PERMANENT SUNLIGHT AT THE LUNAR NORTH POLE. D. B. J. Bussey[1], M. S. Robinson[2], K Fristad[3], and P. D. Spudis[1] [1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, MP3-E180, Laurel MD 20723 (ben.bussey@jhuapl.edu) [2]Northwestern University, Locy Hall 309, 1847 Sheridan Road, Evanston IL 60208, [3]Macalester College, 1600 Grand Ave, Saint Paul, MN 55105.

Introduction: The spin axis of the Moon is nearly perpendicular to the ecliptic plane. This results in the possibility of extreme lighting conditions at the lunar poles [1]. The floors of impact craters may never see the Sun, whilst, theoretically, topographically high regions near the poles could be constantly sunlit. Permanently shadowed regions are the most likely locations for ice deposits believed to exist at both poles [2,3]. Regions which are permanently sunlit represent ideal locations as future landing sites. Not only would there be the availability of constant solar power generation but these areas would permit operations in a reasonably benign thermal environment. It has been modeled that the temperature of a permanently sunlit region close to a lunar pole would be 223 ± 10 K [4].

South Pole: A quantitative study of the lighting conditions at the Moon's south pole revealed some interesting results [4]. Nowhere at the scale of the Clementine imaging data, 500 m/pixel, was constantly sunlit. However several places exist that are illuminated for greater than 70% of a lunar day in winter. Also, two areas close to the rim of Shackleton and only 10 km apart are collectively illuminated over 98% of the time. The quantitative illumination map for the lunar south pole region is shown in figure 1.

North Pole: We have recently completed the first stage in a similar study of the lighting conditions near the lunar north pole. It should be stressed that the available data were collected during summer in the Moon's northern hemisphere.

Method. The primary data set used for this study was the Clementine UVVIS. Clementine was in an elliptical mapping orbit and acquired images of both poles for 71 days. The latitude of perilune was changed approximately half way through the mission from 30° south to 30° north. This resulted in images of the poles that have different resolutions depending on whether they were obtained during the first or second month of operations. Month 1 north polar data has a spatial resolution of approximately 500 m/pixel whilst 2nd month data are at a higher resolution of 250 m/pixel. For our initial analysis of lighting conditions at the north pole we have used month 1 data. This is because although the spatial resolution is a factor of 2 lower than the second month data each image covers approximately four times more of the surface and field of view is more important than resolution.

Orbit strips, from 80° north to the pole were made for all first month orbits that imaged the pole (Figure 2). These were then co-registered to approximately 1 pixel precision. These strips were then turned into a movie that qualitatively shows how the lighting conditions vary as a function of illumination direction. The movie revealed that several places on the rim of Peary crater appear to be illuminated for a large fraction of the day.

The images that made the movie were then converted into a quantitative illumination map which shows the percentage of time during a lunar day in summer that areas are illuminated. This map was produced by masking out areas that are not imaged in every orbit. We therefore have a collection of images that were taken approximately 10 hours apart which show the lighting conditions for a wide range of illumination directions. By choosing a threshold dn value these images are converted into binary light/dark images. These binary images were then combined into the quantitative illumination map which is shown in Figure 3. The spatial extent of the map is constrained by the requirement that a point on the surface be imaged in all images. This results in a map which covers between 1° and 1.5° of the pole, depending on longitude.

Results. The primary result is that four regions exist which were illuminated for the entire lunar day. These are all located on the northwest rim of Peary crater in between the subcraters Peary B and Peary W. The largest area lies on the northern rim of Peary B. We do not know that these places are permanently sunlit, as the data were collected in summer. However areas that are constantly illuminated in summer are obviously the prime candidate, and in fact are the only possible, sites for constant illumination. The illumination map also shows regions that are permanently shadowed. The majority of the permanent shadow is associated with the two Peary subcraters B & W which are 12 and 10 km in diameter respectively. Two of the small craters within the floor of Peary crater also appear to be permanently shadowed. The third area of permanent shadow is located north of 89° between 90° and 180° W. This region consists of highland terrain with many depressions that are permanently shadowed.

