A COMPREHENSIVE STUDY OF MINERALOGY AT APOLLO 17 LANDING SITE. L. Sun[1], G. J. Taylor[1,2], L. M. V. Martel[1,2], P. G. Lucey[1], [1]Hawai'i Institute of Geophysics and Planetology, Dept. of Geology and Geophysics, University of Hawai'i at Mānoa, 1680 East-West Rd. Honolulu, HI 96822, USA, lzsun@higp.hawaii.edu. [2]Center for Lunar Exploration and Science, LPI, Houston.

Introduction: The Apollo 17 landing site and sample suite has been intensively studied, including detailed studies of rock and soil samples [1], field geology [2] and remote sensing [3]. While the chemistry of the Apollo 17 regolith is well known [4], its mineralogy has been less extensively reported.

Here, we combine quantitative XRD analysis of 43 Apollo-17 lunar soil samples from 19 sampling stations and 60 m resolution mineral maps [5] from SELENE Multi-band Imager (MI) [6] to illustrate the detailed mineralogy and petrology of this landing area and its relationship to the local geology.

Methods: Samples were analyzed with an Olympus Terra XRD instrument after sieving to obtain >150 and <150 μm fractions. Some were wet-sieved to smaller sizes for comparison with results from the Lunar Sample Characterization Consortium (LSCC [7–9]). Sample sizes of ~35 mg were measured; we did replicate analyses of each sample and averaged them. Mineral abundances were extracted from XRD patterns using Reitveld refinement as implemented by the Jade program. Glass abundances were determined by choosing a linear background and fitting a broad Gaussian to the scattering hump above background; here we discuss only glass-free results. We calibrated the instrument by using 12 mixtures of 2-5 minerals. Fig. 1 compares our modal mineral abundances for six soil samples (25–45 μm fraction) with data from the Lunar Sample Characterization Consortium (LSCC) [7–9], which were obtained by SEM point counting. The dashed line represents the best-fit line to all the data and has a slope of 0.99 and R^2 of 0.97, indicating good agreement between these two independent measurements.

The comparison of mineralogy between MI mineral maps and the XRD analysis described above for 19 A17 sampling stations are shown in Fig. 2, the dashed line is 1:1 line. Mineral modes of MI mineral maps [5] for sampling sites are extracted from 3x3 boxes centered on the sampling stations by comparing to Apollo traverse maps [10]. It can be seen that MI mineral modes of sampling sites show a good correlation with XRD measurements. In the future, we can further calibrate MI mineral maps with the lunar soil compositions derived by XRD analysis.

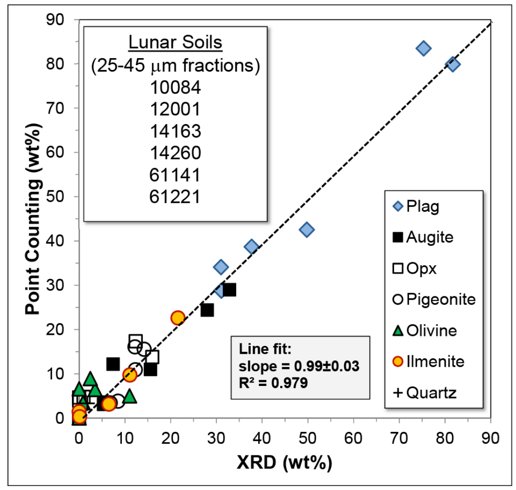

Fig. 1 Modal abundances determined by XRD compared to those determined by SEM point counting [7-9].

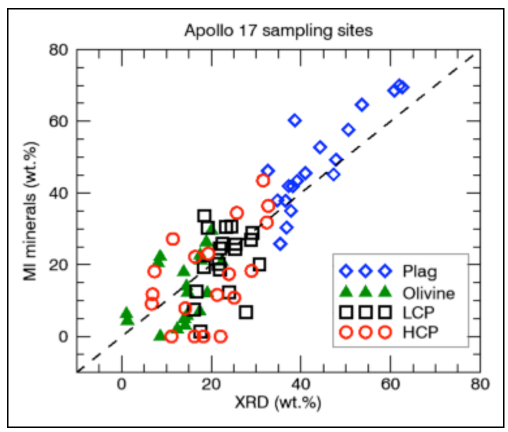

Fig. 2 Mineral modes of 19 A17 sampling stations from MI mineral maps vs. XRD analysis of lunar samples (glass free).

Results and Discussions: Mineral modes of 43 Apollo-17 lunar soil samples (Fig. 3, small symbols) are plotted on the rock classification diagram of Stöffler et al. (1980) [11]. We also extracted mineral abundances from the fresh pixels (OMAT>0.25) on top of the Sculptured Hills and the South and North Massifs from MI mineral maps, then averaged the mineral modes and plotted them with large symbols in Fig. 3. Several clusters can be observed in XRD-derived mineral abundances, and they appear to correlate with location of the stations. Sculptured Hills (A17-S8, LRV 11), South Massif (A17-S2), and North Massif (A17-S6, S7, LRV 10) are distinct clusters. Samples from the South Massif contain the most abundant plagioclase, and the local rock type represented by this composition is anorthositic norite. The landslide (A17-S3, S4, LRV 4–5) located at the north slope of South Massif, and most of the samples from here show similar compositions to South Massif, while some of them are more mafic, which may be the result of mixing with mare basalts from the Taurus Littrow valley floor. Samples from the North Massif are similar to those of the South Massif, except they contain less plagioclase. Mineral abundances on the top of the massifs from MI maps show somewhat more anorthositic composition. XRD analysis show that samples from Sculptured Hills are mainly gabbroic norite, and MI minerals indicate similar compositions but with more diversity in plagioclase content, which agrees with that suggested by Moon Mineralogy Mapper (M^3) data [2].

