PETROLOGY OF SURFACE SOILS FROM THE LANDSLIDE DEPOSIT AT TAURUS-LITTROW: A LINK TO THE ANGSA DOUBLE DRIVE TUBE 73001/73002

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Introduction

A consortium of six teams will study the Apollo 17 double drive tube 73001/73002, the centerpiece of the Apollo Next Generation Sample Analysis (ANGSA) program. Soil was sampled to a depth of 70.6±0.5 cm and the soil column weighs 1.24 kg [1]. It was collected at Station 3, within the "light mantle" landslide deposit at the base of South Massif (Fig. 1). Investigation of this deposit was one of the primary scientific goals of the Apollo 17 mission [2]. Soil from the upper section, 73002, was recently extruded from the core tube and is currently being processed in the Pristine Sample Laboratory at the Johnson Space Center. Samples from it are not yet available for petrologic study, but to better understand its contents, soils from nearby sites are being analyzed.

A companion paper [3] reports lithologies found in samples from Station 3. Here we report on the petrology and mineral chemistry of four surface soils collected during lunar roving vehicle (LRV) traverses: 72141 and 74121, from the light mantle; and 72150 and 75111 from the valley floor near the light mantle (Fig. 1).

Two regions of differing albedo in the light mantle have recently been recognized from high-Sun Lunar Reconnaissance Orbiter Camera (LROC) images. Schmitt et al. [2] concluded that the lower-albedo unit is an older deposit, partially overlain by the younger, higher-albedo material.

