EPSC Abstracts
Vol. 6, EPSC-DPS2011-1314, 2011
EPSC-DPS Joint Meeting 2011

Compositional Ground Truth of Diviner Lunar Radiometer Apollo Site Observations with Simulated Lunar Environment Laboratory Measurements

B.T. Greenhagen (1), I.R. Thomas (2), N.E. Bowles (2), C.C. Allen (3), K.L. Donaldson Hanna (4), E.J. Foote (5), D.A. Paige (5), and the LRO Diviner Team
(1) Jet Propulsion Laboratory, Pasadena, CA, USA, (2) University of Oxford, Oxford, UK, (3) NASA Johnson Space Center, Houston, TX, USA, (4) Brown University, Providence, RI, USA, (5) University of California, Los Angeles, CA, USA. (Benjamin.T.Greenhagen@jpl.nasa.gov)

Abstract

The returned lunar soil samples from Apollo sites offer a unique opportunity to "ground truth" compositional interpretations of Diviner Lunar Radiometer (Diviner) data. Here we compare Diviner observations of Apollo sites to measurements of Apollo lunar soil samples in simulated lunar environment (SLE).

1. Diviner Observations

Diviner, onboard NASA's Lunar Reconnaissance Orbiter, has made the first global, high resolution, thermal infrared measurements of lunar silicate mineralogy [1]. Diviner has three spectral channels near 8 μm designed to characterize the mid-infrared emissivity maximum known as the Christiansen feature (CF) [3], which systematically shifts to shorter wavelengths with increasing silicate polymerization [e.g. 2,4]. For example, lunar maria that are rich in olivine and pyroxene have longer-wavelength CF positions than lunar highlands, which are rich in plagioclase [1].

1.1 Apollo Sites

Diviner observations include all six Apollo sites at approximately 200 m spatial resolution. Spectral differences between the Apollo sites caused by composition and space weathering are apparent in Diviner data [1]. Apollo 12 (Figure 1) and Apollo 15 (Figure 2) are dominated by mare compositions and have longer wavelength CF positions than Apollo 16 (Figure 3), which is dominated by highland compositions.

2. Simulated Lunar Environment

Only laboratory experiments conducted in SLE are directly comparable to Diviner data. The Lunar Thermal Environment Simulator at University of Oxford's Atmospheric, Oceanic, and Planetary Physics Laboratory is uniquely capable of measuring high spectral resolution thermal emission of samples in SLE [5]. In the lunar environment, large thermal gradients develop in the top few hundred microns of the surface, driven by the difference in the solar and thermal skin depths (i.e. the surface is heated to greater depth than the infrared emitting layer). The thermal gradients generally result in a shift and significant enhancement of Christiansen feature spectral contrast and significant decreases in Reststrahlen Bands spectral contrast.

2.1 Apollo Soils

This study includes a wide range of lunar soils from 5 of the 6 Apollo missions (Table 1). The soils include typical low-albedo mare (Apollo 11), high-albedo highlands (Apollo 16), low-titanium basalt (Apollo 12), and high concentrations of volcanic glass (Apollo 15 and 17). Efforts will be made to localize each lunar soil to a small range of Diviner pixels.

Table 1: Lunar soils included in this study

Apollo Site	Sample Name
Apollo 11	10084
Apollo 12	12001
Apollo 15	15071
Apollo 16	68810
Apollo 17	70181

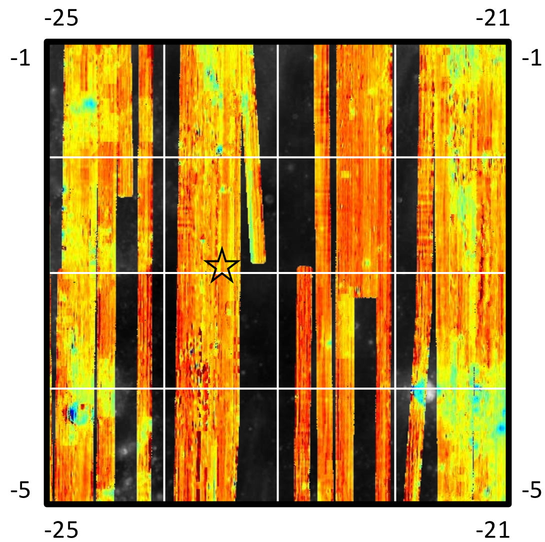

Figure 1: CF Map of Apollo 12, Oceanus Procellarum. The Apollo 12 landing site is indicated by the black star. The CF color stretch is 7.95 (blue) to 8.4 microns (red). The CF map is overlain on the Clementine v2 basemap.

