Exploration of Gruithuisen Domes, Staples T[1], [1]Durham Academy Upper School 3601 Ridge Rd. Durham, NC, 27705, 22staples@da.org

Introduction: The Gruithuisen domes are a set of rhyolitic lava domes (NW, Gamma, & Delta) located on the west edge of the Mare Imbrium (36.3ºN, 319.8ºE).

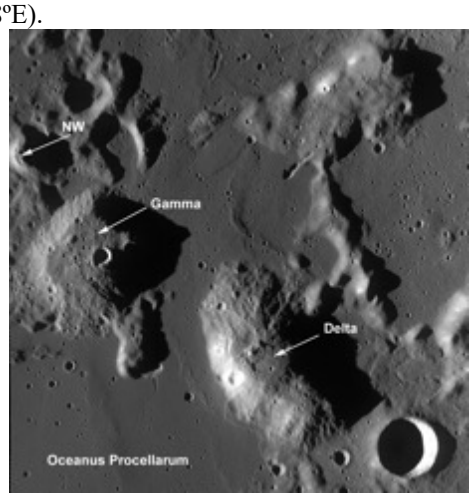

Fig 1: Labeled overview of the three Gruitheisen domes (Source: [1])

These domes are different from typical mare-domes for their steep slopes (up to ~20º) and unusual composition consisting of potassium, rare earth elements, phosphorous (KREEP) and high thorium levels [2]. The current model for explaining the formation of Gruithuisen Domes is that it was formed through the eruption of a silica rich volcano during the Imbrium age [3]. The silicic lavas were much more viscous than the Moon's typical basaltic lava and as a result, the lava clumped together and formed tall domes. This formation explains the steep slopes and composition, but is still largely speculation. The primary goals of a mission to the Gruithuisen Domes will be to study how the silica rich magma formed and get more detailed about the composition of the domes. This information will increase our knowledge of the history of the Earth-Moon system, advance theories on the molten history of the moon, and provide important points of comparison for our study of the formation of other terrestrial planets. In order to further study the domes, we propose landing a rover on the Gamma dome because it is flatter than the surrounding domes and the composition indicated it is the most likely to be silicic.

Landing Criteria: In order to have a successful landing, the proposed location must meet the following criteria:

- Flat area (~100m in diameter) clear from boulders
- Adjacent (within ~500m) to a fresh crater of at least 20m in depth
- Thorium content of at least 9ppm
- FeO wt. % of less than 10%

In order to meet these criteria, we propose the following location in the southwest of the Gamma Dome.

Fig 2: Specific image of Gruisheisen Gamma with a line representing our proposed rover route (image given by NAC)

A key part of this mission will be making sure that the robot can land safely in a good location to survey the Gruithuisen Domes. The proposed landing site is located in the south-west of the Gruithuisen Gamma Dome (36.45ºN, 319.19ºE).

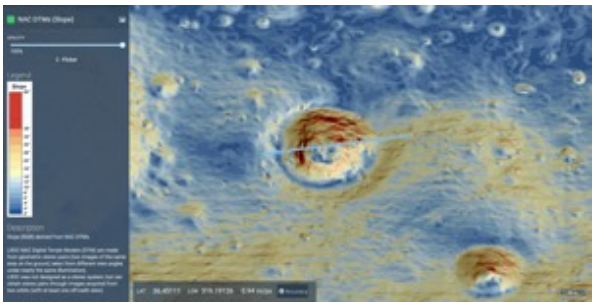

Fig 3: color scale representation of the slope of our proposed transverse as described by the NAC digital terrain model (DTM).

One of the main features of a tenable landing site is a smooth, flat surface. As indicated by the above image, there is a large area (about 100m across) with an average ~1º of slope. This area, therefore, makes for an ideal landing site.

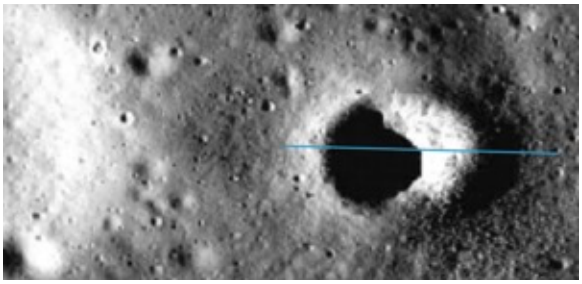

Fig 4: Close up image of the landing site given by NAC high angle camera

Additionally, a landing site should be relatively free from boulders that would interpret the landing. The area to the east of this crater appears to be largely free from such obstructions.

Finally, a good landing site should be near a promising crater to study. The designated crater is a great opportunity because it seems to be relatively fresh and is ~200m across and ~20m deep.

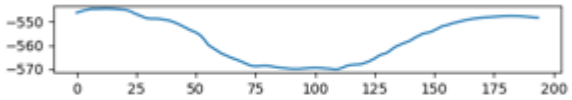

Fig 5: height map with zero vertical exaggeration with data collected by GLD100 (+LOLA).

This landing site is also exciting because, opposite the landing site, there are a large number of exposed boulders. These rocks would provide a large number of samples to study the composition of the dome.

Additional important information about the proposed crater can be found in the compositional data of the region. Areas of high thorium and low thorium indicate a fresh crater that has exposed the inside of the dome.

According to the Lunar Prospector, the thorium levels of the southern region of the dome is ~9.2 ppm, meeting our minimum thorium threshold.

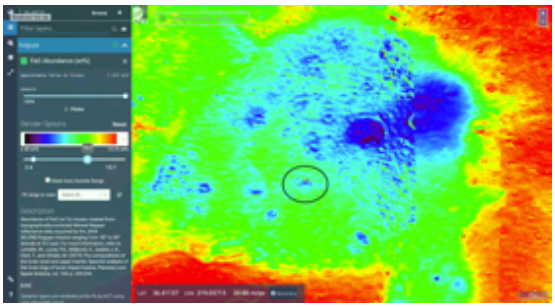

Fig 6: Iron Abundance of the Gruithuisen Gamma Dome given by Kayuga

The proposed crater (circled in black) also has a relatively low iron abundance (~7.5 wt%) compared to the surrounding levels.

Combined these two compositional reading are a good indication that the crater we are studying is a good fit for this mission

Data: The data used to generate these conclusions was primarily drawn from LROC Quickmap web application. LROC provided visual imagery, terrain models, and compositional maps. Figures 2-6 are all generated from the various sources included with LROC Quickmap.

Summary: In summary, the Gruithuisen Domes are an opportunity to study an odd geologic feature that would teach us about planetary formation of terrain planets. We specifically are studying Gruithuisen Gamma because it is more accessible and more likely to be a silicic dome. We propose examining a crater located at (36.45ºN, 319.19ºE) to study because of the nearby easy landing site, the size and low iron abundance indicating the crater is fresh, and the plentiful supply of exposed boulders in the area that allow for further compositional studies of the domes.

References: [1] Ivanov, M. A. et al. (2016) Icarus, 273, 262-283. [2] Timothy D. Glotch, et al. (2010) Science, 329, 1510-1513. [3] Braden, S. (2010) from http://lroc.sese.asu.edu/posts/184.