EXTENSIVE FELDSPATHIC TERRAIN ACROSS THE LUNAR SOUTH POLE PRESENTS A CHALLENGE FOR DIVERSE SAMPLE COLLECTION. C. M. Pieters[1] and P. G. Lucey[2], [1]DEEPS, Brown University, Providence, RI 02912 (Carle_Pieters@brown.edu), [2]University of Hawaii at Manoa, 1680 East-West Rd, Honolulu, HI 96822 (lucey@higp.hawaii.edu).

Introduction: The character of the lunar poles and their potential resources (volatiles) are of great interest to space-faring countries and commercial organiztions as plans are made for future exploration of these enigmatic regions. At polar latitudes, average solar radiation onto the surface is weak since illumination is largely incident at near grazing incidence and some polar areas are in permanent shadow (**Figure 1**). Therefore, useful compositional data derived from remote sensing spectroscopic techniques that relied on solar illumination is currently sparse.

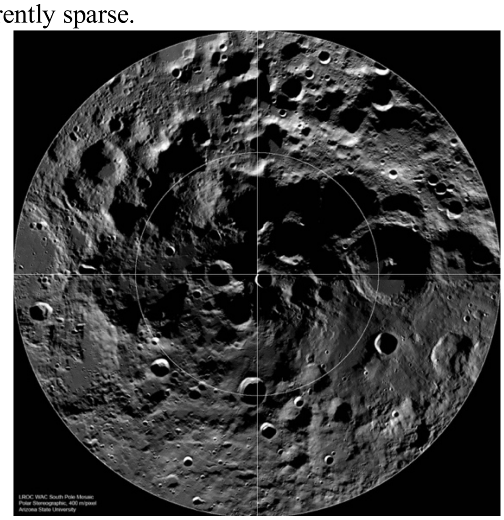

Fig. 1. LROC Wide Angle Camera (WAC) image mosaics of the lunar South Pole, width ~600 km, latitude ranges from 80° to the pole.

Nevertheless, two available data sources can be used to assess the bulk composition of lunar polar regions: a) LOLA global laser albedo maps (acquired with an active laser @ 1 µm) [1] and b) Lunar Prospector gamma ray iron abundance maps [2]. Both are relatively low spatial resolution, but are well suited to evaluate first-order composition properties based on knowledge from Apollo and Luna landed sample return sites at lower latitudes.

Integrated Data. Shown in **Figure 2** is a LOLA albedo map of the lunar nearside. This general view is very familiar to Earth-based observers measuring the Moon at 'Full-Moon' geometry when the sun is directly behind the observer and therefore casts no shadows visible from Earth. LOLA albedo maps are obtained at 1 µm, a slightly longer wavelength than typical optical albedo images (commonly acquired at 0.55-0.60 µm). Three fundamental types of lunar terrain are readily recognized: A) the low albedo basaltic maria (dark largely due to the presence of abundant Fe-bearing minerals), B) the high albedo 'highlands' that are now known to consist largely of low-iron feldspathic breccias [e.g. comparable to materials found at Apollo 16], and C) materials that have not been heavily affected by long exposure to the space environment (space weathering) and are relatively bright compared to surrounding materials. These unweathered areas typically have been recently exposed by events such as an impact crater (e.g. Tycho).

LOLA laser albedo maps can be prepared for other projections such as the hemisphere centered on the South Pole (**Figure 3**). Unlike solar illuminated polar images (Fig. 1), these shadow-free laser albedo maps now provide the same general compositional information as describd for Fig. 2. The feldspathic crustal terrain sampled at Apollo 16, although heterogeneously altered, is seen to extend across the entire South Pole region.

The compositional information associated with lunar albedo is largely dependent on the amount of FeO in lunar soils as well as the variety of ongoing local surface processes that alter the physical form of surface materials. This approximate relation between albedo and FeO provides a first order assessment of the entire south pole terrain composition as feldspathic in character. This interpretation is readily validated by fully independent measurements of FeO by gamma-ray spectroscopy [2] shown in **Figure 4**. The LOLA laser albedo map and the Lunar Prospector FeO measurements both show the lunar South Pole terrain to be low in mafic minerals (low FeO) and comparable to the feldspathic breccias sampled at Apollo 16.

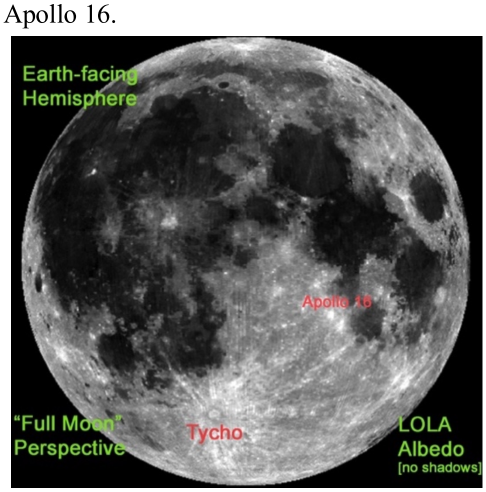

Fig. 2. LOLA laser albedo map (@ 1 µm) of the lunar nearside hemisphere [1] similar to a 'Full Moon' perspective.