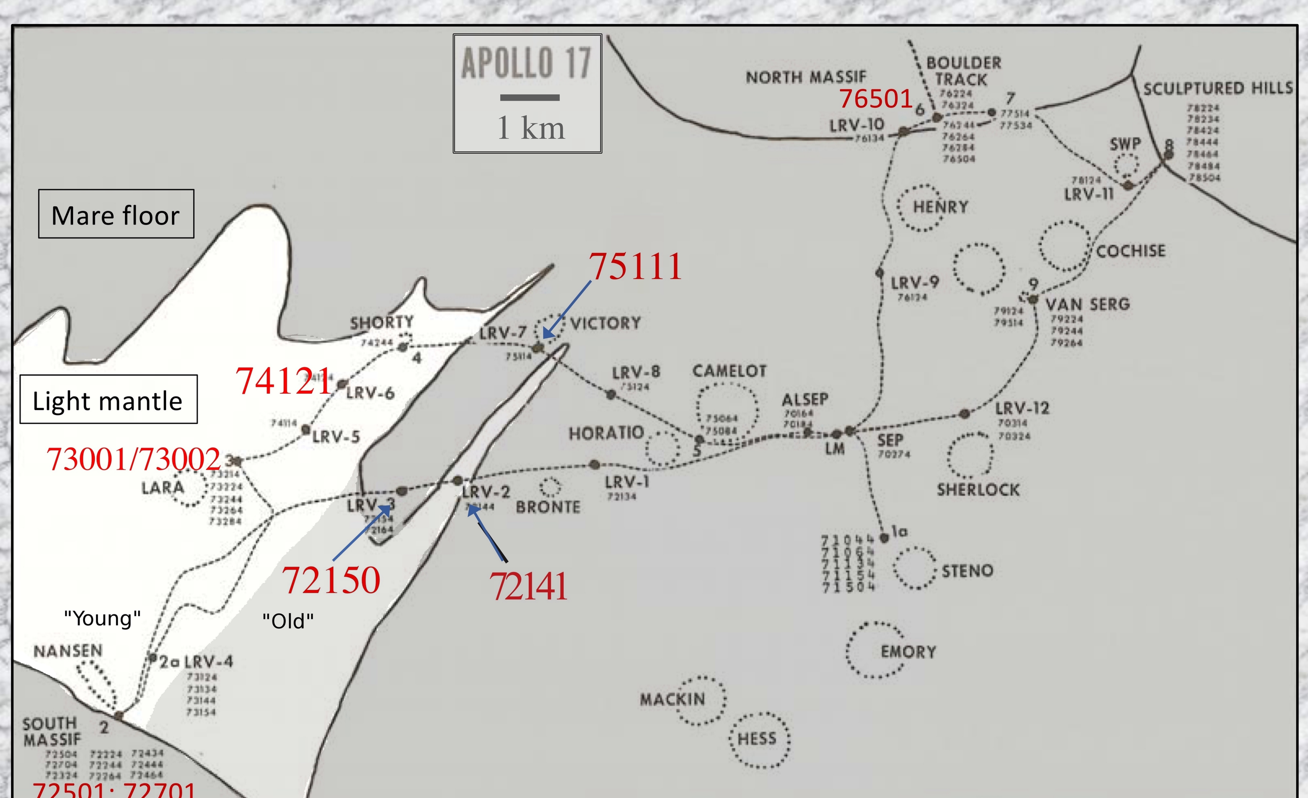


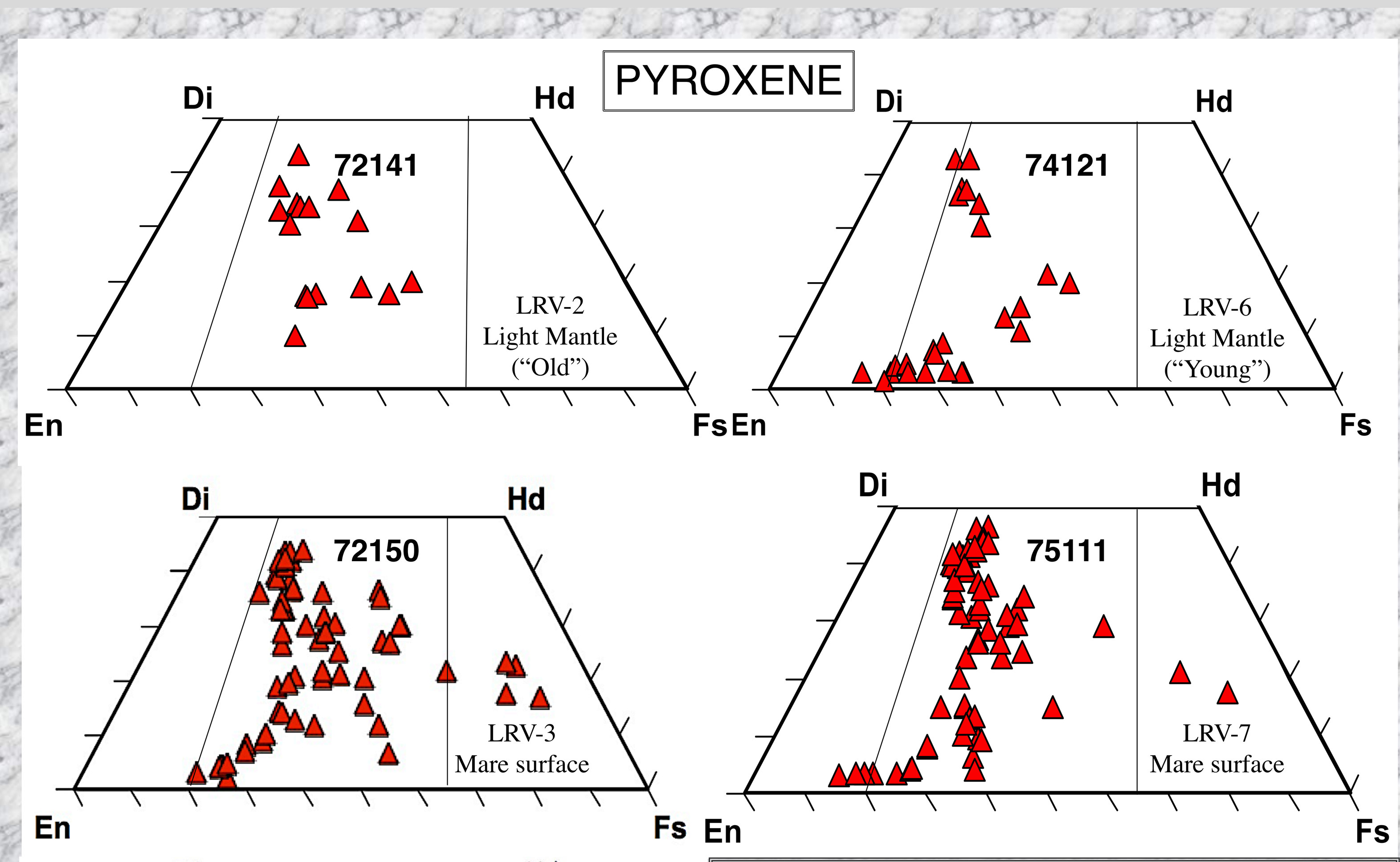
Fig. 1. Sketch map of the Taurus-Littrow valley, highlighting the light mantle landslide deposit and showing the Apollo 17 landing site (LM), lunar roving vehicle (LRV) traverses (dotted lines) and numbered sampling sites. Samples analyzed for this study are 72141 (collected at LRV-2); 72150 (LRV-3); 74121 (LRV-6); and 75111 (LRV-7). The two shadings of the light mantle represent albedo differences as seen in LROC images [2]. After [4].

