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Results from the Multi-Beam Laser Altimeter on LRO

David E. Smith (1), Maria T. Zuber (1), Gregory A. Neumann (2) and Erwan Mazarico (1,2) and the LOLA Science Team.
(1) MIT, Cambridge, MA USA, (2) NASA Goddard Space Flight Center, Greenbelt, MD USA (smithde@mit.edu /Fax: 301-614-6015)

Abstract

The laser altimeter [1] on the LRO spacecraft has operated almost continuously since arrival at the Moon in early July 2009. The altimeter, LOLA, has 5 beams, each beam illuminates a 5 meter spot on the lunar surface. The spots are arranged in a cross formation with the arms of the cross being 25 meters in length. The cross pattern is rotated with respect to the direction of spacecraft orbital motion with the result that from 50 km altitude LOLA makes 5 parallel profiles, approximately 12 meters apart. With a laser pulse rate of 28 Hz the along track spacing of measurements in each profile is about 56 meters thus providing an along track measurement approximately every 11 meters. Within each 5-meter spot LOLA measures the distance from the spacecraft, the reflectance of the surface at the wavelength of the laser (1064 nm), and the roughness of the surface from the spread of the topography within the spot. During the first year of operation LOLA has obtained 2 billion altimeter observations and enabled the development of global models of lunar topography with north-south resolution of 12 to 20 meters, surface roughness at a scale of 50 meters, zero phase surface reflectance at 1064 nm, and slopes on scales of 25 meters and larger.

The LOLA instrument also has a receive capability for Earth-based laser ranging [2]. Laser pulses from an Earth station are sent to LRO and received by a 2.5 cm passive optical receiver on the high gain antenna and the signal fed passively through a fibre optical bundle to one of the LOLA detectors where its arrival time is "stamped" and from which the one-way range can be derived. Several Earth-based laser tracking stations are making ranging observations to LRO by this method with precisions at the 10 cm level.

Shackleton Crater

Of particular interest are the polar regions of the Moon both for scientific and for potential future landing sites for human and robotic exploration. The Shackleton crater at the south pole of the Moon is a near-circular feature 20 km in diameter and approximately 4 km deep. Because of its location and depth most of the interior of the crater has been in near permanent shadow probably since it was formed. Observations by the LOLA instrument since July 2009 have provided a detailed image of the interior of the crater with spatial resolution of about 20 meters and height resolution of about 1 meter. The sides of the crater are steep, appear to be smooth and exceed 35 degrees in places. The floor of the crater, although relatively flat, has several elevated areas that suggest the possibility of mass wasting. There is no evidence of any impact craters within Shackleton although that cannot be ruled out at this time. Below, is a figure of the Shackleton crater from LOLA altimeter data showing the south pole of the moon on the extreme rim of the crater.

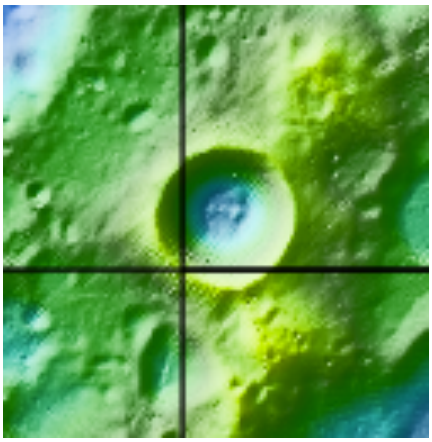

Figure 1: Shackleton crater as seen by LOLA. The floor of the crater is generally in complete darkness except for reflected sunlight from the sun and from Earth.

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References

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