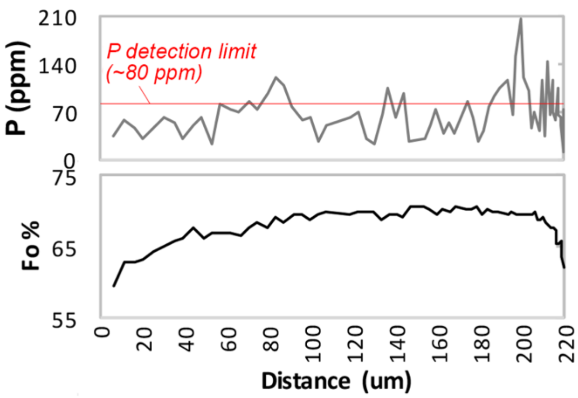

Fig. 3. Phosphorus (ppm) and Forsterite (Fo) % data along the white line shown in Fig. 2 displaying the compositional variation.

Crystallization Ages: Here we report the first geochronology analyses of NWA 8632. Two aliquots (#4 and #7) produced the clearest plateaus to provide age estimates of 2772 ± 41 Ma and 2877 ± 34 Ma, respectively (Fig. 4). These results place the age of NWA 8632 within error of the youngest lunar basalts, such as the paired NWA 032 and NWA 4734, which have Sm-Nd isochron ages of 2931 ± 92 Ma [4] and 3024 ± 27 Ma [10] and mean $^{40}Ar/^{39}Ar$ ages of 2779 ± 14 Ma [17] and 2717 ± 10 Ma [10], respectively.

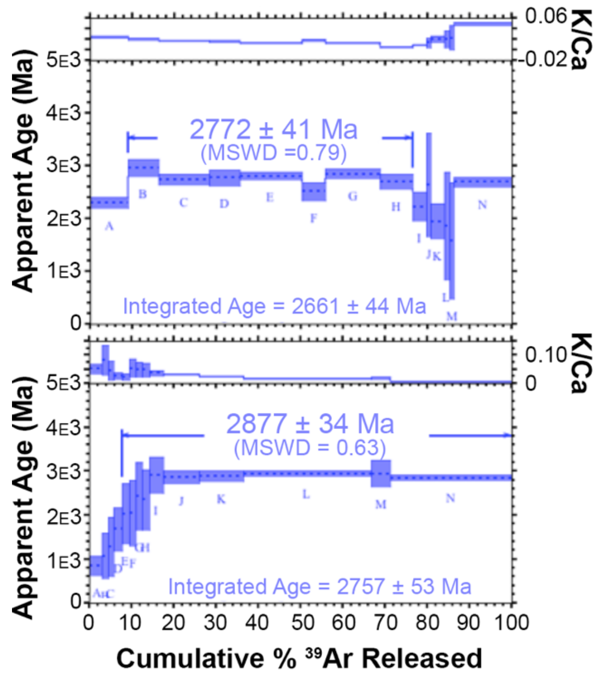

Fig. 4. $^{40}Ar/^{39}Ar$ disturbed step-heating spectra results with 7-step and 10-step plateaus for aliquots #4 and #7 respectively.

Implications: NWA 8632 has some broad similarities to NWA 032, but is compositionally distinct enough to indicate that the two meteorites are not paired [1]. Despite this, the similarities in the ages, P zoning, and textural similarities might indicate a particular style of volcanism on the Moon at ~2.9 Ga with magmatic convection and similar cooling rates.

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