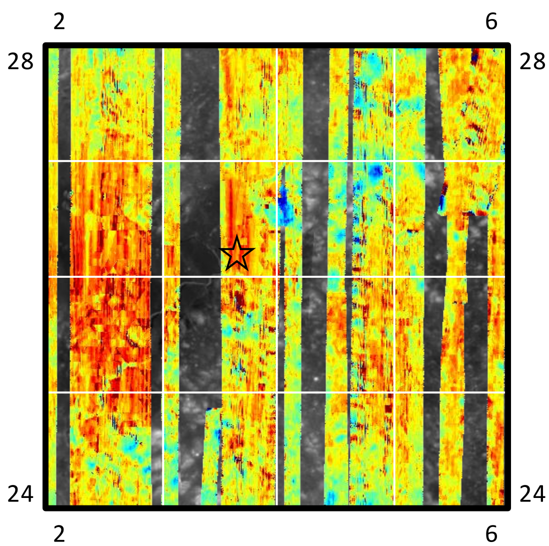

Figure 2: CF Map of Apollo 15, Hadley-Apennines. Color stretch and annotation are the same as Figure 1.

3. Initial Results

Since their compositions are known, the Apollo soils and sites are important calibration points for the Diviner dataset. Initial Diviner observations and SLE measurements show good agreement with each other and with previous laboratory measurements of Apollo soils [e.g. 2]. However, the Apollo sites are

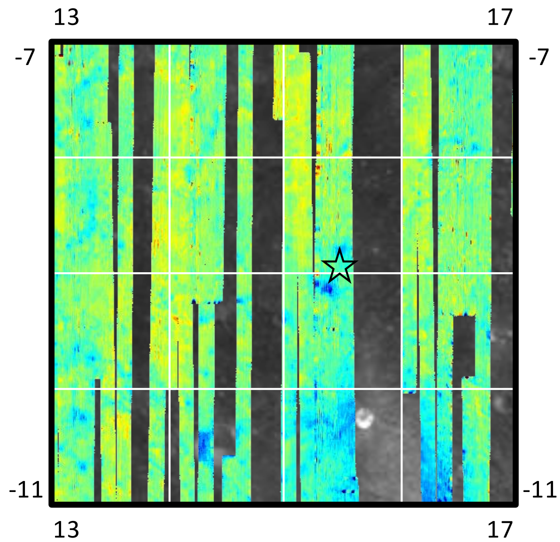

Figure 3: CF Map of Apollo 16, Descartes. Color stretch and annotation are the same as Figure 1.

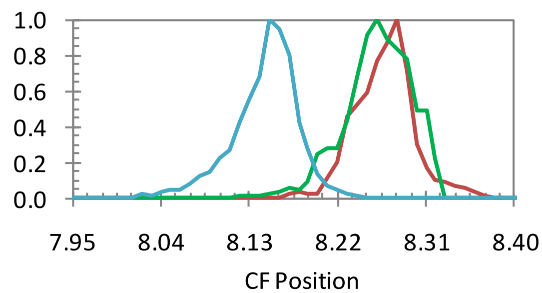

Figure 4: CF Position Histograms. The distribution of CF positions for a 2 x 2 km box centered on the sites of Apollo 12 (red), 15 (green), and 16 (blue).

compositionally complex with a range of compositions within a short distance of the landing site (Figure 4). It's therefore critical to choose the best pixels to represent each soil. This presentation will highlight experiments and observations to date and implications for Diviner compositional studies.

References

[1] Greenhagen, B.T., *et al.*, Science, 329, pp. 1510, 2010.
[2] Logan L.M., *et al.*, Journal of Geophysical Research, 78, pp. 4983, 1973.
[3] Paige D.A., *et al.*, Space Sciences Reviews, 150, pp. 125, 2010.
[4] Salisbury J.W. and Walter, L.S., Journal of Geophysical Research, 94 (B7), pp. 9192, 1989.
[5] Thomas I.R., *et al.*, 41st Lunar and Planetary Science Conference, Houston, TX, USA, Abstract #1364, 2010