**CHEMISTRY AND MINERALOGY OF 73002,455 FROM CLAST 1017C: A TEXTURALLY UNIQUE OLIVINE PORPHYRITIC VERY LOW-TI BASALT.** C. J.-K. Yen[1], P. K. Carpenter[1], B. L. Jolliff[1], R. C. Ogliore[1,2], J. J. Kent[3], R. A. Zeigler[4], S. A. Eckley[5], C. K. Shearer[6,7], and The ANGSA Science Team[8]. [1]Dept. of Earth and Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 (yenc@wustl.edu); [2]Dept. of Physics, Washington University, St. Louis, MO 63130; [3]GeoControl Systems, Jacobs JETS Contract, Houston, TX 77058; [4]ARES, NASA Johnson Space Center (JSC), Houston, TX 77058; [5]Jacobs Technology, Johnson Space Center, Houston, TX; [6]Lunar and Planetary Institute, Houston TX 77058; [7]Dept. of Earth and Planetary Science, Institute of Meteoritics, University of New Mexico, Albuquerque, New Mexico 87131; [8]includes all members of the ANGSA Science Team, which includes the JSC curation team.

**Introduction:** Apollo 17 double drive tube 73001/73002 from the light mantle at the base of South Massif of the Taurus-Littrow Valley, opened as part of the Apollo Next Generation Sample Analysis (ANGSA) initiative [1-3] is a treasure trove that potentially contains new lunar lithologies. We present here an analysis of thick section 73002,455 of clast ,1017C, which was previously studied solely with μXCT [4]. New results on the chemistry and mineralogy of 73002,455 support the prior conclusion that ,1017C is an unusual, perhaps unique, magmatic lithology, namely a porphyritic, very low-Ti (VLT) basalt with olivine phenocrysts.

The μXCT data, which map differences in X-ray attenuation, were interpreted to reflect olivine as the coarser, darker phenocrysts and pyroxene as the finer, brighter phenocrysts based on petrologic knowledge and expected differences in X-ray attenuation. However, the creation of a thick section of ,1017C and the use of an electron probe for microanalysis (EPMA) revealed that the phenocrysts in 73002,455 are exclusively highly magnesian olivine ($Fo_{86-96}$) (Fig. 1). Higher spatial resolution shows that the groundmass comprises oriented plagioclase laths and interstitial olivine, pigeonite, augite, phosphate, and oxide grains.

**Methods:** 73002,455 was sectioned at Johnson Space Center (JSC), where optical microscope images, μXRF, and FE-SEM X-ray maps were also acquired (Fig. 1). These data were consulted when choosing target spots during EPMA analyses. BSE images (48 nm/px) were collected using a Tescan Mira3 FEG-SEM at 15kV and ~2 nA beam current. We analyzed 73002,455 with a JEOL JXA-8200 electron microprobe at Washington University equipped with 5 WDS detectors and 1 SDD for EDS. Spot analyses were made with WDS with an accelerating voltage of 15 kV, beam current of 25 nA (adjusted to 10 nA for phosphates), and focused beam diameter because of the small size of the sample. Quantitative EPMA maps were also acquired at 100 nA, 30 ms dwell time, and 1.76 µm step size, following the methods described in [5]. The acquired quantitative maps of $SiO_2$, $TiO_2$, $Al_2O_3$, $Cr_2O_3$, FeO, MnO, MgO, CaO, $Na_2O$, $K_2O$, and total oxides were stacked together and analyzed in the Environment for Visualizing Images (ENVI) software. We then used the supervised classification methods described in [6] to classify ,455 into eight separate phase classes (Fig. 2). With the average phase chemistry and respective area proportions, we conducted a modal recombination to estimate the bulk composition of 73002,455.

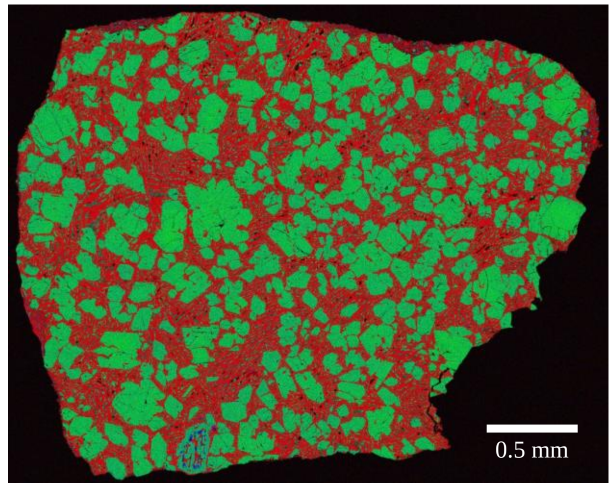

*Figure 1.* Al-Mg-Fe RGB image of 73002, 455 using the FE-SEM X-ray maps. The troilite-bearing grain is seen at the bottom.

