PERMANENT SHADOW IN SIMPLE CRATERS NEAR THE LUNAR POLES. D. B. J. Bussey[1], P. G. Lucey[2], M. S. Robinson[3], P. D. Spudis[1], K. D. Edwards[4], and D. Steutel[2] [1]Johns Hopkins University Applied Physics Laboratory, Laurel MD 20723 (ben.bussey@jhuapl.edu), [2]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 2525 Correa Road, Honolulu HI 96822, [3]Northwestern University, Locy Hall 309, 1847 Sheridan Road, Evanston IL 60208, [4]Q&D Programmers, PO Box 1002, Hearne, TX 77859.

Introduction: Simulation of illumination conditions at the lunar poles permits the investigation of lighting scenarios for which imaging and high quality topographic data do not exist [1,2]. Using this technique with realistic crater topographic profiles makes it possible to model the amount of permanent shadow in impact craters surrounding the lunar poles. Knowledge of the extent of permanently shadowed regions has important ramifications for the location of cold traps and possible deposits of water ice [3,4,5].

Simulations: The morphologic parameters of lunar simple craters have been quantitatively characterized as a function of diameter [6]. These parameters, which include depth, rim height, rim width, and flat floor diameter, provide enough information to generate realistic digital elevation models for this type of crater. Simulations using these realistic profiles have been conducted to determine how the amount of permanent shadow contained in a simple crater varies as a function of crater size and latitude.

Figure 1. Simulation for a 17.5 km crater.

Simulations were conducted for craters with diameters from 2.5 to 20 km located at all integer latitudes within 20° of the pole. An example of a typical simulation is shown in Figure 1; results show that latitude, rather than diameter, is the dominant parameter in determining the amount of permanent shadow in a simple crater. Figure 2 shows how the amount of permanent shadow varies as a function of latitude for craters 20 km in diameter. Figure 3 shows how the amount of permanent shadow in a simple crater changers as a function of size at a constant latitude. A key result of our work is that craters as far as 20° from a pole may still contain significant amounts (22-27 %) of permanent shadow.

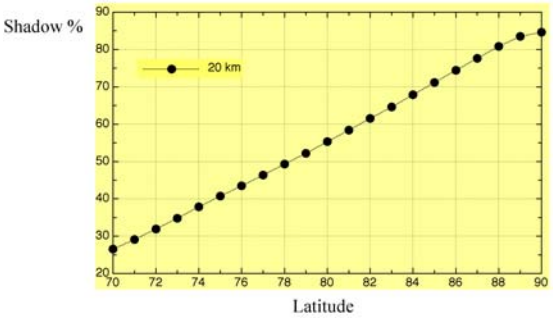

Figure 2. Percentage of the inside of a 20 km crater that is permanently shadowed, as a function of latitude.

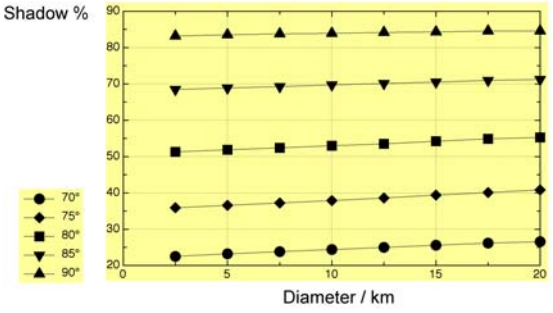

Figure 3. Plot showing how the amount of permanent shadow in a crater varies as a function of crater size.

Darkness Maps: The results from all the simulations were used to produce an equation which predicts the amount of permanent shadow in a crater as a simple function of latitude and crater size [2]. By measuring the diameter of all fresh-looking simple craters near both lunar poles and using our permanent darkness equation we have calculated a model value for the amount of permanent shadow located in simple craters at the lunar poles.

North: 832 simple craters with diameters between 2.5 and 20 km were mapped between 78° to 90°N.

