Albedo-Porosity Relationship at the Gruithuisen Domes

Elena M. Dolgas[1], A. R. Dove[1], B. D. Byron[1], A. D. Whizin[2]

[1]University of Central Florida, [2]Southwest Research Institute

Introduction

One of the goals of the Lunar Vulkan Imaging and Spectroscopy Explorer (Lunar-VISE) mission is to characterize the geotechnical properties of the regolith around the Gruithuisen Domes. One relationship of particular interest is between reflectance (albedo) and porosity. Since Lunar-VISE will be the first mission to visit a lunar red spot, or non-mare volcanic region, we examine existing orbital measurements of the area, in combination with numerical modelling, to further constrain this relationship. We utilize orbital data from the Lunar Reconnaissance Orbiter (LRO) mission, specifically, the Lyman Alpha Mapping Project (LAMP) and the mission's camera (LROC).

Methods

The LRO mission has been observing the Moon's surface for over a decade, providing details maps for a range of wavelengths, from the far ultraviolet with LAMP to the visible range with LROC. LROC images of the domes, such as the one shown in Figure 1a, provide details about topography of the volcanic region. Additionally, radiance maps can be created from using the camera's UV filters and Hapke parameters, Figure 1b, normalized to 60° phase angle.

The LAMP instrument observes the Moon in unique far ultraviolet wavelengths. From the reflected photons measured, we can produce brightness maps, shown in Figure 2a. Albedo maps, Figure 2b, from LAMP are equal to a radiance map, normalized to 30° phase angle. We further focus on the uppermost portion of the wavelength range, ~155-190 nanometers. Using the methods of Byron [1], we can make a modeled porosity map of the Gruithuisen Domes, based on albedo values. Note: Maps in Figure 2 are in progress and undergoing further analysis.

Preliminary Results

Through analyzing the albedo maps from LROC and LAMP, we notice "bright" regions, or higher albedo areas. For the LROC map with the UV filter for 360 nanometers, the two large impact craters of Mons Gruithuisen Gamma have the highest radiance factors between both domes. In the LAMP albedo map, the domes appear to have some of the lowest albedo values in the far ultraviolet

The LAMP maps span a time frame of 2009-2016, which is known as pre-FDO, or prior to the fail-safe door's opening. The brightness map's plotting range is 2 sigma from the mean. The albedo map's range is 1 sigma from the mean. In both images, the Gruithuisen Domes are darker than the surrounding mare. Based on initial modelling, both domes would have high porosity.

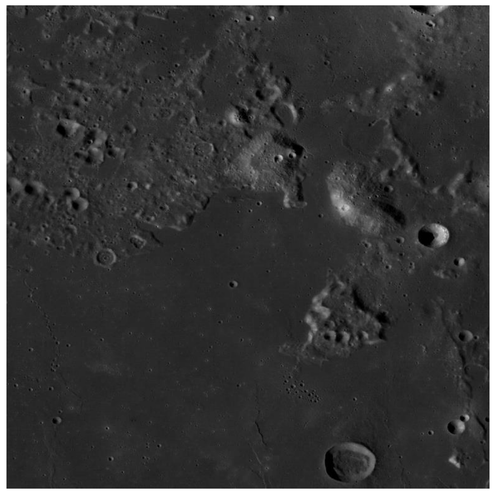

Figure 1a: LROC image of the Gruithuisen Domes region. Image courtesy LROC QuickMap.

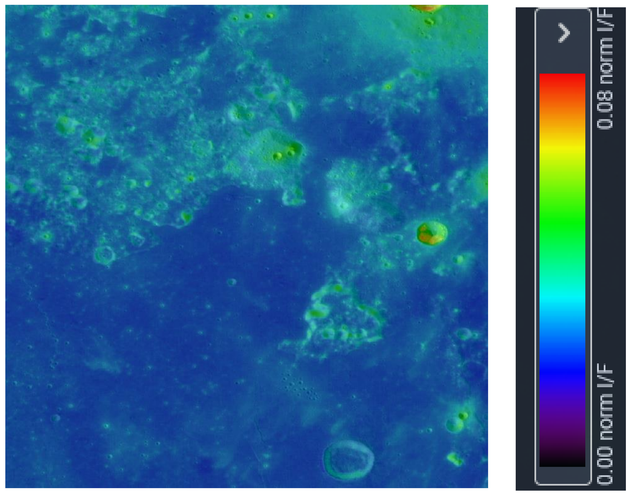

Figure 1b: LROC 360 nm filter image of the Gruithuisen Domes region. Image courtesy LROC QuickMap.

