Diviner thermal infrared observations of mare basalts within Oceanus Procellarum

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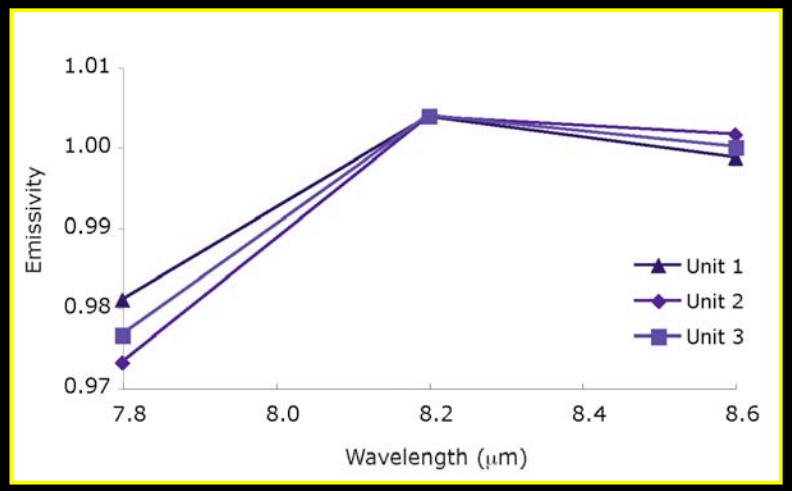
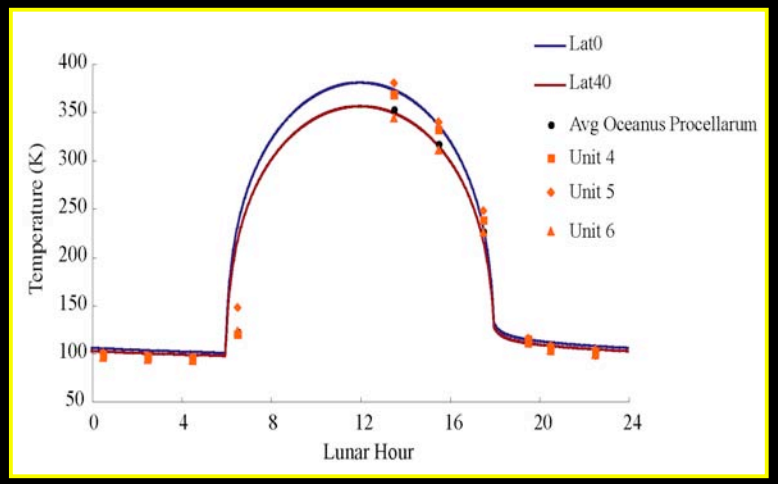
Research Objectives

- Examine new Diviner observations collected across Oceanus Procellarum.

- Provide new insight to the evolution of mare basalt flows over time.

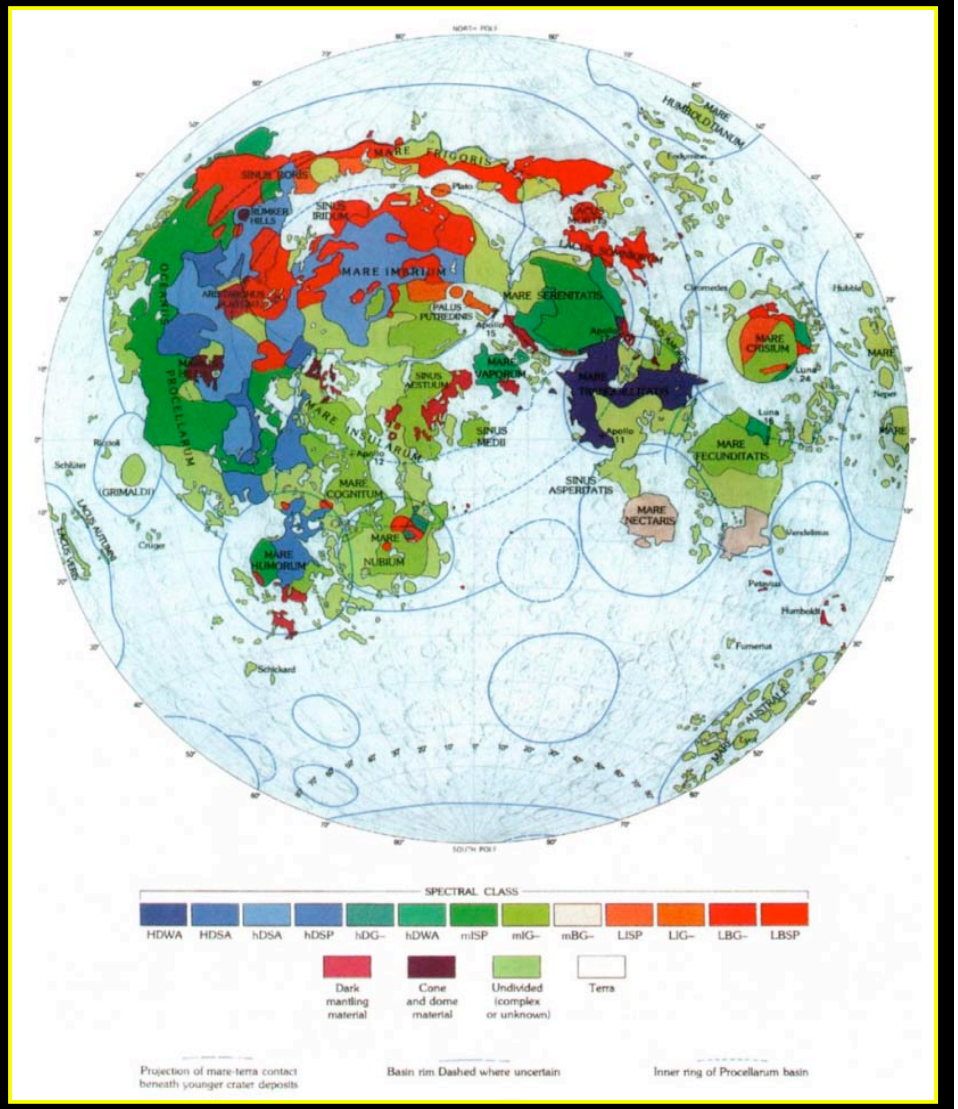
Surface Compositions and Thermophysical Properties





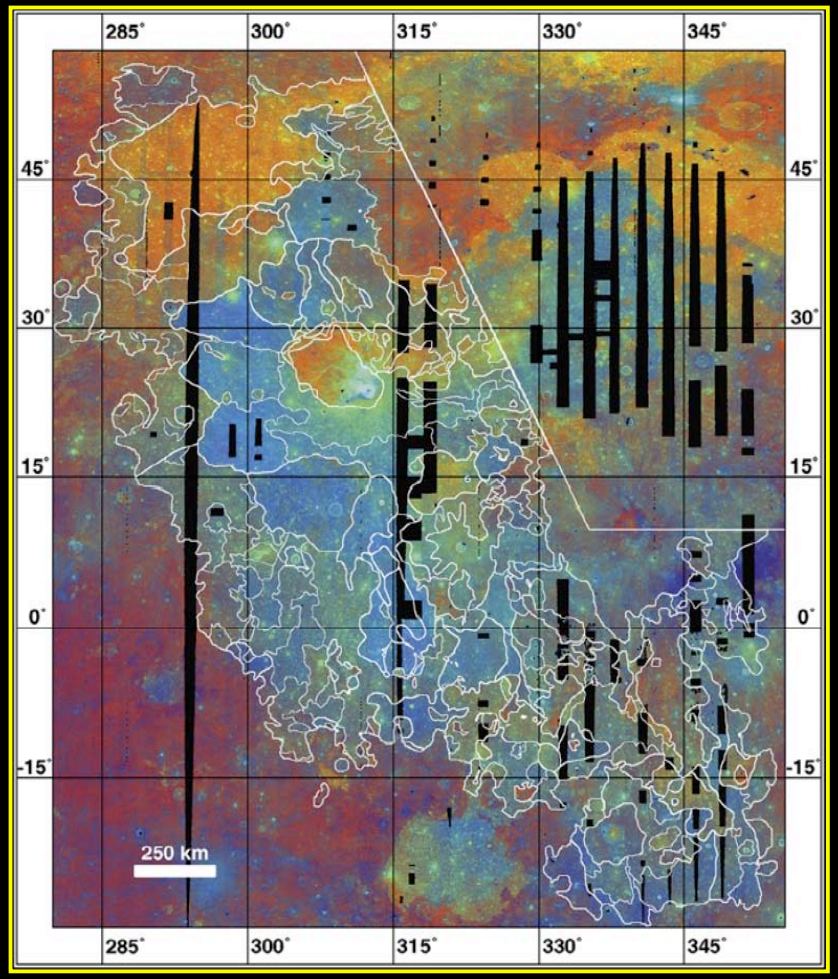
Background

- Pieters (1978) compiled VNIR telescopic observations to identify 13 different mare basalt types
- 4 parameters used to "distinguish general mineralogical and chemical differences":
  1) UV/VIS slope [H, h m, L]
  2) Albedo [B, I, D]
  3) Depth of the 1 μm band [S, G, W]
  4) Depth of the 2 μm band [P, A, -]