Mare units include the center Valley (A17-LM, S1, S5, S9, LRV 1–3, LRV 7–9 and LRV 12). The average ilmenite content for samples from the Valley is ~15.7 wt.% (Fig. 4), which suggests very high Ti mare basalts [1]. Two different kinds of olivine-bearing high-Ti basalt samples can be observed from Fig. 3a and 3c, one group has higher olivine content (>8 wt.%), and the other one has relatively lower olivine content (<2 wt.%), consistent with modes of basalt rock samples [1]. No regolith samples show VLT mare basalt compositions known from studies of small basaltic fragments [1, 3] in the Valley.

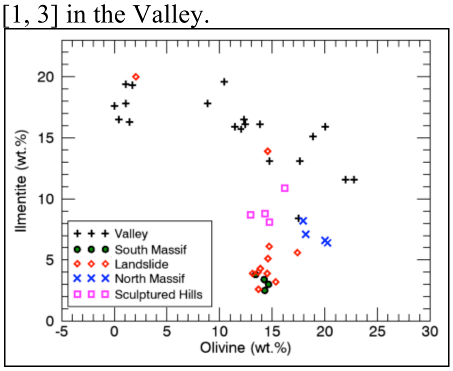

Fig. 4 Ilmenite vs. Olivine of 43 A17 lunar soils.

Conclusions: We combined the XRD analysis of A17 lunar soil samples with MI mineral maps to investigate the mineralogy of Apollo 17 landing site. Our results suggest that the North and South Massifs have similar mineralogy, which is consistent with [3]. Samples collected at the base of the Sculptured Hills show less diversity of compositions compared to remote sensing data. We observed low-olivine and high-olivine high-Ti mare basalts in the Valley, but no regolith samples dominated by VLT basalts.

References: [1] Papike J. J., et al. (1998) Rev. Mineral. Geochem., 36, 5.1-5.234. [2] Schmitt, H.H., et al. (2017). *Icarus*, 298(sup. C), 2-33. [3] Robinson, M.S. & Jolliff, B.L. (2002). *JGR*: Planets, 107(E11), 1-30. [4] Korotev, R.L. & Kremser, D.T. (1992) 23rd LPSC. [5] Lemelin, M., et al. (2015). *JGR: Planets*, 120(5), 869-887. [6] Ohtake, M., et al. (2013). *Icarus*, 226(1), 364-374. [7] Taylor, L.A. et al. (1996) *Icarus, 124*, 500-512. [8] Taylor, L.A. et al. (2001) *Meteoritics & Planet. Sci., 36*, 288-299. [9] Taylor, L.A. et al. (2010) *JGR ,115*. [10] Robinson, M., et al. (2010). *Space Sci. Rev.,* 150(1), 81-124. [11] Stöffler, D., et al. (1980). *Proc. Conf. Lunar Highlands Crust*, 51-70.

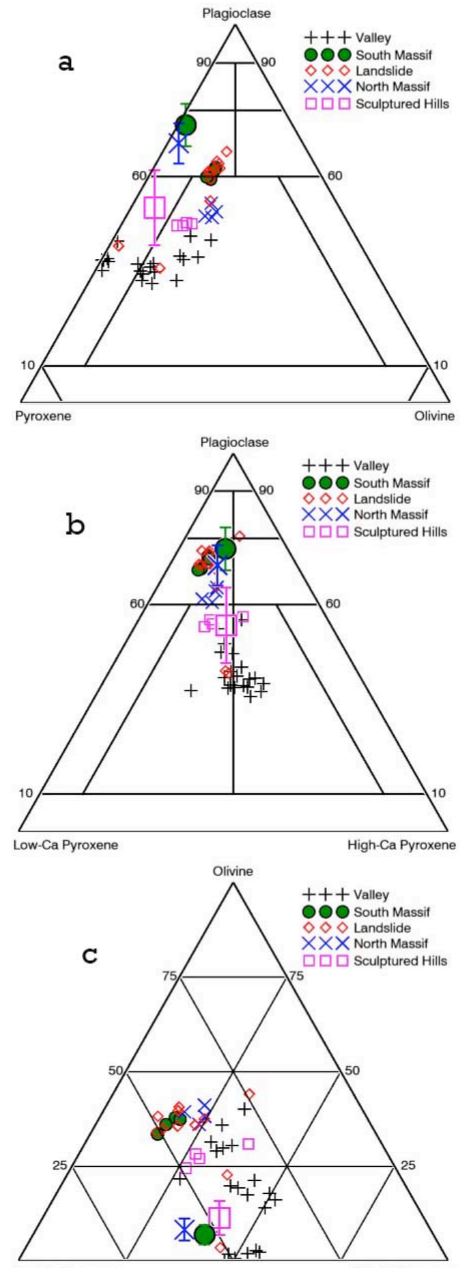

Fig. 3 Mineral abundances of 43 Apollo 17 lunar soils analyzed on rock classification diagram of [11], small symbols are from XRD analysis and large symbols are from MI mineral maps, and error bar indicate error of minerals.