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Startling Discoveries from the Lunar Reconnaissance Orbiter Camera

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The Lunar Reconnaissance Orbiter (LRO) was originally conceived and launched (June 2009) to acquire measurements necessary to support upcoming NASA crewed missions to the Moon. After the first year of operations the objectives were switched to a science rationale. Five and a half years of observations from the Lunar Reconnaissance Orbiter Camera (LROC) are providing answers to old questions, calling into question currently held beliefs, and raising new questions both in terms of science and exploration issues.

Globally distributed meter scale LROC Narrow Angle Camera (NAC) images revealed a large population of small (and thus young) compressional tectonic scarps that were likely formed as molten portions of the core cooled and transitioned to a solid, resulting in a negative volume change. These features are so young that it is likely that seismic induced faulting and surface deformation occurs in the present era. Sample return and systematic seismic measurements are needed to confirm this discovery.

Lunar volcanism is generally thought to have terminated 1.5 to 1.0 by ago. However, NAC images revealed over 60 occurrences of small (<5 km) young volcanic extrusions with ages proposed to be <100 my, raising the prospect that future extrusive events may occur. If the proposed age of these deposits are confirmed from future sample return missions, thermal history models must be modified to accommodate an extended tail of late stage volcanic episodes.

LROC Wide Angle Camera (WAC) observations led workers to question the current stratigraphic relations of touchstone basin forming events (Imbrium, Serenitatis, Crisium), and thus the body of evidence for the late heavy bombardment. The only way the timing of key basin forming events can be definitively determined is with detailed fieldwork and a host of laboratory measurements on returned documented samples.

Temporal (before/after) NAC imaging is revealing hundreds of changes to the surface in the form of new craters, enigmatic low reflectance dark splotches and landslides. As the mission progresses and more temporal pairs are acquired and analyzed hard constraints on impact hazards and the dynamic nature of the lunar surface will be revealed.

The WAC repeat stereo observations for the whole Moon allowed production of a 100 m pixel scale near-global (80°S to 80°N) elevation model; the most detailed topographic map of the Moon in existence. WAC multi-temporal color observations enabled the first ever set of Hapke parameter maps for any object in the Solar System (one degree scale). From this color dataset a new high-resolution high-precision TiO2 abundance map was derived (70°S to 70°N).

Even though LROC has imaged the Moon more than 1.25 million times, many new observations are needed to complete a global meter scale high/low Sun image database, two m scale topography for key science targets, and temporal monitoring of the surface. Future crewed exploration of the Moon and Solar System requires a focused lunar exploration program to answer key issues being raised by LROC as well as to test feed forward technologies.