Background

- Hiesinger et al. (2003) used higher spatial resolution Clementine UVVIS data and re-examined Pieters (1978) basalt type boundaries in Oceanus Procellarum
- Identified 60 units based on Clementine spectral ratios and morphology
- Each unit is assumed to extrude over a short period of time indicating a single eruptive phase
- Dated flows of varying ages between 3.93 and 1.2 Ga



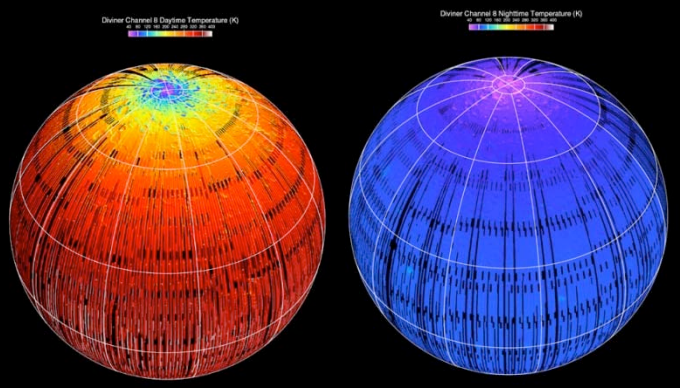
Clementine Color Ratio Composite
R: 750 - 400 / 750 + 400
G: 750 / 990
B: 400 / 750

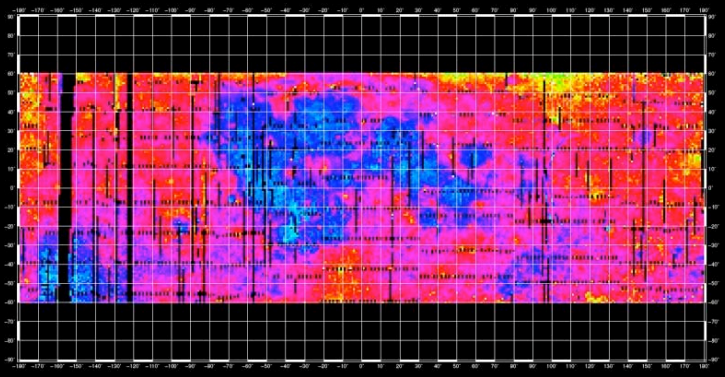
DIVINER Lunar Radiometer Experiment

One of seven instruments aboard NASA's Lunar Reconnaissance Orbiter

Principal Investigator: David Paige

UCLA JPL STONY BROOK BROWN W NASA





Diviner Investigation Goals

1) Map global day/night surface temperatures
2) Characterize thermal environments for habitability
3) Determine rock abundances at sites
4) Identify polar cold traps and ice deposits
5) Map variations in silicate mineralogy

Diviner Approach to Mare Basalts

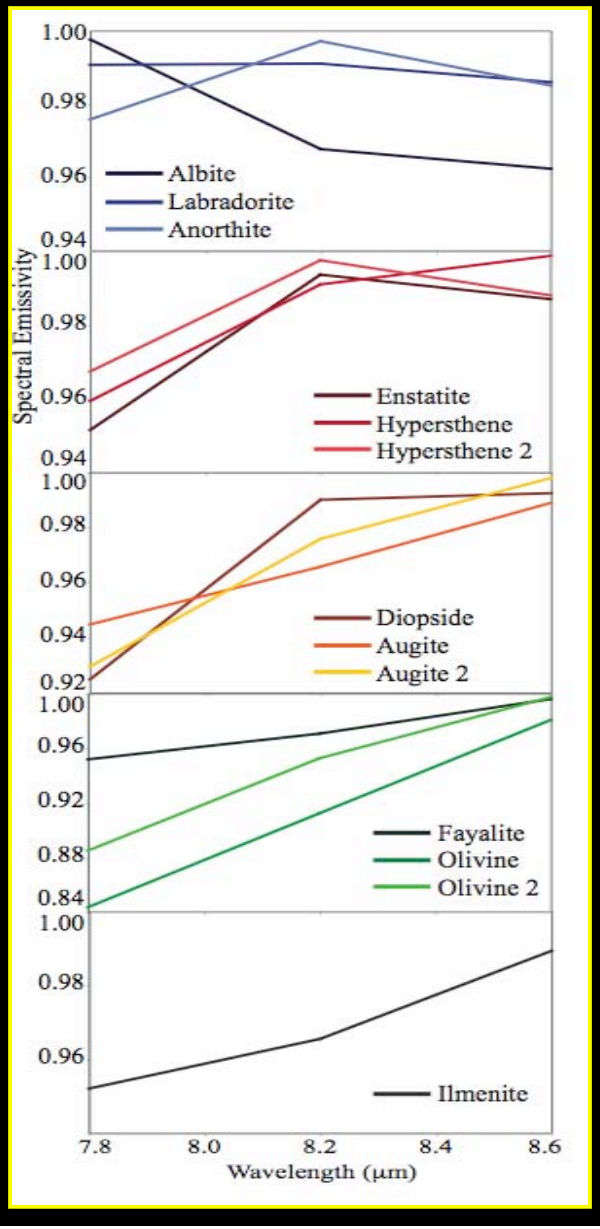
Surface Compositions

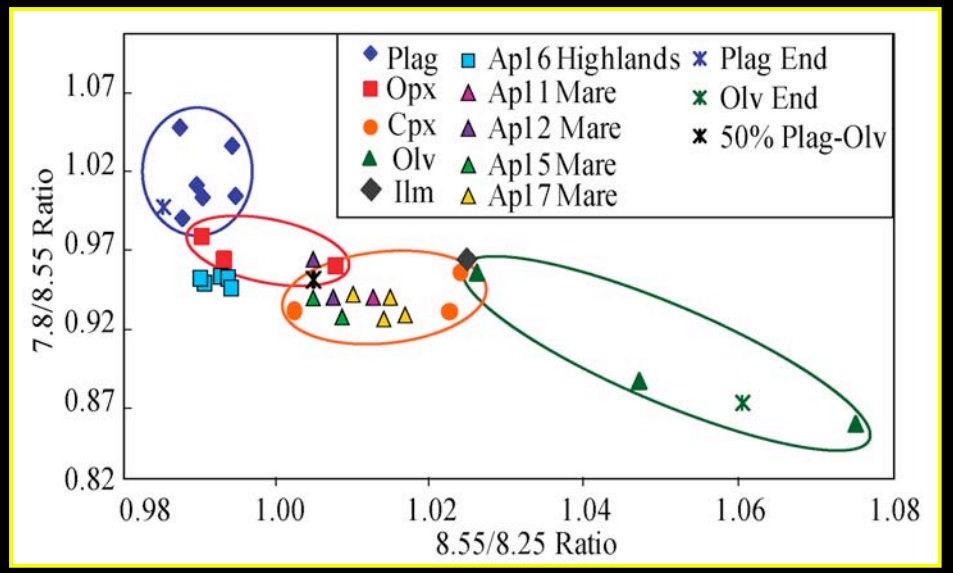
1) Spectral emissivity measurements at 7.8, 8.25 and 8.55 μm are used to evaluate basalt compositions:
    a) Spectral shape
    b) CF position *[B. T. Greenhagen et al. 2010]*
    c) Band Ratios *[K. L. Donaldson Hanna et al. 2009]*