Methods

One polished grain mount of the 90–150 μm size fraction of each sample was studied by optical microscopy and with a TESCAN LYRA3 scanning electron microscope at the University of New Mexico (UNM). A backscattered electron photomosaic of each mount was produced. Quantitative major and minor element analyses of minerals and glasses were obtained with a JEOL 8200 fully automated electron microprobe at UNM operated at 15kV with a focused 20nA beam. We identified glasses by color in transmitted light.

Results

The modal petrology of this size fraction was reported for all four soils by Heiken and McKay [5], so our main efforts were directed toward determining the composition and provenance of mineral grains and glasses, which have not been previously investigated. Compositions of monomineralic pyroxene grains are summarized in Fig. 2 and 3, histograms of proportions of plagioclase endmember components in Fig. 4, and glass compositions are illustrated in Fig. 5. Glasses are orange, pale yellow/green, or colorless. Olivine is rare in these soils but both light mantle samples (72141 and 74121) contain grains that are more forsteritic than Fo_{90}, suggesting a troctolitic source. One ~250 μm grain of pink spinel (63.5 and 4.2 wt% Al_2O_3 and Cr_2O_3, respectively) was found in 74121, also indicative of a plutonic component.



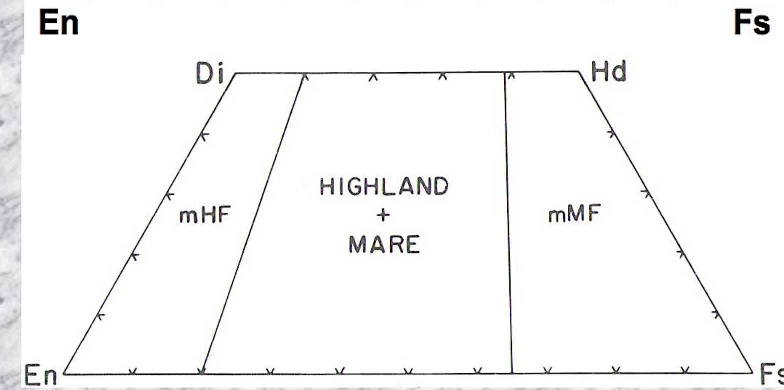


Fig. 2. Proportions of the main pyroxene quadrilateral components $CaMgSi_2O_6$–$CaFeSi_2O_6$–$Mg_2Si_2O_6$–$Fe_2Si_2O_6$ (Di-Hd-En-Fs) in monomineralic grains in the four soils studied. Minimum mare fraction (mMF) and minimum highland fraction (mHF) fields from [6]. No unambiguous mare pyroxenes were found in the samples from the light mantle.

