ILLUMINATION CONDITIONS AT THE LUNAR POLES. D.B.J. Bussey[1], M.S. Robinson[2], and P.D. Spudis[3], 1. ESA/ESTEC Code SO, PO Box 299, 2200 AG Noordwijk, The Netherlands; bbussey@estec.esa.nl. 2. Northwestern University, Evanston IL 60208. 3. Lunar and Planetary Institute, Houston, TX 77058

Introduction: The Clementine spacecraft, launched in January 1994, mapped the Moon in a near polar orbit for a period of 71 days. In doing so, it has provided for the first time a digital data set with which to analyse the lunar poles at medium-high resolution (250-500 m/pixel) with contiguous, consistent coverage. The Moon's poles are inclined 1.5° from a perpendicular to the ecliptic plane. The Sun will always appear close to the horizon near poles as the Moon slowly rotates on its axis every 708 hours (about 29 Earth days). Thus, topographically high and low points in the vicinity of the poles are potentially permanently illuminated or shadowed, respectively [1,2,3]. An initial examination of new Clementine images of the south polar region did indeed suggest that some areas were in near-permanent darkness and illumination [4,5,6,7].

South Pole: A quantitative illumination map of the south polar region has been produced that shows the percentage of time that a point on the surface is illuminated during a lunar day. Of particular interest are regions that experience lighting extremes, both areas that appear to be in constant darkness as well as regions that receive large amounts of sunlight. The spatial extent of the illumination map is constrained by the condition that for a point on the surface to be in the map, it must be covered in every image. The map considers a region centered at the pole and extending out to approximately 88.5°S (within 45 km of the pole), covering about 7000 km^2 of the lunar surface. Areas that receive excess amounts of illumination (more than half a lunar day) are of interest as potential landing sites and possibly, future outpost sites. Not only do they offer a near continuous availability of solar energy (possibly negating the requirement of other power sources, such as a nuclear), but they would also permit surface operations in relatively benign thermal conditions (it has been estimated that temperatures in permanently lit areas near the lunar poles are on the order of -53° ± 10° C [8]).

At the spatial scale of the Clementine resolution, we find no location that is in constant sunlight. However several areas exist in the south polar region which receive large amounts of illumination (these lunar massifs experience sunlight for > 70% of the lunar day). The most illuminated area lies on the rim of Shackleton crater, it appears to be illuminated for > 80% of the lunar day. A second massif, only 10 km away, also receives large amounts of sunlight. Collectively, these two areas are illuminated for > 98% of the lunar day.

The Clementine data has also made it possible to consider illumination histories for sites of interest, i.e. massifs that receive large amounts of illumination. These illumination profiles show whether or not a region receives sunlight as a function of subsolar longitude direction. The illumination profile for the massif on the rim of Shackleton crater is displayed in Figure 1.

North Pole: A similar project has begun for the lunar north pole. Unfortunately the coverage of this pole by Clementine's UVVIS camera is not as comprehensive as for the south pole. However it is possible to make a revised estimate as to the amount of permanently shadowed areas in this region. This is of particular interest considering the recent discovery by Lunar Prospector. Initial estimates for the amount of permanent darkness in the north polar region was very conservative, essentially only including the area of a few small impact craters close to the pole. The initial estimate was only for a few hundred square kilometres [5]. We have discovered that the north facing crater walls for impact structures as far south as at least 80° can be in constant shadow. An initial analysis of such structures has increased the estimate of permanent darkness to approximately 13000 km^2. We will apply similar analysis to the south pole and expect the new estimates of the cumulative amount of permanent darkness at the south pole would be greatly increased from the previous conservative estimate of 15000 km^2 [5].