Thermophysical Properties

2) Temperature data of the basaltic flows are used to evaluate:
    a) Diurnal temperatures *[A.R. Vasavada et al. 1999]*
    b) Rock abundance *[J.L. Bandfield et al. 2010]*
    c) Regolith temperature *[J.L. Bandfield et al. 2010]*

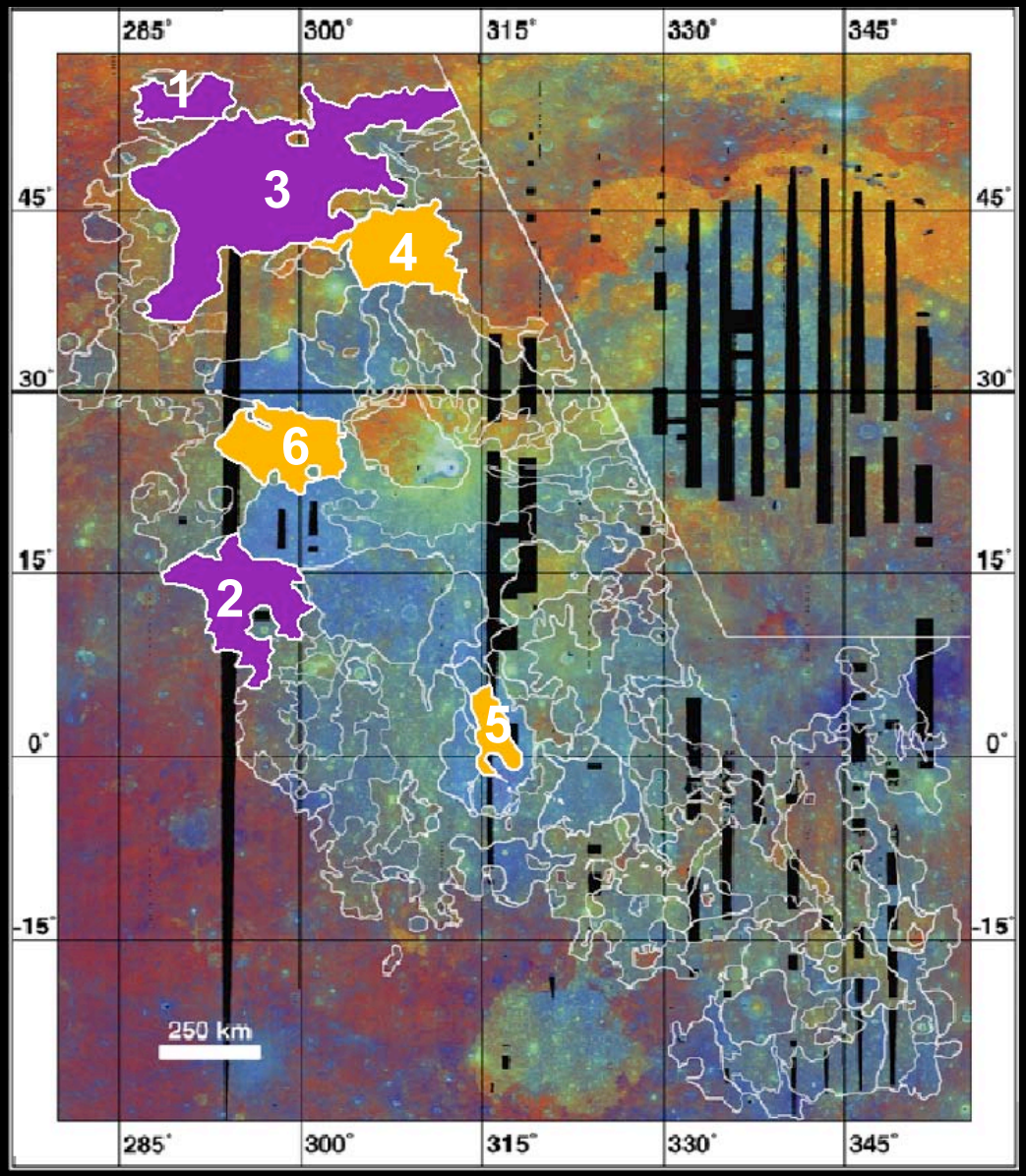
Surface Compositions: Band Ratios





- 7.8 / 8.55 Band ratio (Y-Axis) approximates general trend concave up or concave down of the spectra
- 8.55 Band / 8.25 Band ratio (X-Axis) approximates the slope between the 2 bands

Mare Basalts: Compositional Analysis



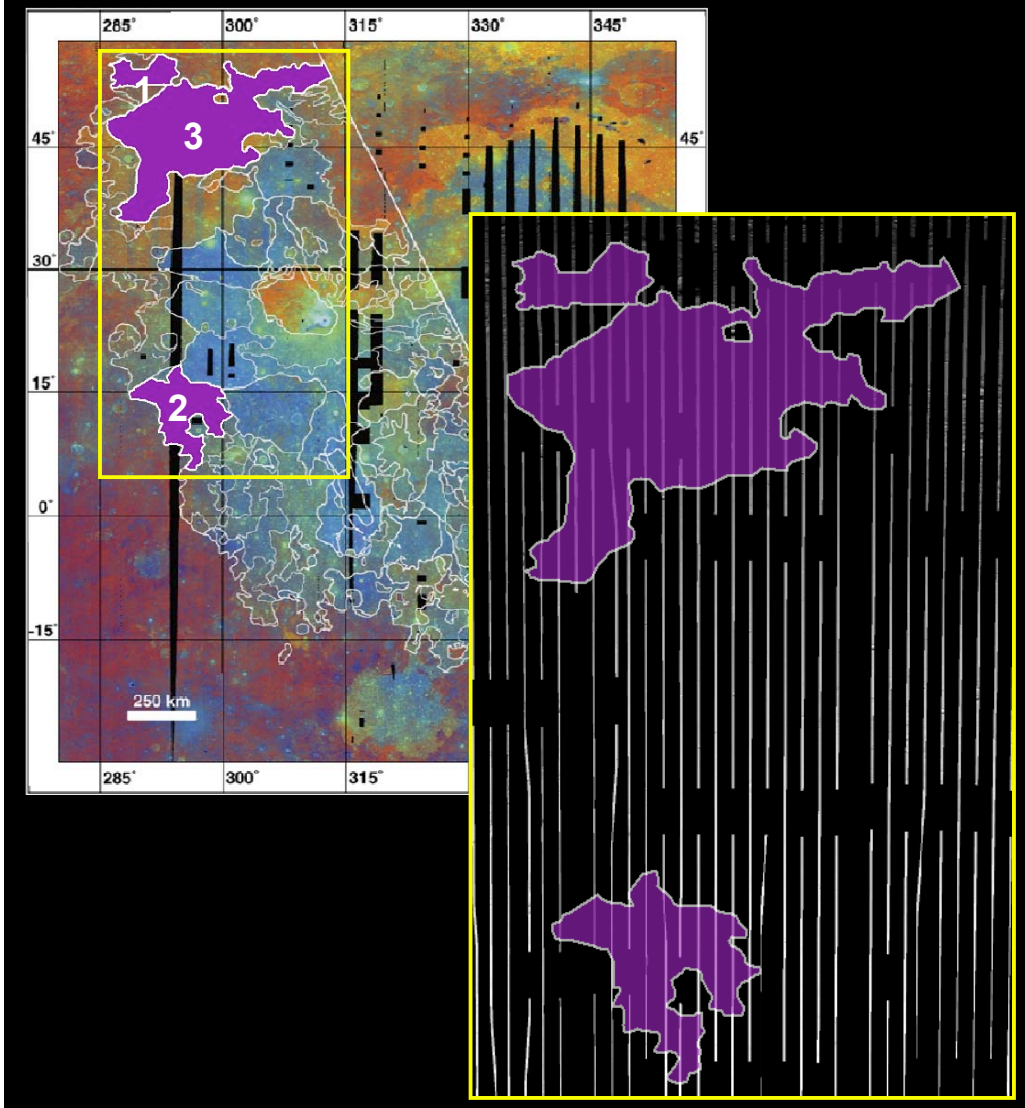
Varying Composition

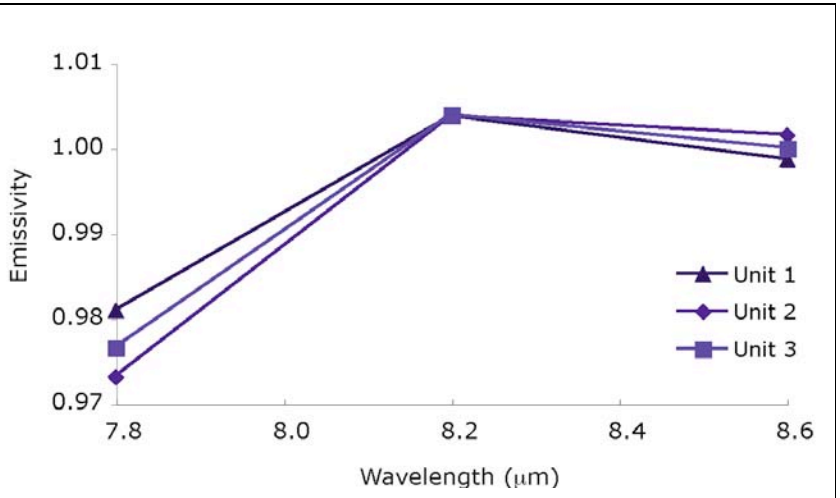
Unit	Basalt Type	Age (Ga)
1	hDWA	3.59
2	mISP	3.31
3	LBG-	3.44