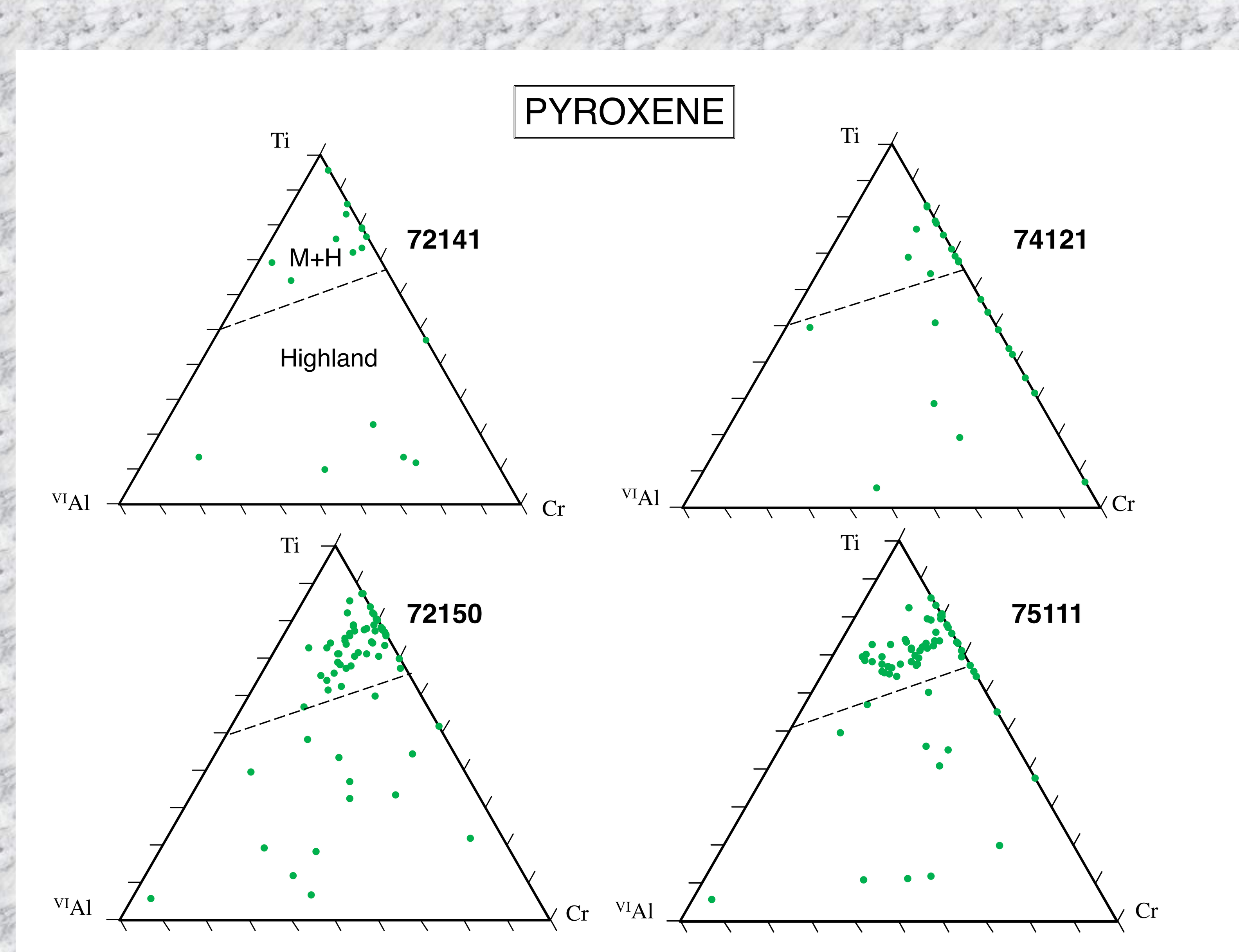


Fig. 3. Proportions of Ti, Cr, and octahedrally coordinated Al (^{VI}Al) cations in monomineralic pyroxene grains, as determined by electron microprobe, in the four soils studied. The low-Ti subfield is occupied only by highland pyroxenes. After [7].