Conclusions: We have produced the first quantitative illumination map of the Moon's north polar region. This has permitted us to identify which areas are permanently shadowed. Additionally we have identified places that were constantly lit throughout a lunar day in summer and represent the prime candidate locations for permanently illuminated regions.

References:

[1] Heiken G. D. et al. (1991) The Lunar Sourcebook *CUP 736pp*. [2] Feldman W. C. et al. (2001) *JGR 106*, 23232-23252. [3] Nozette S. et al. (2001) *JGR 106*, 23253-23266. [4] Bussey D. B. J. et al (1999) *GRL V26 No. 9*, 1187-1190.

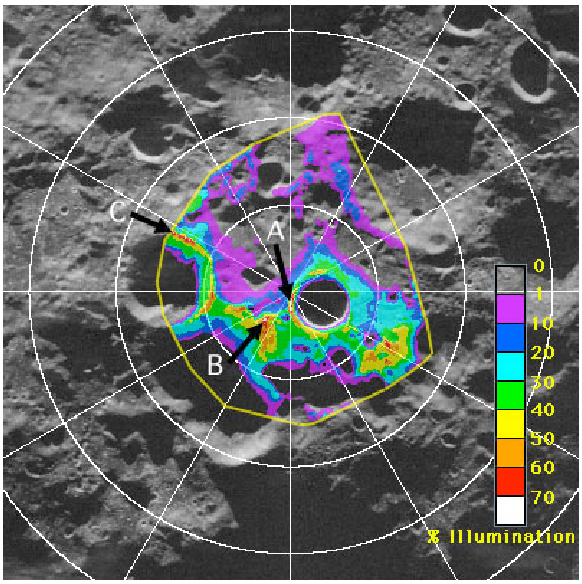

Figure 1. Quantitative illumination map of the lunar south polar region [4].

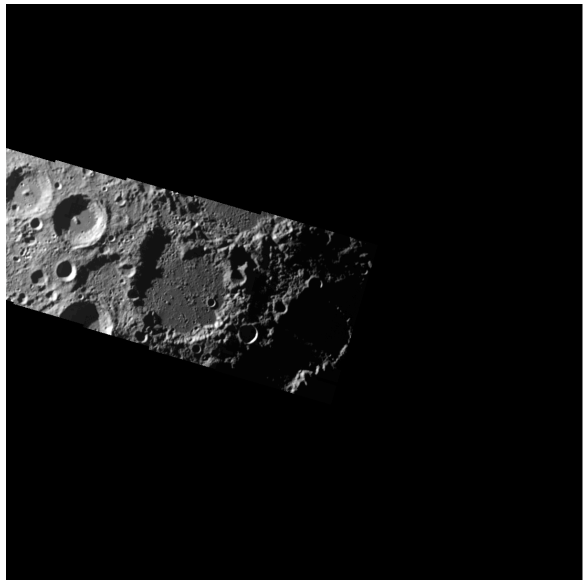

Figure 2. Orbit strip for Clementine orbit 075. The mosaic covers from 80° to the pole and shows how the image strip covers the region beyond the pole.

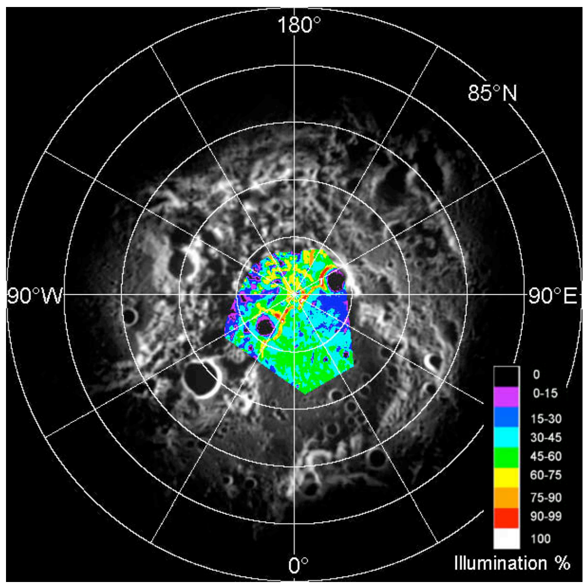

Figure 3. The quantitative illumination map overlaid on top of a UVVIS mosaic of the lunar north polar region.