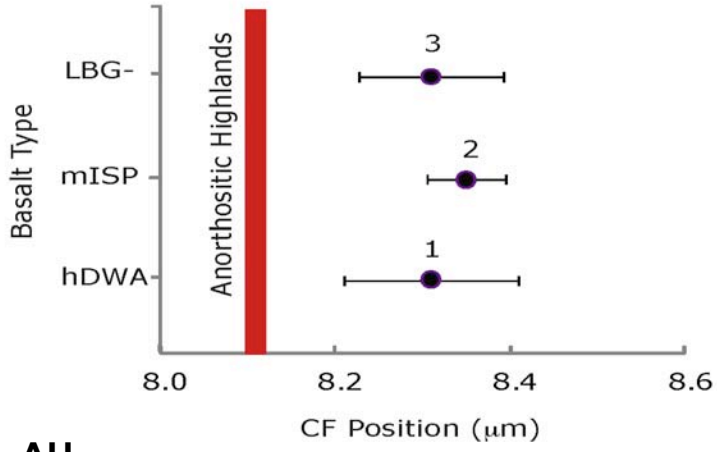
Varying Age

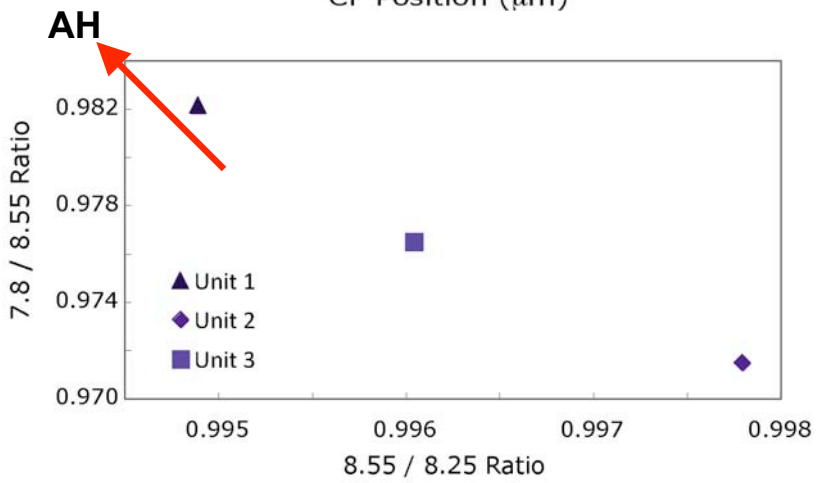
Unit	Basalt Type	Age (Ga)
4	hDSA	1.33
5	hDSA	2.08
6	hDSA	2.76