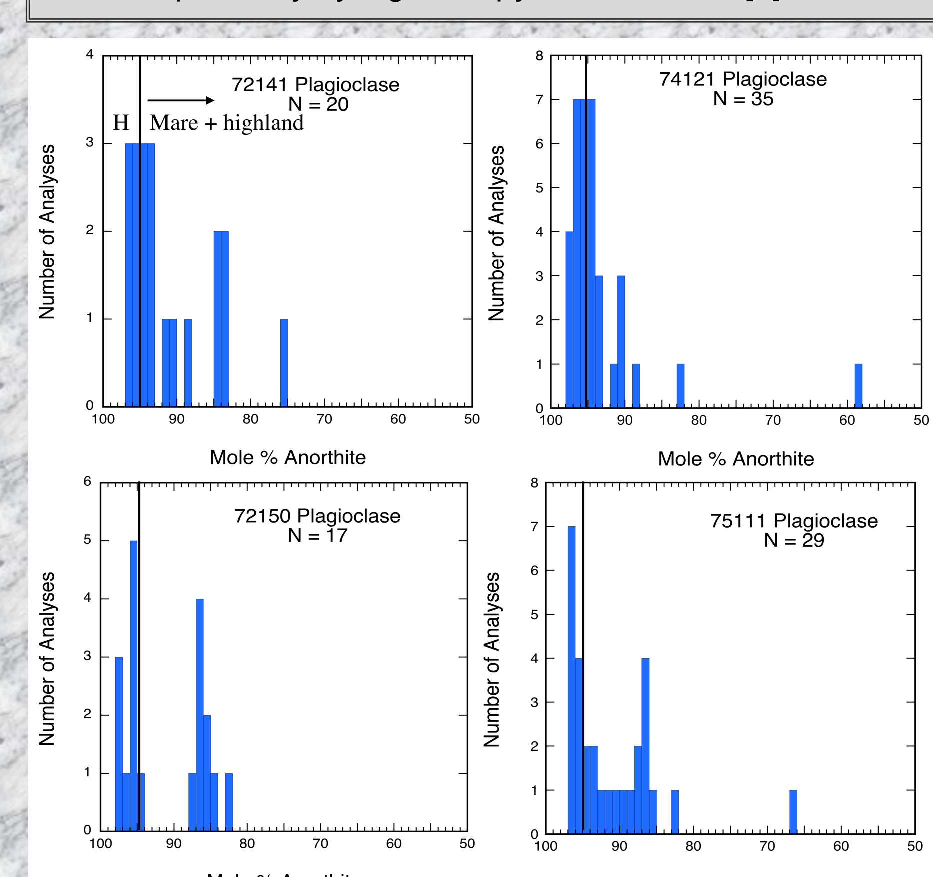


Fig. 4. Anorthite contents of monomineralic plagioclase grains in the four soils studied. Grains with anorthite contents > 95 mole % are of highland origin [6]. Those more calcic than An_{90} are probably of highland origin as well, unless they are from very low-Ti (VLT) basalts [8]; plagioclase in A-17 high-Ti basalts is typically $An_{77–89}$ [8].

