REVISITING THE APOLLO LANDING SITES WITH MOON MINERALOGY MAPPER DATA. D. P. Moriarty III[1,2] and N. E. Petro[2], [1]NASA GSFC, [2]USRA (Daniel.P.Moriarty@NASA.gov).

The Apollo program is one of the greatest achievements of our civilization, transporting humans to the surface of another planet and enabling decades of follow-up science and engineering discoveries. In particular, samples returned from the diverse Apollo landing sites greatly improved our understanding of the formation and evolution of the Moon, as well as its relationship to the Earth.

The Apollo samples have been characterized in detail by terrestrial laboratories. The Lunar Soil Characterization Consortium and Lunar Rock and Mineral Characterization Consortium focused on integrating mineralogy, petrology, and spectroscopy of these materials. In addition to the insights directly gained through laboratory analyses of these samples, this understanding can also be leveraged to greatly improve our global understanding of the lunar surface by serving as groundtruth for remote sensing analyses. This groundtruth validates and enriches orbital observations.

The Moon Mineralogy Mapper instrument was a hyperspectral camera that orbited the Moon on board the Chandrayyaan-1 spacecraft from 2008-2009. The instrument achieved nearly global coverage at spatial resolutions ranging from 70-280 meters per pixel across 85 spectral channels from 540-3000 nm. The instrument is sensitive to spectral diversity resulting from differences in mafic mineralogy, volatiles, plagioclase, glass, oxides, and optical maturity.

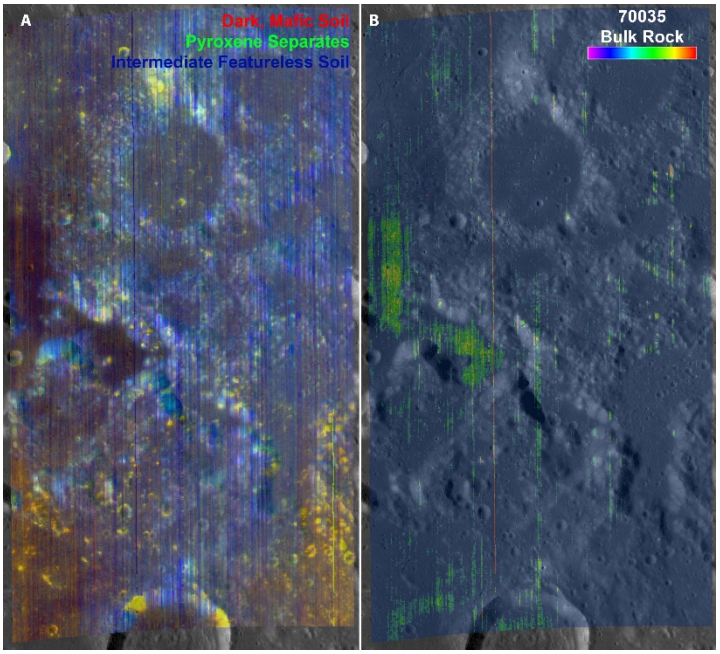

Fig. 1: Endmember maps resulting from unmixing Moon Mineralogy Mapper image M3G20090606T053022 covering the Apollo 17 Taurus-Littrow Valley landing site (center left). Endmembers were chosen from LSCC and LRMCC samples. (A)Color composite image showing the three most abundant sample endmembers. The red channel is dark mafic soil (71501 20-45 µm), blue is intermediate featureless soil (70181 <10 µm), and green is the sum of the pyroxene separates from basaltic slabs 70035 and 70017. (B)Contribution from the 70035 bulk rock endmember. Basemap is LROC WAC.

Our approach in this analysis is to comprehensively integrate Moon Mineralogy Mapper hyperspectral data with the suite of Apollo samples, with a particular focus on laboratory data from the Lunar Soil Characterization Consortium and Lunar Rock and Mineral Characterization Consortium. Our goal is to develop and validate new spectral parameters and analysis techniques related to composition and mineralogy, enriching the science return from the Moon Mineralogy Mapper as well as other near-infrared spectrometers. This is especially relevant as we enter a new era of commercial and international exploration of the Moon, and many current and future missions employ such instruments, including Chang'E-4, the first mission to the lunar farside.

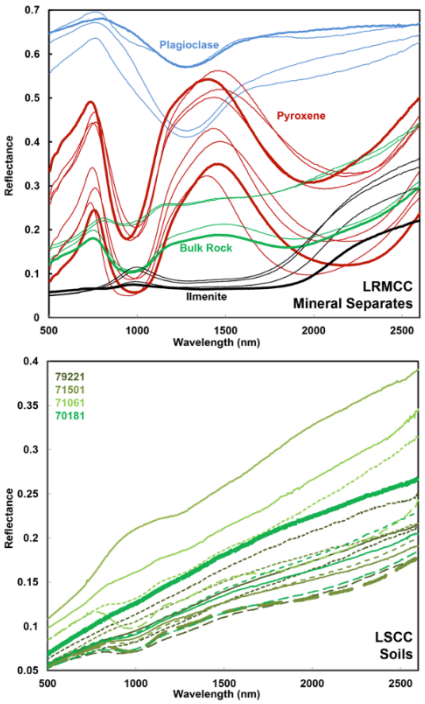

Fig. 2: RELAB spectra of the LRMCC (top) and LSCC (bottom) samples. Bolded spectra are used in the "select endmembers" un-mixing method presented in Fig. 1.

Preliminary analyses integrating LSCC and LRMCC data with M^3 data are shown in Fig. 1. We will expand on these analyses by integrating the full suite of Apollo samples and M^3 data for each of the Apollo landing sites.