Water and Hydroxyl Features at Reiner Gamma

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Lunar Swirls

• Bright Albedo Patterns
• Associated with Magnetic Fields
• Protected from Solar Wind
  • Less Space Weathering
  • Less hydrogen implantation

Hemingway and Garrick-Bethell 2012
Previous Work at Reiner Gamma

- OH differences have been observed on and off the swirl in M3 data (Kramer et al 2011)
Ground Based Telescopic Observations of Lunar Hydroxyl

- NASA InfraRed Telescope Facility-IRTF
  - Observations from 1.6-4.0 microns
  - Able to be used as an Imaging Spectrometer
- Varied solar reflected and thermal emitted contributions
  - Observed at three phase angles including opposition
  - Observed during local partial eclipse
  - All observations within Earth’s magnetotail
    - Very low solar wind flux

Ground based observations of swirl

IRTF
Reflectance Enhancement at Opposition Surge

- Reflected light increases at low phase angles
- Temperature stays constant
- Ratio of reflected to thermal flux is increased

Buratti et al 1996
Partial Eclipse

• In partial eclipse solar flux is reduced
• Phase angle remains constant

Earth Viewed From the Moon During Partial Lunar Eclipse.
### Observing Conditions Summary

<table>
<thead>
<tr>
<th>Date</th>
<th>Phase Angle</th>
<th>Incidence Angle</th>
<th>Relative Photometric Intensity</th>
<th>Relative Solar Illumination</th>
<th>Net Received Solar</th>
<th>Radiative Temperature</th>
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<tbody>
<tr>
<td>Oct 23</td>
<td>18</td>
<td>73</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>280K</td>
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<td>Jan 21</td>
<td>3</td>
<td>57</td>
<td>2.4</td>
<td>1</td>
<td>2.4</td>
<td>330K</td>
</tr>
<tr>
<td>Jan 21</td>
<td>1.5</td>
<td>58</td>
<td>2.3</td>
<td>0.3</td>
<td>0.7</td>
<td>240K</td>
</tr>
<tr>
<td>Eclipse</td>
<td></td>
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</table>
Results - Comparison of thermal contribution

One of the points was supposed to be that the eclipse data shows a step and already has very little thermal, so I think I should add a stand-alone data/star of the eclipse so that can be seen.
Results-Comparison of Thermal Contrast

- Ratio of off swirl spectrum to On swirl spectrum
- Thermal contrast shown in slope at longer wavelengths
- Eclipse has lowest contrast
What water on the moon looks like

Sulpicius Gallus - Pyroclastic deposit

Normalized Reflectance

Water-Bearing Mid Ocean Ridge Basalt Glass

Wavelength (μm)
• Kramer et al 2011 showed Maria with stronger hydroxyl feature
• Very weak in telescopic data
• Ratio spectra show stronger band when off swirl has a larger band
• Swirls contain less hydroxyl than surrounding Maria
• Consistent with prior results
Maria / swirl ratios

- Ratio spectra show stronger band when off swirl has a larger band
- Swirls contain less hydroxyl than surrounding Maria
- Consistent with prior results
Band depth image

Reflectance

OH Abundance
Conclusions

• OH absorption varies on and off the Swirl even under these different conditions
• This strengthens the conclusions of Kramer et al 2011
• Hydroxyl absorption feature in maria present in magnetotail
Questions?

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