Mare Basalts: Compositional Analysis

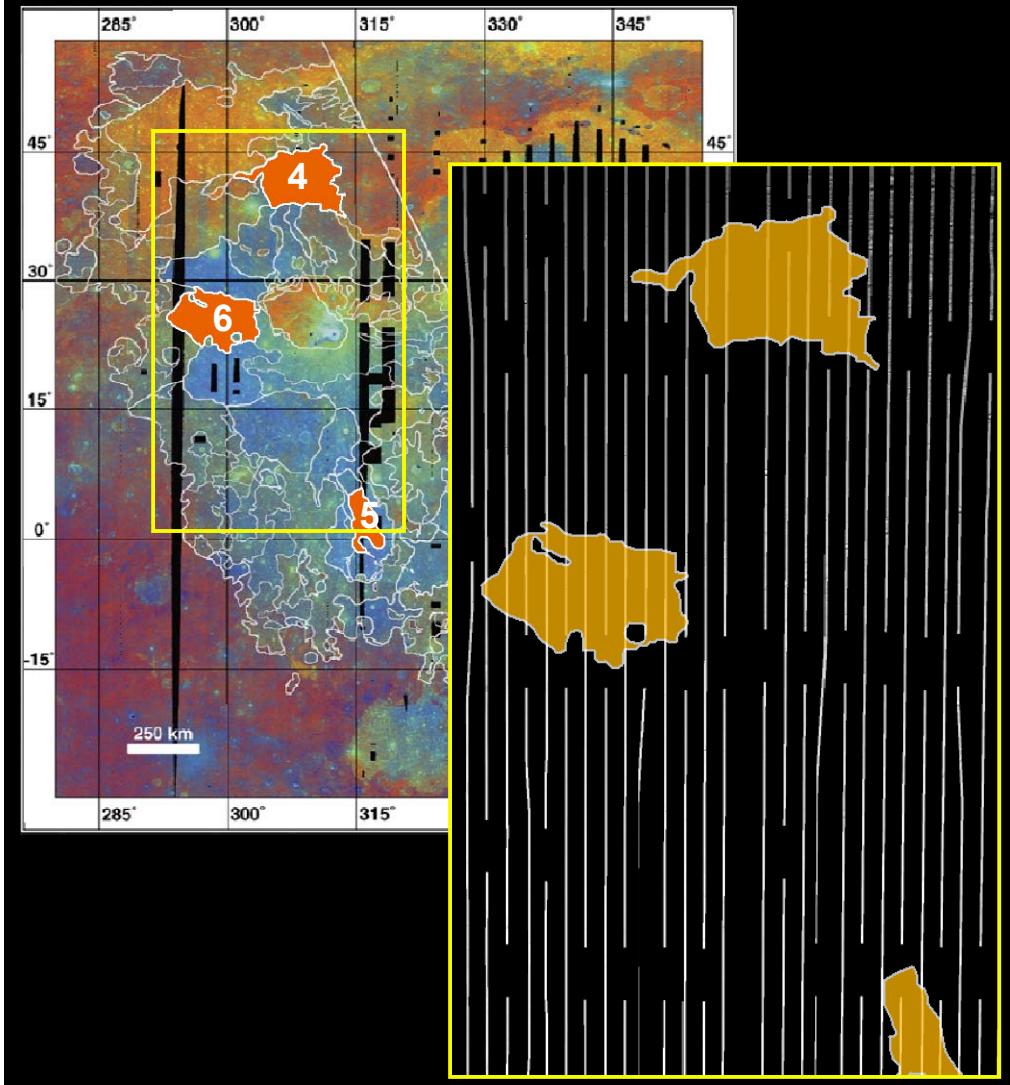


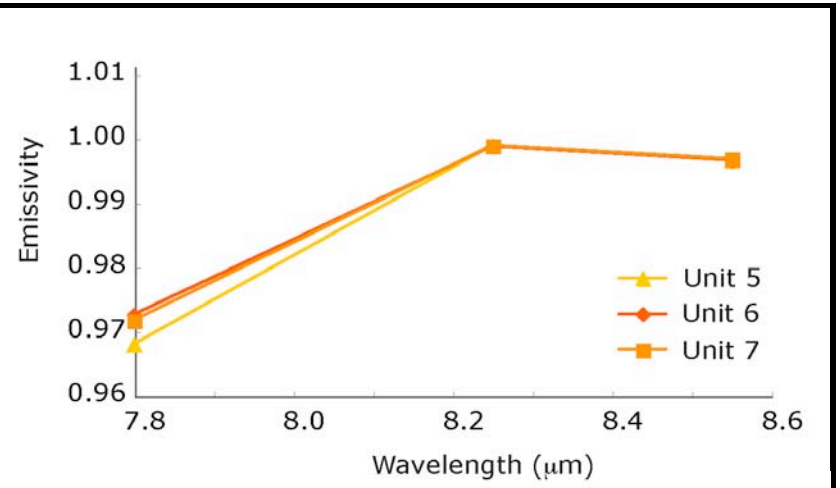


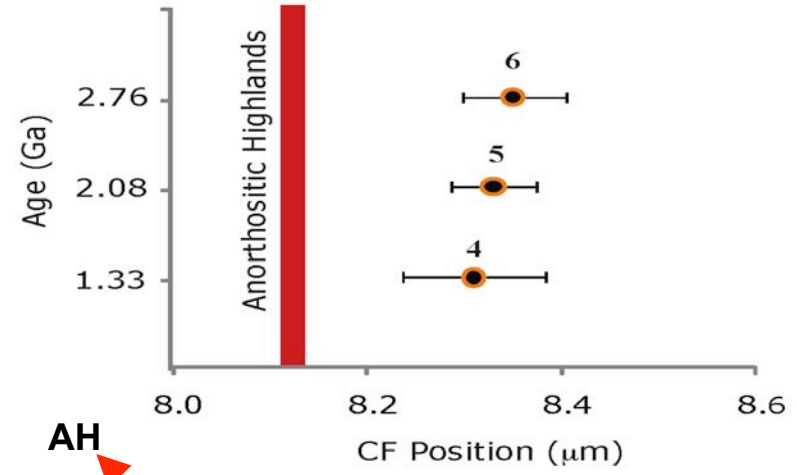


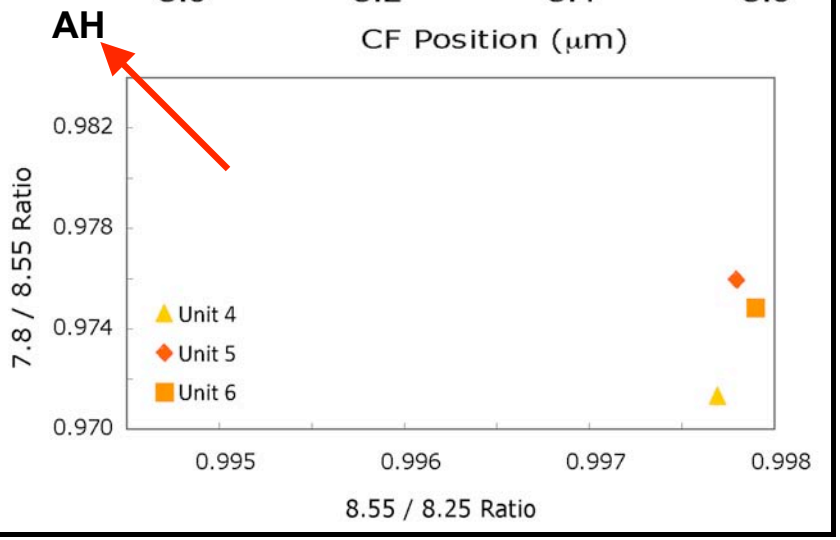


Mare Basalts: Compositional Analysis

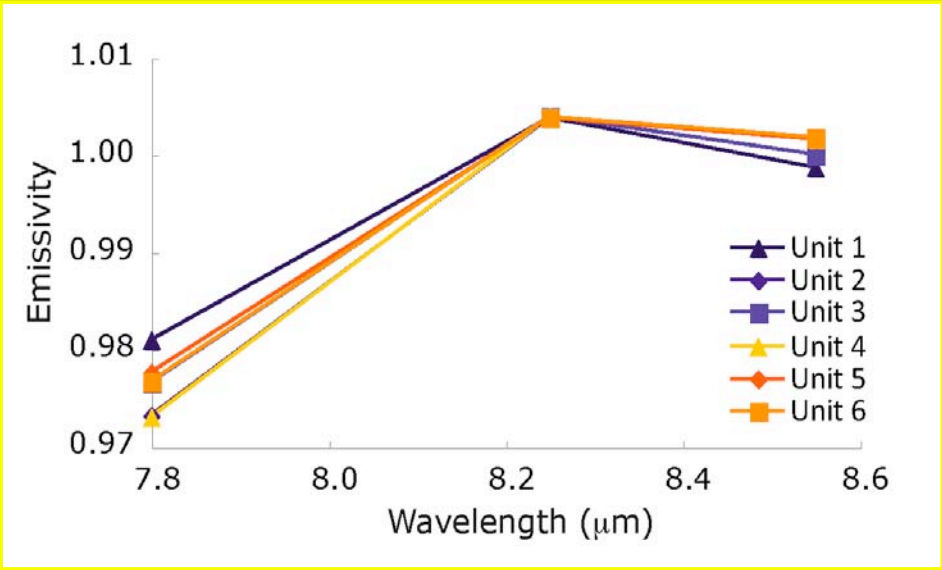


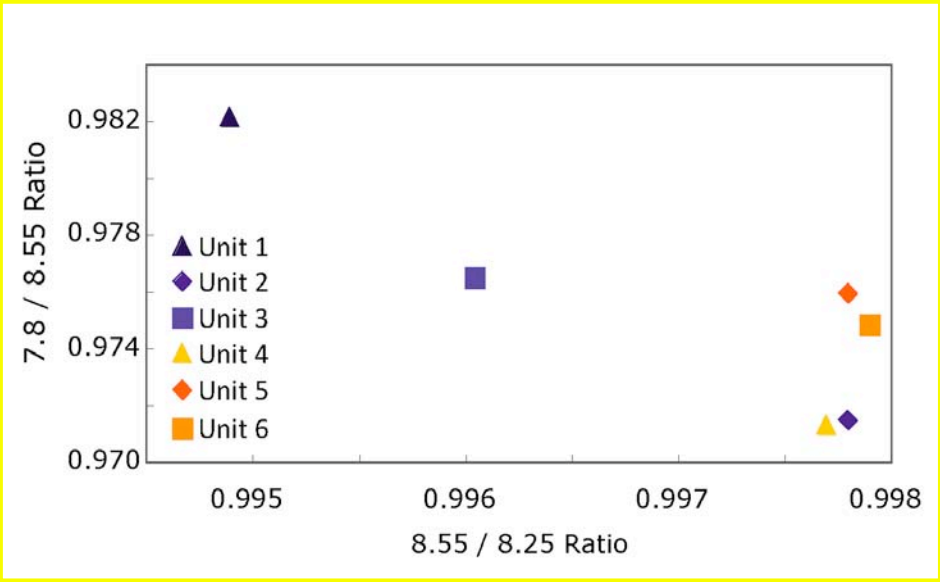




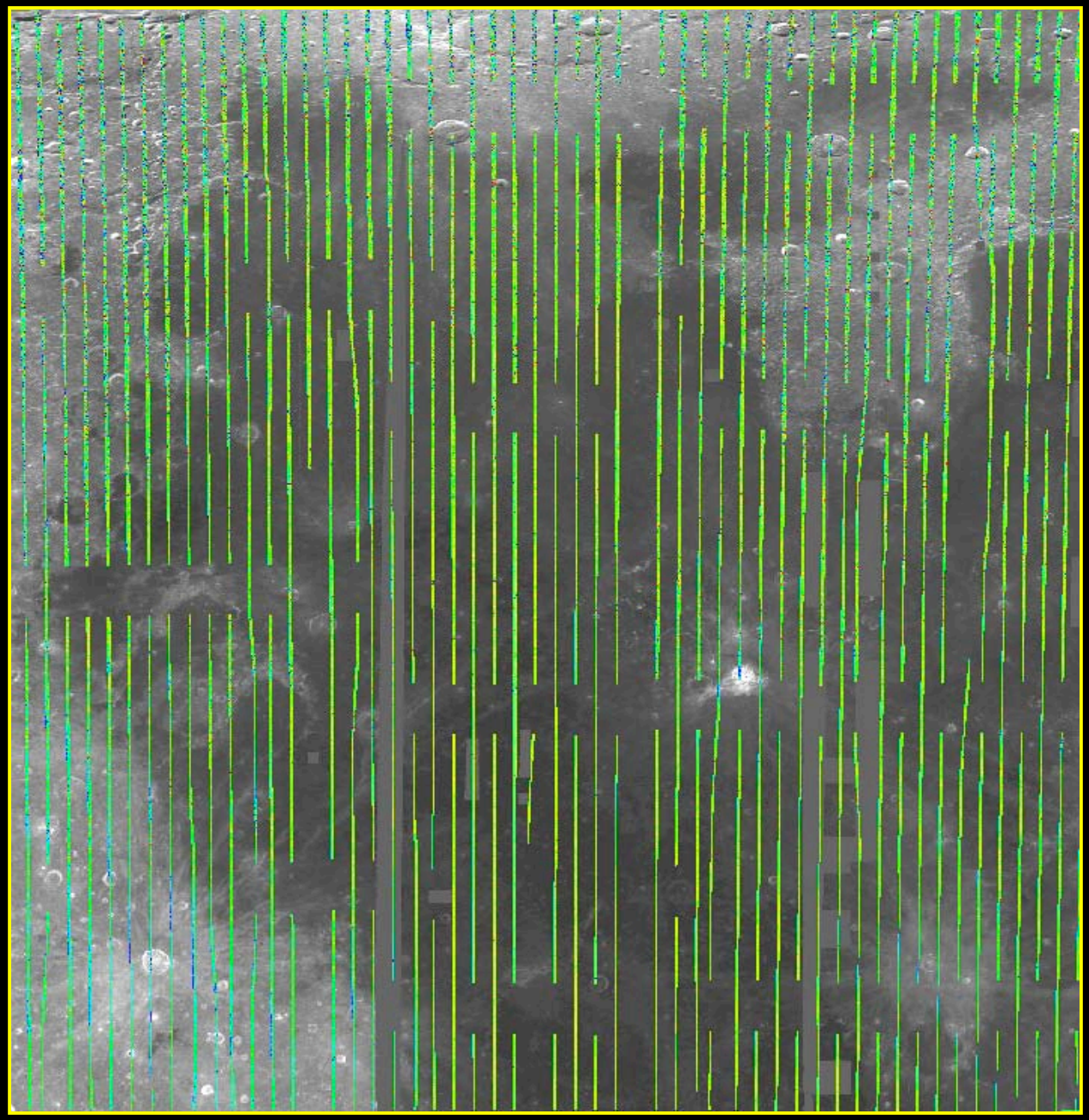