**Results and Discussion:** We studied the chemistry and mineralogy of thick section 73002,455 and characterized this sample of clast ,1017C as an olivine porphyritic VLT basalt with highly magnesian olivine phenocrysts and glomerocrysts, and plagioclase-rich groundmass. 73002,455 has ~45% phenocrysts compared to 61% determined by [4] using the whole-sample XCT data—the variability is probably a 2D slice vs. 3D volume issue. Preliminary analysis shows that 73002,455 has ~48% olivine, 36% plagioclase, and 15% pyroxene by area, with minor amounts of phosphate, oxides, and Fe metal. The classification map will continue to be refined, especially the olivine and pyroxene classes. 73002,455 and ,1017C also contain numerous elongate vesicles. The absence of orthopyroxene phenocrysts and uniformity of ,455 except for two troilite-bearing phenocrysts (e.g., Fig.1, one occurs near the edge), were useful in determining where in the XCT stack ,455 originated.

The atomic Fe/Mn of olivine (85-115) and pyroxene (35-80) confirm a lunar origin of ,455 and clast ,1017C. The composition of the olivine in ,455 forms a single bell curve centered at $Fo_{88}$ with a standard deviation of 1.8.

The most magnesian cores of the phenocrysts seen in Fig. 1 are $Fo_{94-96}$ while the finer, brighter phenocrysts are $Fo_{84-87}$. The olivine grains in the interstitial groundmass as well as the skeletal troilite-bearing phenocryst are closer to $Fo_{83}$. Several melt inclusions occur in the olivine phenocrysts. The rims of numerous olivine phenocrysts have fingers extending into the groundmass, which transition to pyroxene at the peritectic further into the groundmass (Fig. 2). Plagioclase in the groundmass is $An_{89-91}$ and pyroxene ranges between magnesian pigeonite (e.g. $Fs_{16}En_{77}Wo_{7}$) and magnesian augite (e.g. $Fs_{10}En_{51}Wo_{39}$). Phosphates include apatite grains that transition to RE-merrillite (Ce peaks observed in EDS). One apatite grain occurs adjacent to Co-bearing Fe-Ni metal. Tiny Cr- and Ti-bearing spinels are scattered throughout the groundmass and spot analyses revealed no stoichiometric ilmenite. Several Ti-bearing grains show Zr peaks in EDS and these are likely loveringite [7]. One plagioclase lath contains a small inclusion of K-rich glass (Fig. 3).

73002,455 and its parent clast ,1017C could represent a sample that initially underwent near-equilibrium, closed-system cooling and crystallization, producing the phenocryst assemblage in an olivine accumulation zone in the parent magma, resulting in excess olivine. Upon or just prior to reaching the peritectic, eruption of the magma led to rapid crystallization of the groundmass through the peritectic and then along the plagioclase-pyroxene cotectic. Plagioclase surrounding the olivine phenocrysts protected them from reacting with the interstitial melt to form pyroxene. The crystallization sequence suggested by ,455 is olivine → plagioclase → pyroxene. The absence of orthopyroxene phenocrysts in ,455 could be a sampling issue as potential coarse, elongate phenocrysts different from the olivine are inferred from the XCT data, and further sections could sample one.

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**References:** [1] Shearer, C. et al. (2019) *LPS L*, Abstract #1412. [2] Shearer, C. et al. (2022) *LPS LIII*, Abstract #2546. [3] Schmitt, H. et al. (2017) *Icarus, 298*, 2-33. [4] Yen, C. J.-K. et al. (2022) *LPS LIII*, Abstract #1547. [5] Carpenter, P. et al. (2019) *LPS L*, Abstract #2148. [6] Yen, C. et al. (2020) *LPS LI*, Abstract #2804. [7] Zhang, A, et al. (2020) *Am. Min., 105 (7)*, 1021-1029.

| 73002,455 | Bulk composition | Groundmass estimate |
|---|---|---|
| SiO2 | 42.67 | 44.74 |
| TiO2 | 0.38 | 0.60 |
| Al2O3 | 12.03 | 21.68 |
| Cr2O3 | 0.19 | 0.24 |
| FeO | 7.60 | 4.58 |
| MnO | 0.14 | 0.12 |
| MgO | 29.78 | 15.15 |
| CaO | 6.78 | 12.18 |
| Na2O | 0.35 | 0.60 |
| K2O | 0.07 | 0.10 |
| Total | 100 | 100 |
| Mg# | 87 | 85 |

*Table 1.* ENVI bulk composition reconstructions.