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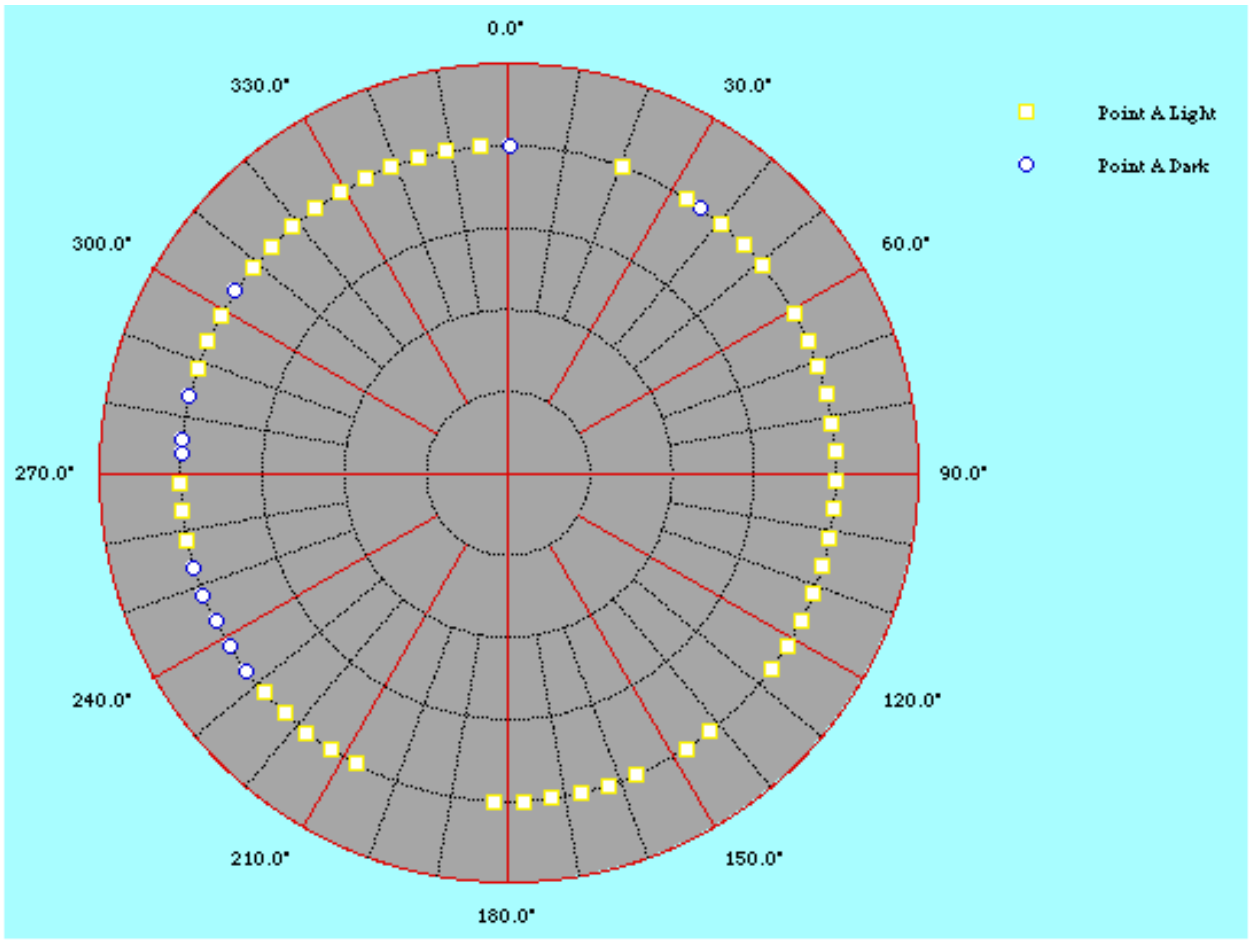

Figure1. The illumination history for the massif on the rim of Shackleton crater that receives sunlight for > 80 % of the lunar day making it the most illuminated area in the south polar region. It indicates whether the massif receives sunlight (yellow square) or not (blue circle) as a function of illumination direction.