WATER AND HYDROXYL FEATURES AT REINER GAMMA Abigail Flom[1], Paul Lucey[1], Casey Honniball[1], Chiara Ferrari-Wong[1] [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 2500 Campus Rd, Honolulu, HI 96822 (aflom@hawaii.edu)

Introduction: A common view of the Moon as inherently dry abruptly changed when a Moon-wide 3 μm band was detected by multiple remote sensing instruments: EPOXI High Resolution Instrument, Cassini Visual and Infrared Mapping Spectrometer (VIMS), and the Moon Mineralogy Mapper (M^3) [1, 2, 3]. This band signifies the presence of OH bonds, which has been supported by the discovery of hydroxyl with solar wind hydrogen in lunar agglutinate glasses[4]. The study of this surface OH has important implications for understanding volatiles on airless bodies throughout the Solar System.

A key hypothesis for the origin of lunar surface hydroxyl is the interaction of solar wind hydrogen with surface oxygen. Lunar swirls are bright albedo features that have been linked to the presence of local magnetic fields. A magnetic field could shield the surface from the solar wind, which may decrease space weathering, causing that material to be brighter. Solar wind is also hypothesized to be the source of the observed hydroxyl via hydrogen implantation onto surface oxygen. A swirl is a natural laboratory for studying solar wind interaction because it can show differences in the water band while keeping other parameters constant.

This project focuses on the behavior of water on and around the swirls Reiner Gamma and Airy. In previous studies with Moon Mineralogy Mapper (M^3), it was found that absorptions in the 3 micron region are deeper off the swirl than on the swirl[5]. In fact, it was suggested that swirls can be better identified with this feature than with other methods [5]. However, data in the 3 μm region is complicated by the presence of both emitted and reflected radiation, and there is debate about how to best correct for thermal emission in M^3 data, which does not contain any wavelengths beyond 3 μm to constrain thermal models. Some corrections see differences in the 3 μm feature with latitude or lunar time of day [6, 7], but some do not [8].

In addition, M^3 data is limited in its wavelength coverage. A strong test of thermal corrections is their quality at longer wavelengths where thermal emission is increasingly dominant. To deal with this thermal modeling problem, this work uses ground based observations which have complete coverage of the 3 micron feature and the spectrum extends out to longer wavelengths where the thermal emission dominates. Plus, observations can be taken at lunar times of day that are not available in M^3. For Reiner Gamma, we have data ranging from incidence angles of 4 to nearly 90 degrees and at near 57 degrees we have very different temperatures due to observations obtained during a partial lunar eclipse.

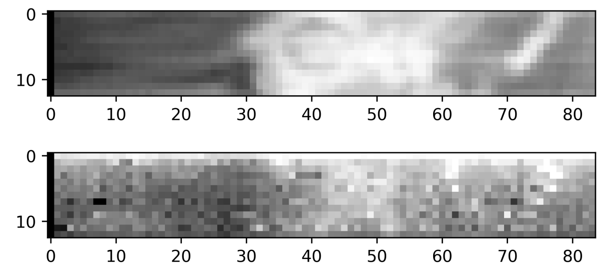

Figure 1: *The top image is a reflectance image of the lunar swirl Reiner Gamma and the bottom image is a corresponding 3 μm band depth map. Both images were created using SPeX data.*

Reiner Gamma	Phase (deg)	Incidence (deg)	Radiative T (K)
3/26/19	60.7	4.0	372.5
1/20/19	3.0	57.0	330.0
1/20/19 (Eclipse)	1.1	58.0	240.0
1/19/19	13.3	68.4	290.5
10/22/18	18.3	71.2	280.0
6/26/18	9.6	71.5	279.8
11/20/18	25.9	78.3	250.4
1/18/19	27.3	80.9	235.1
10/21/18	29.5	83.5	216.2
6/25/18	21.0	84.3	209.3
4/16/19	29.5	89.6	107.7
Airy			
4/16/19	43.2	39.4	349.5
4/15/19	56.9	51.5	331.1

Table 1: *Table of Ground-Based Swirl Data Collected*

Results: As shown in previous work, the material surrounding the swirl shows deeper 3 μm bands than the bright portions of the swirl. However, the correlation of reflectance and 3 μm band depth is less than observed with M^3 and some portions of the bright parts of the swirl show stronger 3 μm band depths.

The differences between previous results on the swirl and what we are observing are interesting and could be influenced by feature coverage or thermal correction differences. Beyond that, the data presented here are from lunar times of day which are not observed by M^3.

References: [1] Clark R.N. Science, 326:562565, 2009. [2] Sunshine J.M. et al.Science, 326:565568, 2009. [3] Pieters C. M. et al.Science, 326:568572, 2009. [4]Y. Liu et al.Nature Geoscience, 11:779, 2012. [5] G. Kramer.Journal of Geophysical Research, 16, 2011. [6] J. L. Bandfield et al.Icarus, 248:257372, 2015. [7] S. Li et al.Sci.Adv. 3:e1701471, 2017. [8] C. Wohler et al.Sci. Adv. 3:e1701286.