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LUNAR RECONNAISSANCE ORBITER CAMERA: FIRST RESULTS

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Abstract

The Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Cameras (NAC) and Wide Angle Camera (WAC) commenced data collection from lunar orbit on 30 June 2009. The two NACs are monochrome narrow-angle linescan imagers (0.5m/pixel) while WAC is a 7-color push-frame camera (100 and 400 m/pixel visible and UV, respectively). To date (May 2010) LROC has collected over 25 Terabytes of raw data while LRO orbited the Moon over 4000 times.

1. Introduction

LROC [1] addresses two primary LRO measurement requirements and six other key science objectives. 1) Assessment of meter and smaller-scale features to facilitate safety analysis for potential lunar landing. 2) Acquire multi-temporal synoptic 100 m/pixel imaging of the poles to identify regions of permanent shadow and permanent or near-permanent illumination. 3) Meter-scale mapping of regions with permanent or near-permanent illumination of polar massifs. 4) Repeat observations of potential landing sites and elsewhere for the derivation of high resolution topography. 5) Global multispectral observations in seven wavelengths to characterize lunar resources, in particular ilmenite. 6) A global 100-m/pixel basemap with incidence angles (60°-80°) favorable for morphological interpretations. 7) Sub-meter imaging of a variety of geologic units to characterize their physical properties, the variability of the regolith, and other key science questions. 8) Meter-scale coverage overlapping with Apollo-era panoramic images (1-2 m/pixel) to document the number of small impacts since 1971-1972.

LRO was launched 18 June 2009 on an Atlas V 401 rocket from the Cape Canaveral Air Force Station Launch Complex 41. Following a four day Earth-Moon transit, the spacecraft first entered a three month commissioning phase in a 30×200 km orbit. LRO entered a quasi-circular 50-km mapping orbit on 15 September 2009 for a planned one-year nominal mapping mission. Following the conclusion of the nominal mission, a multi-year extended mission in a fixed 30×200 km orbit is possible.

2. Uplink

Typically the WAC acquires data over the whole illuminated portion of each orbit. Additionally, on the night side background (dark) images are acquired as part of inflight calibration. Each NAC image is individually targeted through prioritized requests generated by the LROC team. Priorities are as follows: (1) exploration targets requested by NASA's Project Constellation (Cx) [2], (2) targets that fulfill other LROC Level 1 Requirements, (3) targets that support LROC Science Team objectives, (4) science requests from outside the LRO team, (5) public target requests. Personnel in the LROC Science Operations Center build command loads for the NAC and WAC from the most recent predicted LRO spacecraft ephemeris (received from the LRO Mission Operations Center), and the NAC Target Request Database for upcoming orbits. An operations plan for the 72 hours of normal operations is generated and submitted to the LRO project each day. The NACs can be commanded individually or together, and in normal operating mode acquire images of any length in 1024-line increments up to the full length of 52,224 lines with a maximum of 15 NAC image-pairs of the illuminated surface possible per orbit, for

a maximum daily total of 180 NAC pairs (or 360 images). Each LROC operational plan (3 days) include NAC requests for at least 1000 images. Before NAC images are written to the spacecraft's solid-state data recorder, they are temporarily stored in a 256 MB buffer in each camera. It takes approximately 15 seconds to acquire a full NAC image pair and another 110 seconds to read each image through the Sequence and Compressor System to the LRO solid-state recorder (220 seconds for the pair). It is not possible to obtain another NAC image until the buffer is cleared, so after the collection of each NAC pair there is typically an 11° down-track latitude zone where additional imaging cannot be acquired. In addition to NAC commands for target requests, each 3 day plan also includes systematic mapping commands for the WAC.

3. Downlink

LRO has completed 4,150 orbits of the Moon as of May 20, 2010 (1017 orbits during Commissioning and 3,133 orbits during the mapping phase). LROC has acquired 206,320 images (133,917 NAC and 72,493 WAC), totaling approximately 25 TB of raw data. The first PDS data release of LROC was on 15 March 2010, and included all images from the commissioning and the first 3 months of the mapping phase.

4. Imaging Results

The WAC has imaged the entire Moon in seven wavelengths, several times. A preliminary global WAC stereo-based topographic model is in preparation [3] and global color processing is underway [4]. As the mission progresses repeat global coverage will be obtained as lighting conditions change providing a robust photometric dataset. The NACs are revealing a wealth of morphologic features at the meter scale providing the engineering and science constraints needed to support future lunar exploration. All of the Apollo landing sites have been imaged as well as the majority of robotic landing and impact sites. Through the use of off-nadir slews a collection of stereo pairs is being acquired that enable two-meter scale topographic mapping [5-9]. Impact morphologies (terraces, impact melt, rays, etc) are preserved in exquisite detail at all Copernican craters and are enabling new studies of impact mechanics [10,11]. A surprising number of relatively young (Copernican to Eratosthenian) tectonic features (Fig. 1) have been discovered in the highlands. These include compressional features (lobate scarps) and extensional features (graben). Other topical studies are underway [12-18].

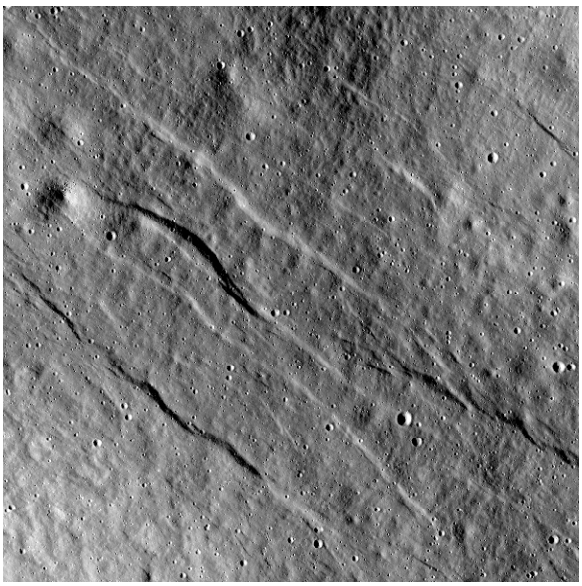

Figure 1. Extensional graben (17°N, 189°E), NAC M118668817RE, image width 300 meters.

Acknowledgements

Collection of LROC data requires dedicated work by team members at the LROC Science Operations Center as well as the LRO Mission Operations Center (MOC), their efforts are greatly appreciated.

References

[1] Robinson et al. (2010), Space Science Reviews, 150: 81–124 [2] Jolliff et al. (2010) 41st LPSC [3] Scholten et al. (2010) 41st LPSC this volume [4] Denevi et al. (2010a) 41st LPSC [5] Beyer et al. (2010) 41st LPSC [6] Archinal et al. (2010) 41st LPSC [7] Mattson et al. (2010) 41st LPSC [8] Tran et al. (2010) 41st LPSC [9] Oberst et al. (2010) 41st LPSC, [10] Bray et al. (2010) 41st LPSC [11] Denevi et al (2010b) 41st LPSC [12] Hiesinger et al. (2010) 41st LPSC [13] Van der Bogert et al. (2010) 41st LPSC [14] Plescia et al. (2010) 41st LPSC [15] Lawrence et al (2010) 41st LPSC [16] Gaddis et al. (2010) 41st LPSC [17] Watters et al (2010) 41st LPSC [18] Garry et al (2010) 41st LPSC.