HIGH-RESOLUTION TOPOGRAPHY AND PHOTOMETRIC DATA CUBES FOR MERCURY AND THE MOON. J. R. Weirich[1], D. L. Domingue[1], E. E. Palmer[1], and A. Rodriguez[1], [1]Planetary Science Institute 1700 East Fort Lowell, Suite 106, Tucson, AZ 85719. jweirich@psi.edu

Introduction: We have generated high resolution topography and have co-aligned images to this topography. This alignment allows us to generate photometric data at resolutions previously unattainable. Table 1 lists locations on the Moon and Mercury for which we generated data. Products are available from the lead author.

Name	Location[1]	Size (km)	GSD[2] (m)
Moon			
Ingenii	-35.8, 161.8 -33.6, 163.4	9 x 9 9 x 9	5.0 2.6
Karpinsky	73.8, 167.6	5 x 20	5.0
Tsiolkovskiy	-19.4, 128.6	10 x 10	5.0
Reiner Gamma	7.0, 300.8	7 x 7	5.0
Moscoviense	26.5, 144.3	7 x 7	2.6
Aldrovandi	25.8, 29.1	20 x 20	6.4
Mercury			
Nathair Facula	34.6, 65.7 35.9, 64.3	130 x 130 80 x 80	120 60
Raditladi	28.3, 120.3 27.6, 120.4 27.9, 120.3	17 x 17 17 x 17 17 x 17	20 20 20
Larrocha	43.6, 291.6	40 x 40	48
Hopper	-12.5, 304.2	20 x 20	120

Table 1. [1]Location is in Lat/East Lon. [2]GSD is Ground Sample Distance

The stereophotoclinometry (SPC) software suite developed by Dr. R. Gaskell [1] generates topography and positioning data from spacecraft images, and aligns these images with an accuracy equivalent to a few image pixels [2,3]. With this high resolution topography, co-registration, and alignment, photometric information and properties can be explored on a pixel by pixel basis, instead of on a regional basis. Here we present our datasets for Mercury and the Moon, showing the regolith properties for local regions of interest.

Knowledge of the illumination (incidence angle) and viewing geometry (emission angle) that accounts for the effects of topography provide more robust inputs into the photometric models that are used to describe the physical characteristics of the upper microns of the surface regolith. Properties such as single scattering albedo, physical albedo, and Bond albedo provide information to determine compositional, structural, and even thermal properties of the surface. For example, the derivation of thermal emission comparisons across the surface tell us those regions that retain or emit heat more/less than other regions. This is important for understanding the regolith's ability to retain implanted hydrogen from the solar wind.

Other properties that can be deciphered from the photometric modeling include grain properties (how they scatter light, which is correlated to grain structures such as inclusions, fractures, and pores) and intergrain relationships (such as porosity and surface roughness). In turn these surface characteristics are governed by the processes acting on the regolith. Comparisons of these properties across a region can indicate changes in surface processing.

Topography and Photometric Data: We use stereophotoclinometry (SPC) [1-3] to generate Digital Terrain Models (DTM) of the Moon using Lunar Reconnaissance Orbiter Camera (LROC) images, and Mercury using the Mercury Dual Imagining System (MDIS) on the MESSENGER spacecraft.

SPC generates a highly accurate DTM, as well as images that are accurately aligned to the DTM. As such, the photometric data for each image can be easily generated. The phase angle, emission angle, incidence angle, and I/F (i.e. reflectance) are generated for each vertex of the DTM.

We have generated topography and photometric data cubes at many locations on the Moon and Mercury. We present and compare the surface properties across these regions.

Mercury: On this planet we have examined two different geologic regions associated with volatiles: a volcanic vent (Nathair Facula) and sublimation pits, also known as hollows (Raditladi, Larrocha, Hopper).

We examine two regions within the Nathair Facula volcanic vent. The smaller region is focused on the vent, the larger region contains both the vent and associated lava flows.

We examined several hollows features, which in the albedo images appear as depressions surrounded by bright material and have been associated with volatile loss due to sublimation [4]. Figure 1 shows an example of one of the hollows regions in Raditladi.

Moon: The features examined on the lunar surface in our studies include a wrinkle ridge (Aldrovandi), terraces on the rim and a rille on the floor of Karpinsky crater, the central peak region within Tsiolkovsky, and several swirl regions (Reiner Gamma, Ingenii [5], and Moscoviense).

Each of these regions were part of separate studies to examine processes occurring across the lunar surface. The Aldrovandi region includes a lobate scarp that transitions into a wrinkle ridge, and was selected to examine potential evidence for tectonic activity. Both Karpinsky [6] and Tsilokovsky [7] were selected to examine thermal conditions associated with solar wind hydrogen retention. The swirl regions were part of a study to examine the formation processes at work to create these distinct lunar albedo features. Figure 2 shows an example of a region within Karpinsky crater.

Conclusions: These locations have been generated in support of multiple, ongoing investigations. These studies include investigations into the water content of the Moon, lunar swirl formation, investigation of hollows formation on Mercury, and lava vent comparisons between Mercury and the Moon. These data products will soon be available through the PDS.