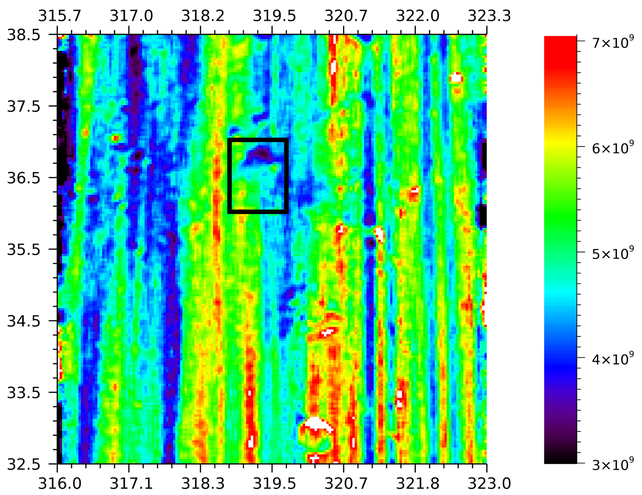

Figure 2a: LRO LAMP brightness map of the Gruithuisen Domes region. Mons Gruithuisen Gamma in black rectangle.

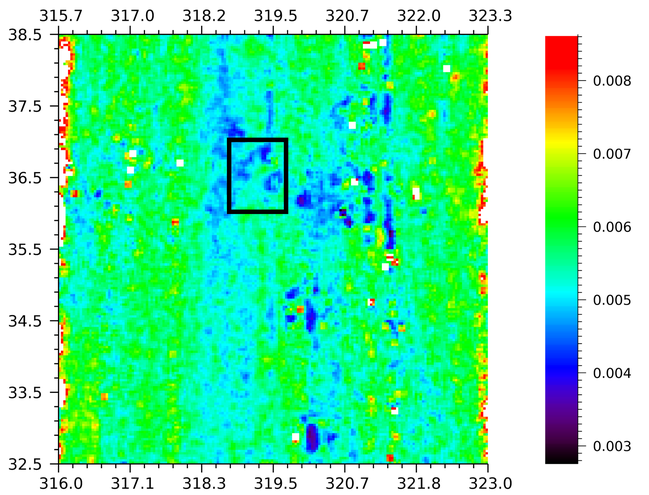

Figure 2b: LRO LAMP albedo image of the Gruithuisen Domes region. Mons Gruithuisen Gamma in black rectangle.

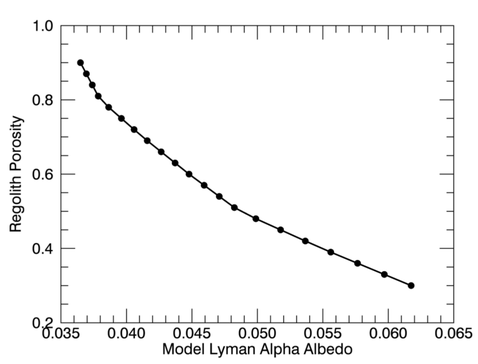

Figure 3: Byron [1] modeled albedo vs porosity, based on LAMP albedo and Hapke [2] parameters.

Future Work

This project is still on-going and will continue to be updated and studied. The next step is application of Byron's porosity model, Figure 3, to the maps of the Gruithuisen Domes. For the LAMP maps, further calibration will be applied to utilize data after the fail-safe door was opened, providing access to more data.

Further work will include comparison to spectroscopy of sample analogs in a laboratory setting, spanning from the ultra violet through infrared.

References

[1] Byron, B. Porosity maps of the lunar surface derived from LRO-LAMP albedo data [abstract]. In: Lunar and Planetary Science Conference 2019.

[2] Hapke, B. (2008) Icarus, 195, 918–926.