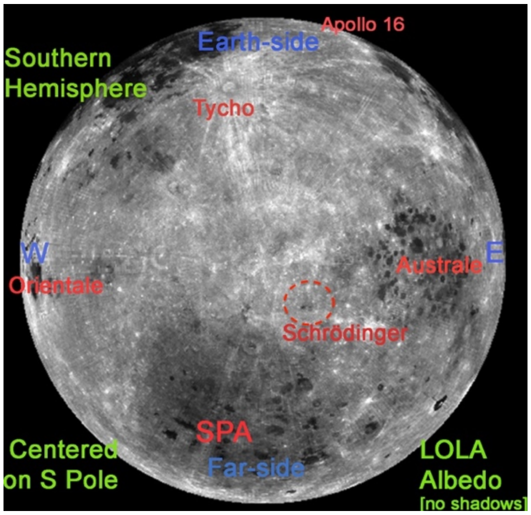

Fig. 3. LOLA laser albedo map [1] of the lunar hemisphere *centered on the South Pole*. The feldspathic Apollo 16 region is near the top. The south polar region is seen to be a continuation of the crustal feldspathic terrain.

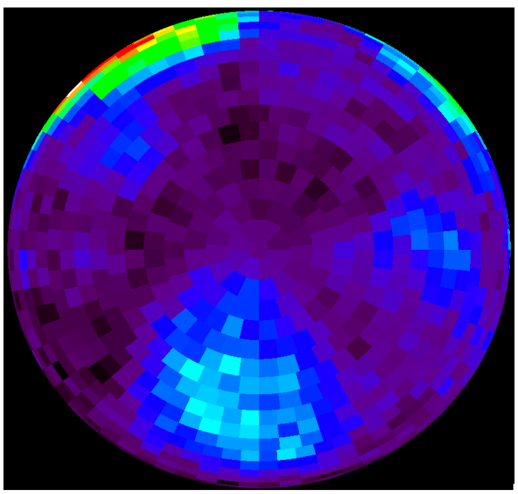

Fig. 4. Lunar Prospector FeO gamma ray data [2] for the hemisphere *centered on the South Pole* (same projection as Fig. 3). The lowest values of FeO are shown in dark purple shades.

Shown in **Figure 5** is a closer look at the LOLA laser albedo for the South Pole. The area within the black circle allows comparison to be made with the same area in the shadowed WAC optical image of Fig. 1. The bulk composition of the entire South Pole region is comparable to the feldspathic breccias sampled by Apollo and Luna. Although the low-albedo area of pyroclastic material in Schrödinger basin [e.g. 3] can be seen, it is readily recognized that regions of mafic-rich materials associated with unsampled basaltic terrain or SPA are located several 100s km distant from the South Pole.

Given the extended impact history of the surface of the Moon, it is known that materials can be transported great distances and mixed with terrain of a different

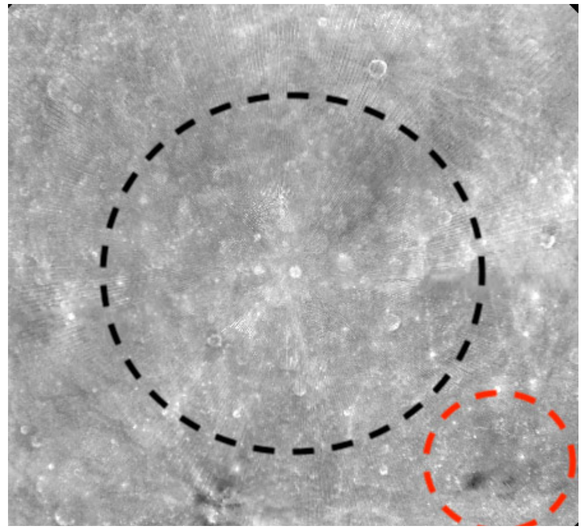

Fig. 5. LOLA laser albedo map centered on the unexplored lunar South Pole. The black circle outlines the 600 km WAC image of Fig. 1. The red circle outlines Schrödinger basin (as in Fig 3.).

composition. For example, returned samples of Apollo 16 mature feldspathic soils show geochemical signatures of ~6% mare derived material [4]. Thus, a small amount of foreign materials from distal areas such as Tycho, SPA, or Australe basalts could occur in the South Pole region, but such materials will be quite rare.

Identifying such exotic lithologies will require careful training of geologist-astronauts (as was done in Apollo) as well as adding capable 21st century tools and approaches. Specific recommendations include implementing sensitive modern high spectral/spatial resolution *remote sensing* instruments to identify and characterize variations of local lithologies in geologic context along with rapid *in-situ* capabilities for assessment of rock and soil compositions and efficient sample collection.

References:

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