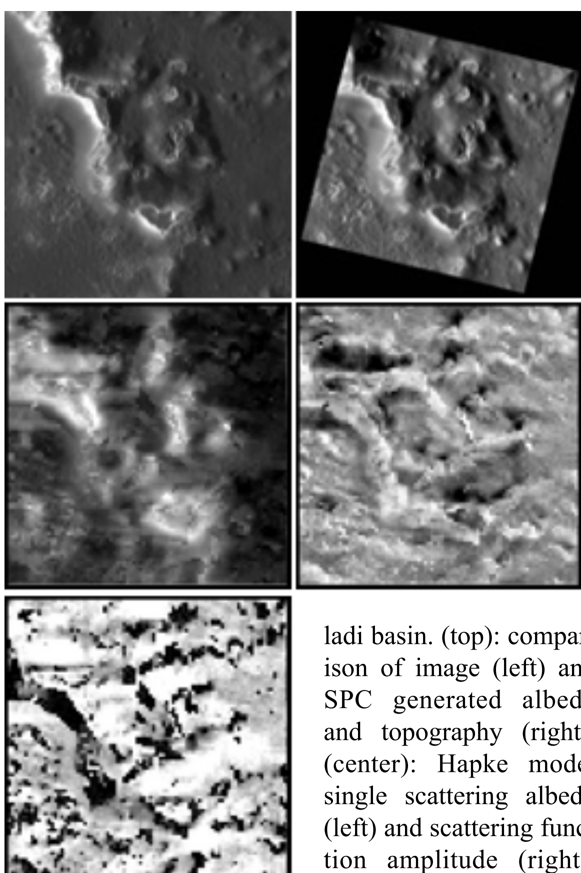

Figure 1. Hollows along central peak ring in Raditladi basin. (top): comparison of image (left) and SPC generated albedo and topography (right). (center): Hapke model single scattering albedo (left) and scattering function amplitude (right). (bottom): Hapke model surface roughness values across the region.

These products all support the characterization of the structure of the upper regolith (top few microns). Photometric modeling provides insight into the intergrain properties, such as grain size, porosity/compaction, and roughness. These are influenced by geologic processing (endo- and exo-genic). The modeling also provides insight into the grain properties, such as inclusions and fracturing. Comparisons of these properties across regions provides insight into the evolution of these surfaces and identifies commonalities and differences in regolith processing across the solar system.

References:

[1] Gaskell R.W. et al. (2008) MAPS 43, 1049-1061. [2] Palmer E.P. et al. (2022) Submitted for publication. [3] Weirich J.R. et al. (2022) Submitted for publication. [4] Blewett, D. T. et al. (2018) Mercury: The View After MESSENGER, Ch 12. [5] Domingue, D. L. et al. (2019) *LPS L*, Abstract #1936. [6] Weirich, J. R. et al. (2019) *LPS L*, Abstract #2681. [7] Domingue et al. (2018) *Icarus* 312, 61–99.

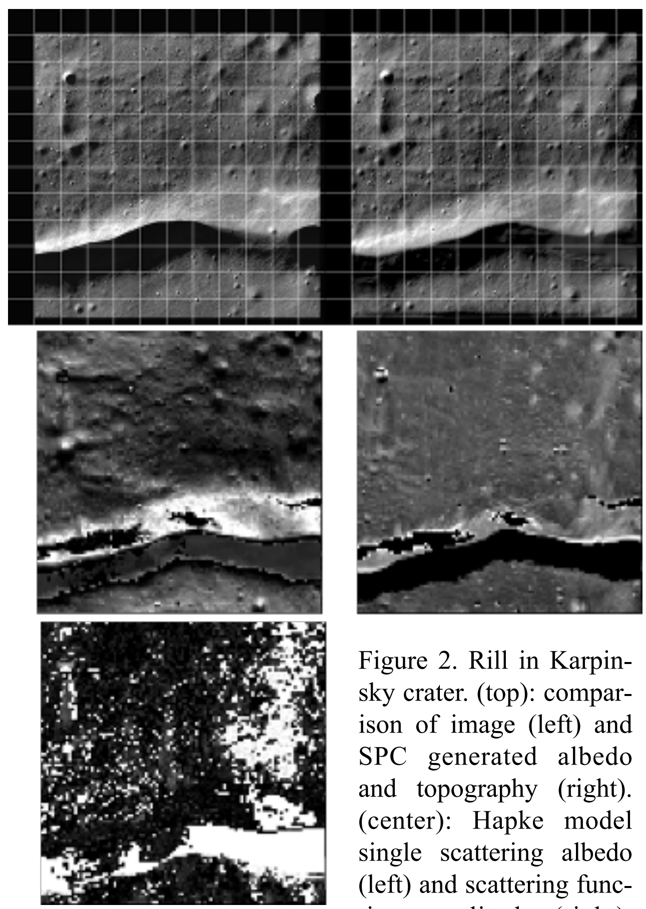

Figure 2. Rill in Karpinsky crater. (top): comparison of image (left) and SPC generated albedo and topography (right). (center): Hapke model single scattering albedo (left) and scattering function amplitude (right). (bottom): Hapke model surface roughness values across the region.