Compositional Summary



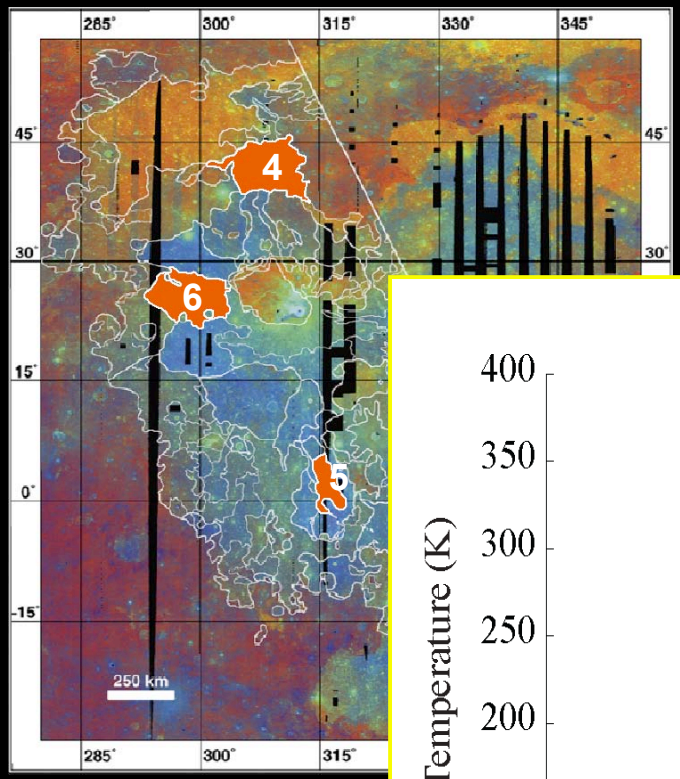


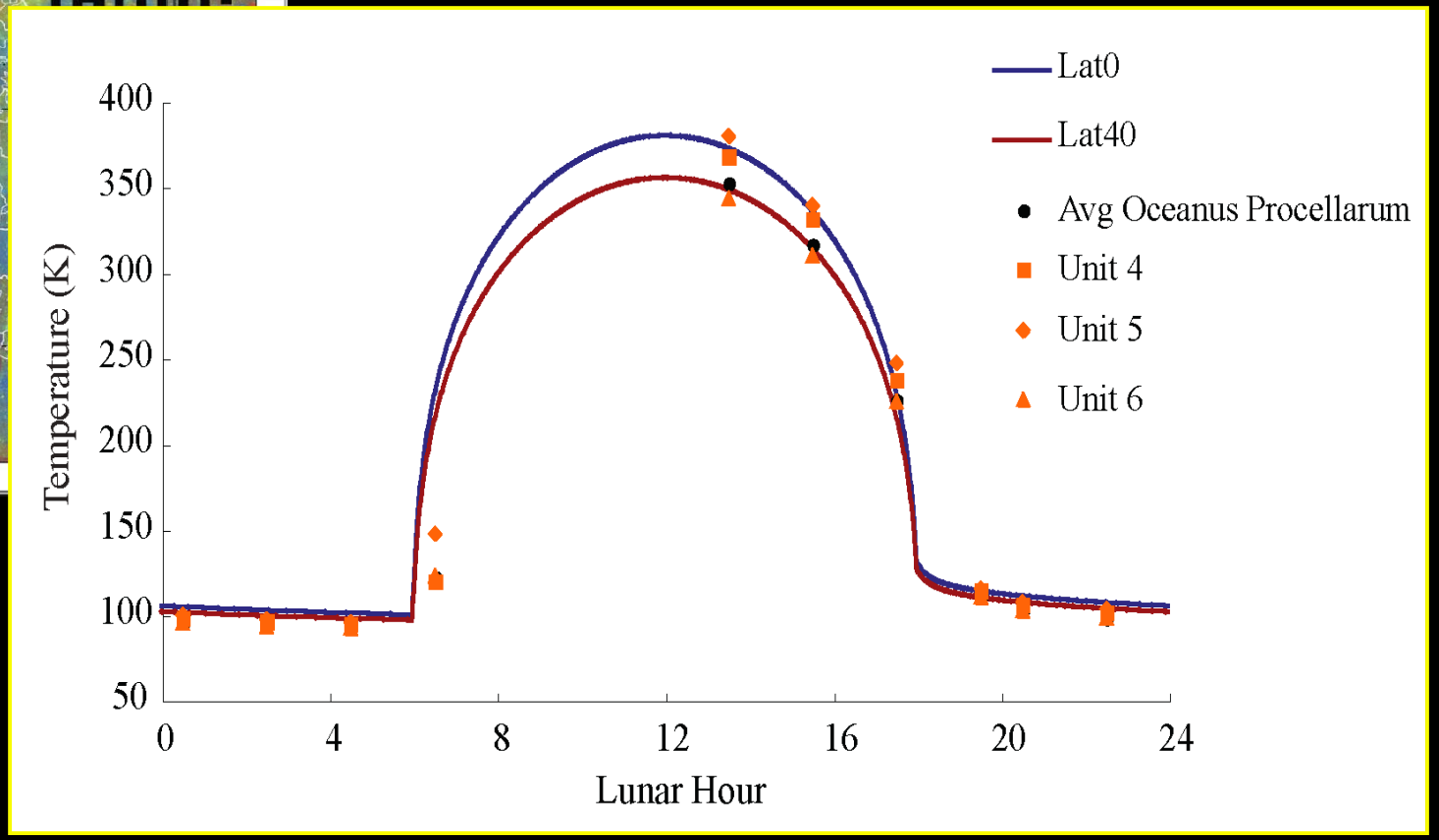
- Units 2, 4, 5, and 6 identified in VNIR data with strong 1 μm bands have highest 8.55 / 8.25 ratio values
- Units 1 and 3 identified with weaker 1 μm bands have lower 8.55 / 8.25 ratio values
- Diviner band ratios can be used to distinguish between units of varying mafic signatures