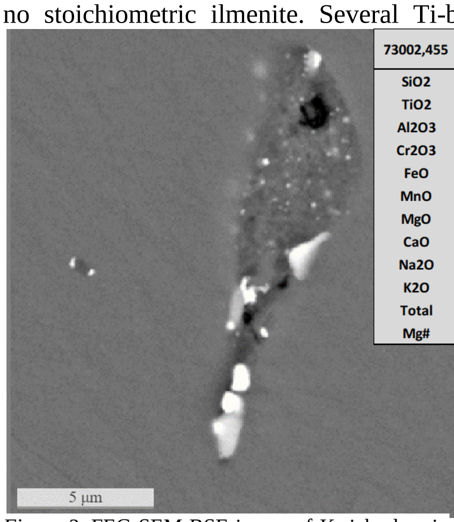
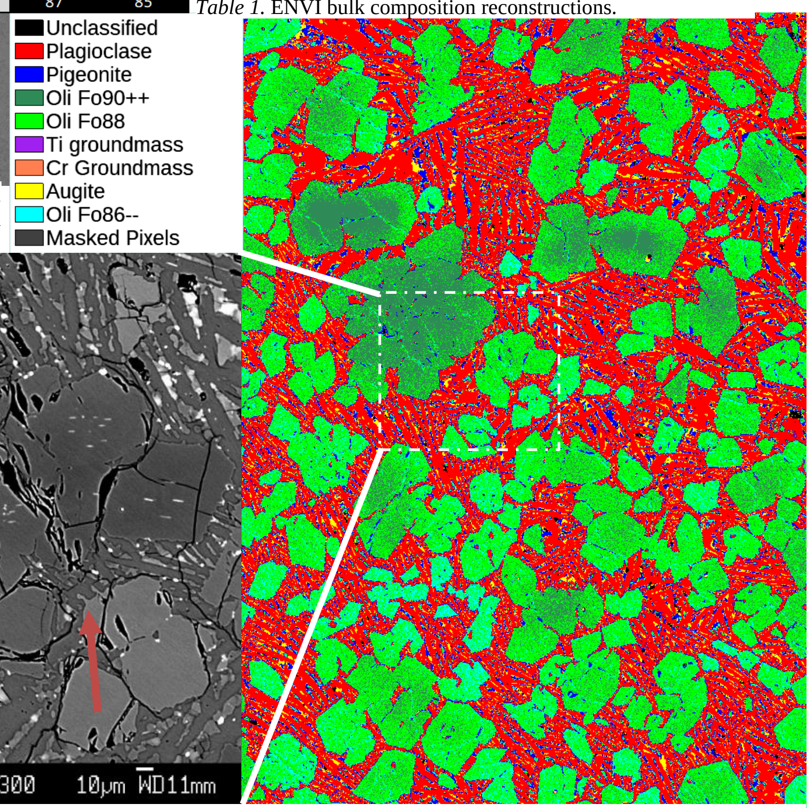



*Figure 3.* FEG-SEM BSE image of K-rich glass in 73002,455, with bright Fe-Ni metal grains which have a Co peak in their EDS spectra.



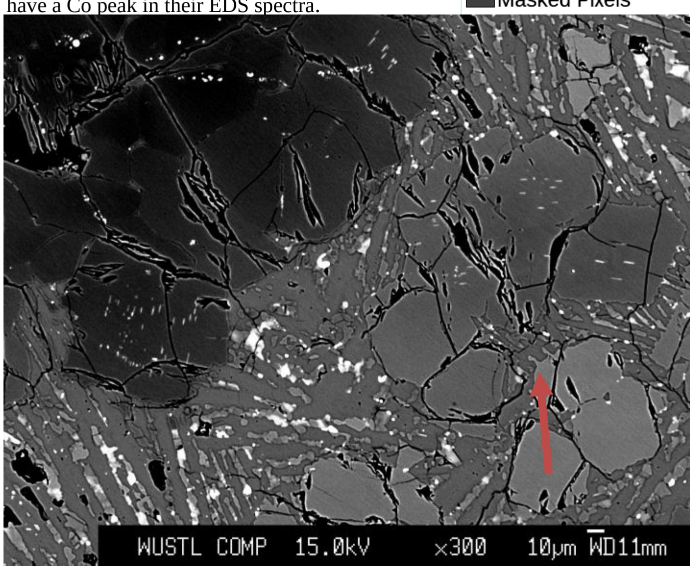




*Figure 2.* Left: BSE image of a subset of the classification map (white box), showing in higher spatial resolution the phenocrysts, plagioclase lathes, and interstitial groundmass. Red arrow pointing out an example of an olivine rim extending into the groundmass. Right: ENVI classification map of a subset of ,455 highlighting olivine phenocrysts and plagioclase groundmass.