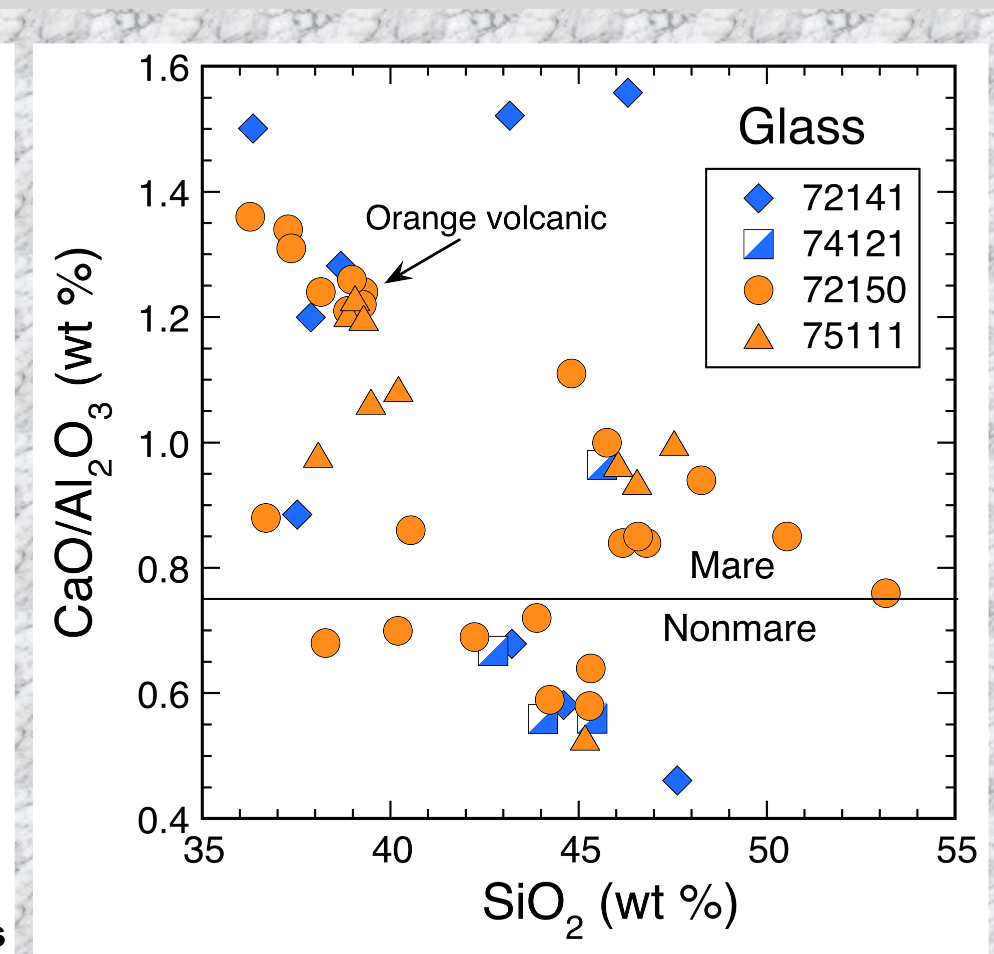


Fig. 5. Plot of CaO/Al_2O_3 vs. SiO_2 in glass fragments and beads in the four soils studied. Mare glasses (and basalts) are less aluminous than those of highland origin and have CaO/Al_2O_3 ratios > 0.75 [6]. Rocks and glasses of highland origin have CaO/Al_2O_3 ratios < 0.75, with 0.55 a common value, as seen here and in [6]. The orange glasses in the present samples have compositions typical of Apollo 17 orange volcanic glass, forming a cluster of data points at ~38 wt% SiO_2 and CaO/Al_2O_3 ~ 1.2–1.3.

Discussion and Summary

The soils are mixtures of mare- and highland-derived materials. Mare pyroxenes are more abundant than highland pyroxenes while highland plagioclase is more abundant than mare-derived plagioclase, reflecting the modal mineralogy of the source rocks, and the effect is magnified by the local geology. In the soils from the light mantle (72141 and 74121), highland plagioclase dominates the feldspar population even more strongly than in the mare-derived soils (Fig. 4).

The minimum highland fraction (mHF) of pyroxenes based on the quadrilateral components is very low in all soils (Fig. 2). The Ti-Cr-Al data (Fig. 3) indicate, however, that some of the grains that plot in the "highland + mare" field in Fig. 2 are of highland origin and that the highland pyroxene component is non negligible in all four soils.

The orange glasses found here have compositions typical of the Apollo 17 orange/black volcanic glass beads found at Station 4 and throughout the A-17 regolith (i.e., indistinguishable from 74220). The yellow/green glasses also have compositions within the range of those in previously studied A-17 regolith, such as the deep drill core [10], and the small cluster at ~46 wt% SiO2 and CaO/Al2O3~1 (Fig. 5) has a composition similar to the yellow/green VLT glass reported by [10]. No KREEP glass (>50 wt% SiO2, CaO/Al2O3~0.6; [7]) was found in the present samples.

The lithic fragment population is also typical of A-17 regolith, with high-Ti basalt and impact melt rock fragments dominant. As found by Heiken and McKay [5], we observed that basalt fragments are more abundant in the valley floor soils (72150, 75111) than in the soils from the light mantle.

Sample 72141 was collected from the lower-albedo light mantle, which is thought to be older than the higher-albedo light mantle, from which 74121 was collected (Fig. 1). The older material is thought to consist of more mature regolith, but these two samples have similar agglutinate contents and maturity indices [5, 9], leading Schmitt et al. [2] to conclude that, due to an impact, 74121 sampled the underlying, low-albedo mantle. **Our work shows that the samples are not petrologically identical, however, as 74121 contains a high-Mg, low-Ca pyroxene component not seen in 72141 (Fig. 2).**

Acknowledgments

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