8.55 / 8.25 Ratio

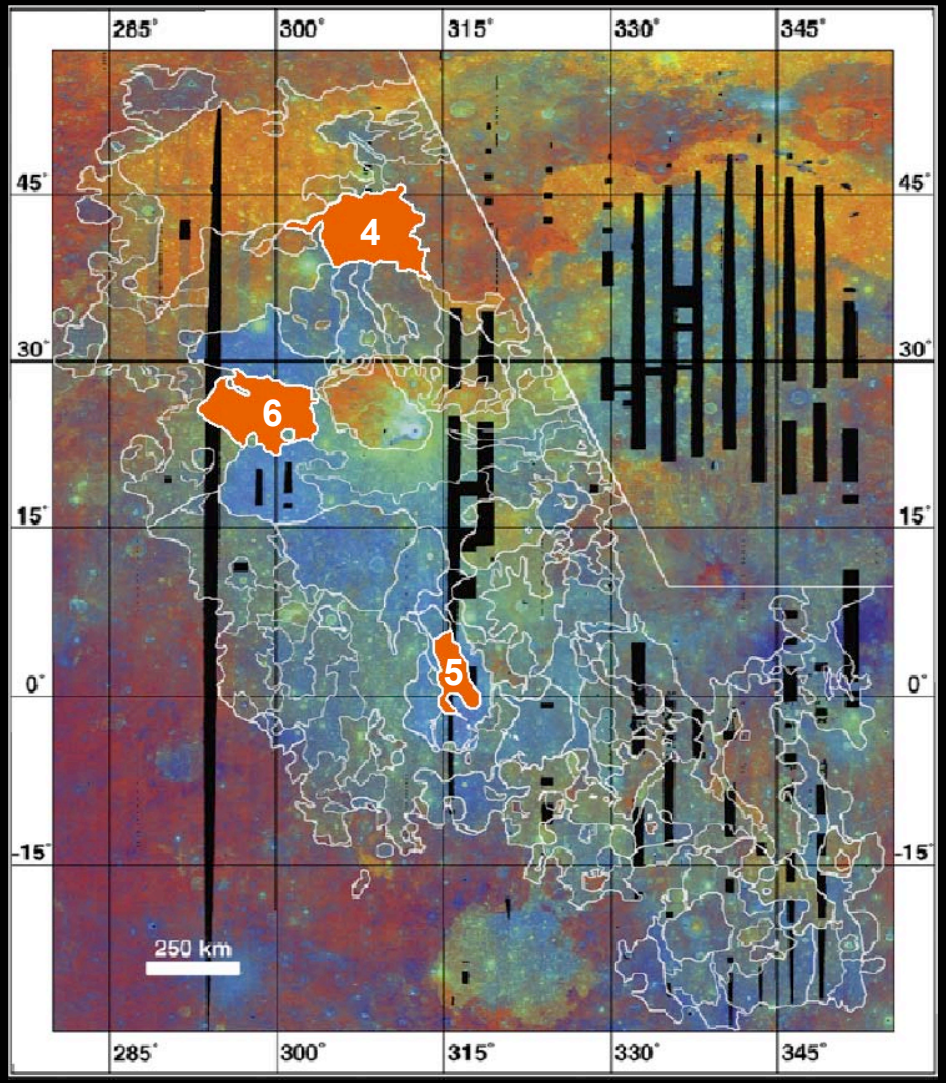
Mare Basalts: Thermophysical Analysis



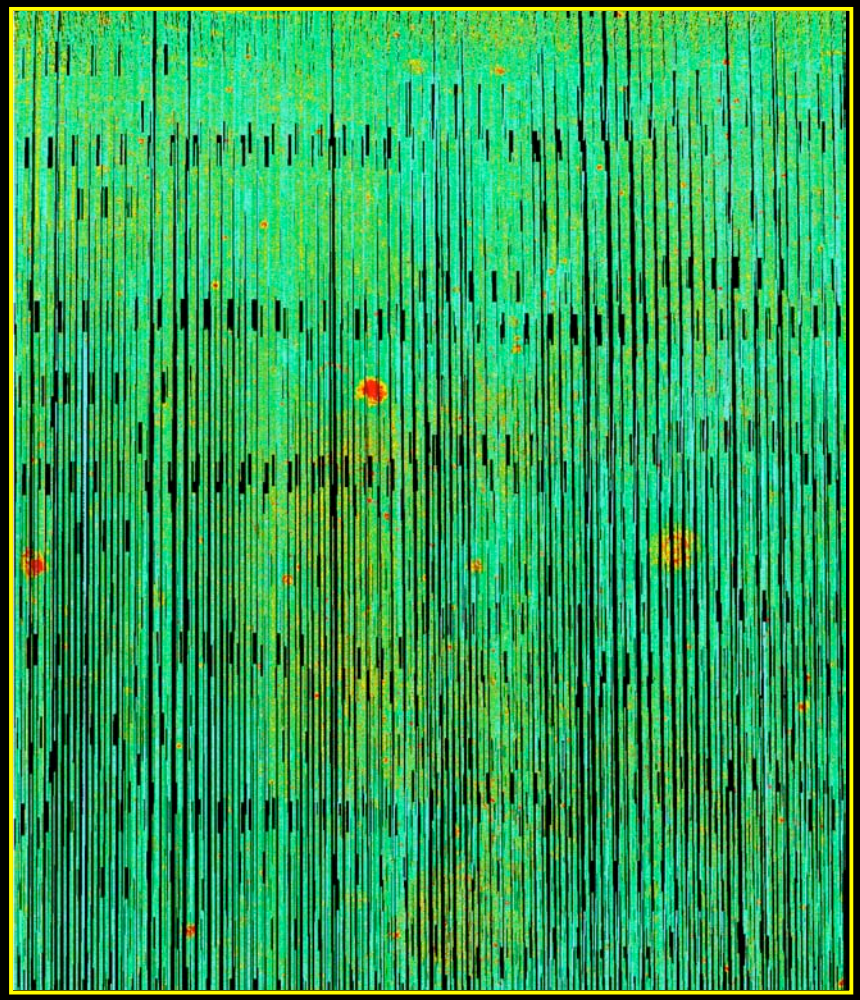


Vasavada et al. 1999

Mare Basalts: Thermophysical Analysis

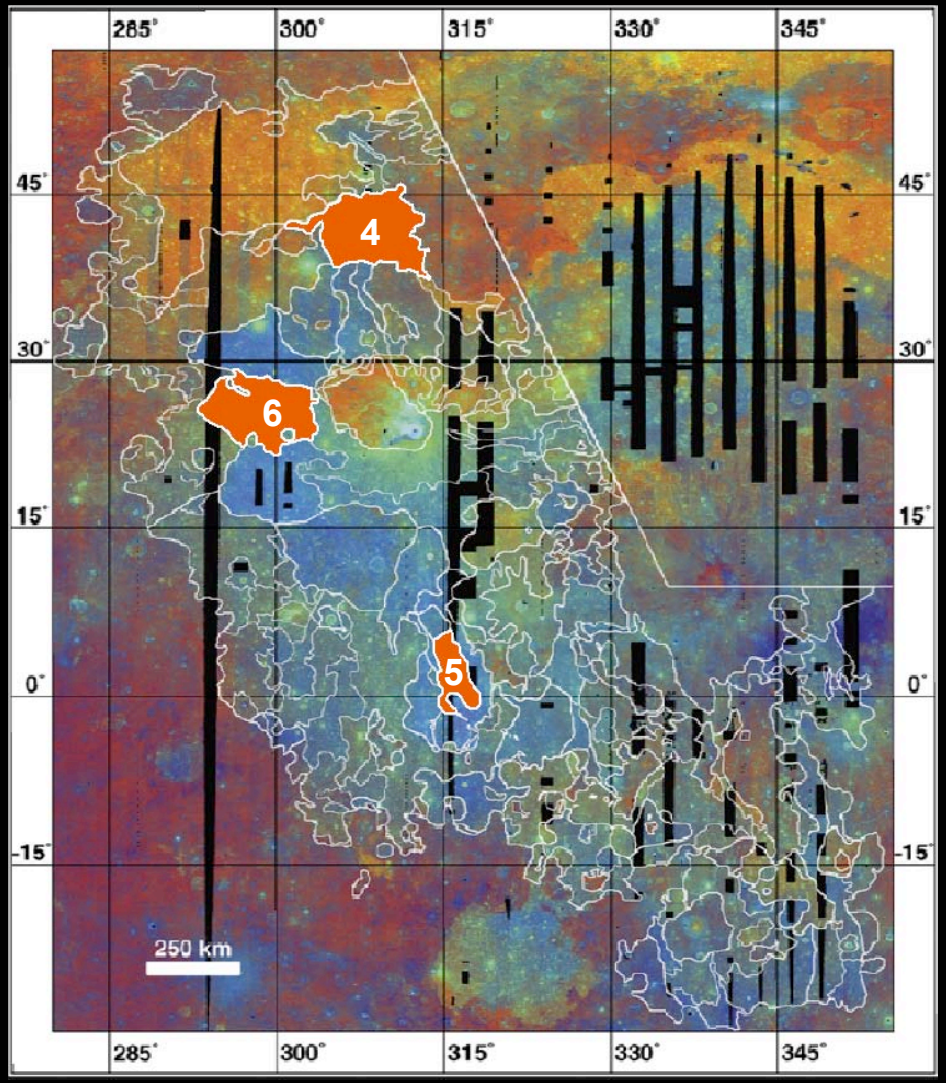


Rock Abundance

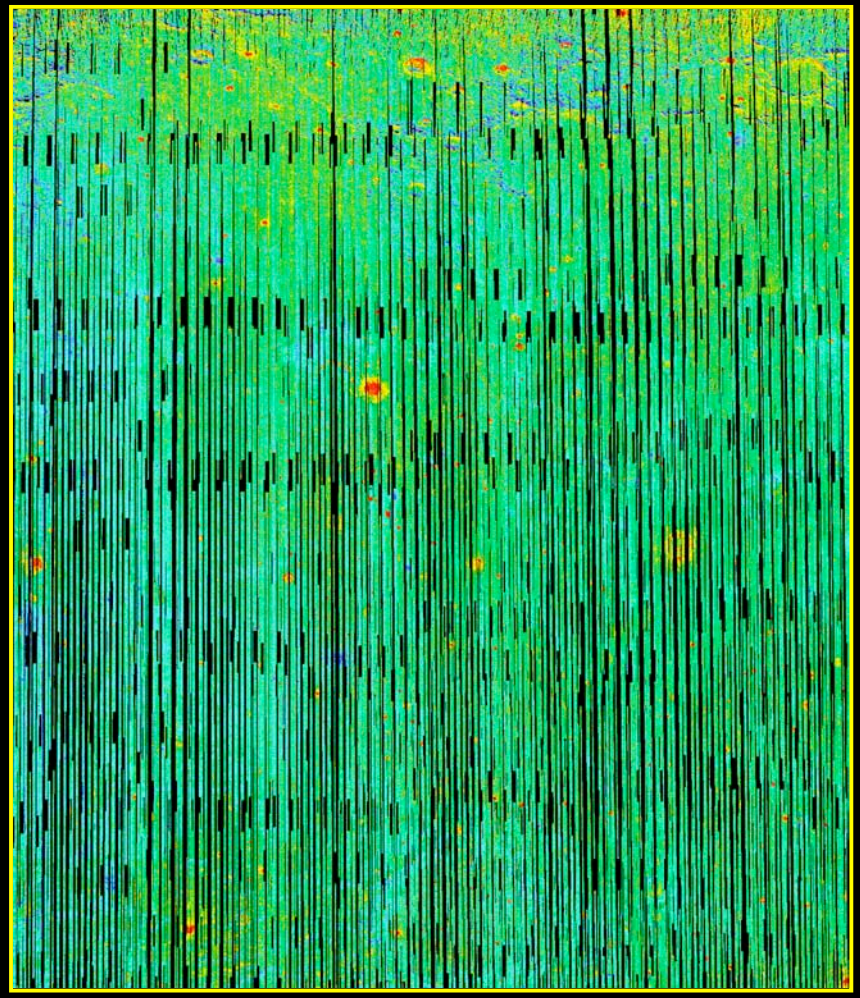


J.L. Bandfield et al. 2010

Mare Basalts: Thermophysical Analysis



Regolith Temperature



J.L. Bandfield et al. 2010

Mare Basalts: Thermophysical Analysis

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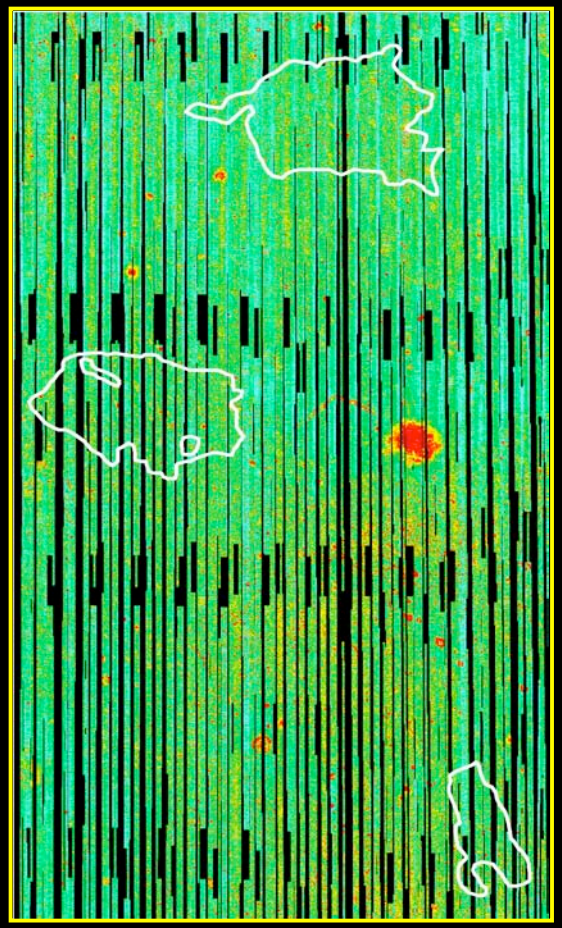
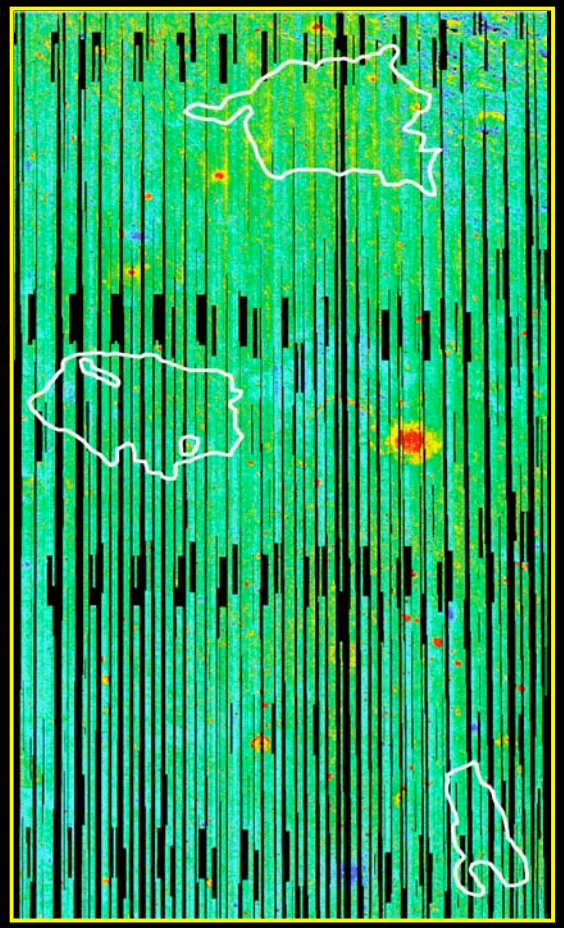


Regolith Temperature



Conclusions

- Diviner spectra, CF position, and band ratios can be used to distinguish between mare basalts with varying mafic signatures.
- Diviner thermal infrared data thus compliments previous VNIR measurements over Oceanus Procellarum and provides additional insights into the region.
- The lunar regolith in Oceanus Procellarum has thermophysical properties similar to that of the bulk Moon. Local scale areas of high rock abundances and regolith temperatures are currently being studied.
- Future integration of Diviner data with high spatial and spectral resolution M^3 and SELENE VNIR data will help further characterize the compositional and thermophysical properties of the region.