These craters represent about 3% of the total surface area of the Moon in this region, or roughly 12,500 km^2. The total amount of permanent shadow associated with these craters is 7500 km^2. This represents a lower limit on the total amount of permanent shadow near the north pole as our value does not include the contribution of poleward facing walls of complex crates such as Rozhdestvensky K (82.7°N 145°W) which are likely to contain significant amounts of permanent shadow. Although craters that lie on regional slopes may exhibit both more or less shadow than the modeled amounts (based on whether they lie with or against the regional slope), we assume that such effects will, on balance, cancel each other out. A map of the simple craters identified in this study is shown in Figure 4. Whilst being a lower limit, our value of 7500 km^2 is significantly larger than previous estimates for permanent shadow near the lunar north pole [7,8]

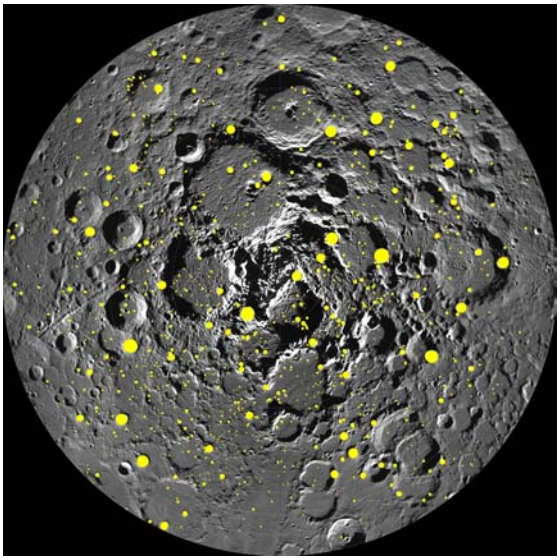

Figure 4. A plot of all 832 fresh looking simple craters near the north pole that contain permanent shadow.

South: A similar study of the south polar region identified 547 craters with a total area of 11,200 km^2. The amount of permanent shadow associated with these craters is 6500 km^2. This is a lower limit on the total amount of permanent shadow close to the pole as several complex craters (in the 20 – 35 km diameter range) exist in the south polar region. In addition, there appears to be a sizeable depression in the vicinity of the south pole, towards the Earth-facing hemisphere; this zone may contain a significant area of permanent shadow, unrelated to the presence or absence of simple craters.

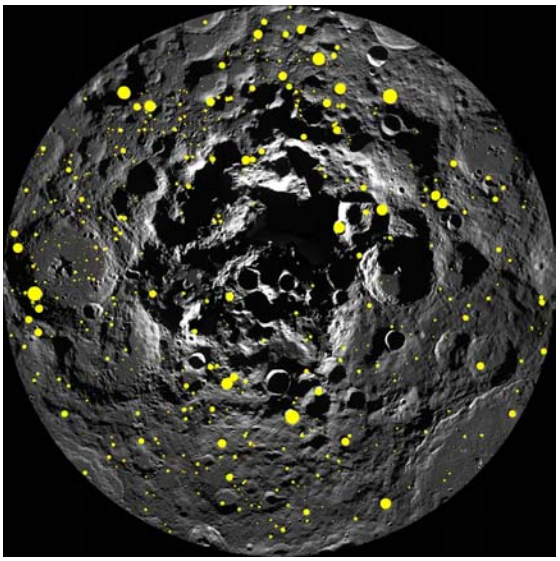

Figure 5. A plot of all 547 fresh looking simple craters surrounding the lunar south pole used in our study.

For this reason, we believe it is important to collect both detailed topographic data for the poles as well as monitoring the lighting conditions near both poles for at least one year. Such observational data will be required for any definitive assessment of the amounts of permanent shadow and permanent light near the lunar poles.

References: [1] Bussey D. B. J. et al. (2002) *LPSC XXXIII*, Abs. # 1819. [2] Bussey D. B. J. et al. (2002) *GRL*, *in press*. [3] Watson K. et al. (1961) *JGR* 66 3033-3040 [4] Arnold J.R. (1979) *JGR* 84 5659-5668 [5] Ingersoll A.P. et al. (1992) *Icarus* 100 40-47 [6] Pike R. J. (1977) *Impact and Explosion Cratering*, 489-509. [7] Nozette S. et al (1996) *Science* 274 1495-1498. [8] Margot J. L. et al. (1999) *Science* 284 1658-1660.