NEW LRO INVESTIGATIONS OF VOLCANISM, TECTONISM, AND THE LUNAR INTERIOR

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Introduction: Data from LRO have formed the basis of much of our current understanding of lunar geology. As LRO finishes its fourth extended mission (ESM4), the LRO team is looking toward science objectives and future observations to address within the next five years. Key questions about interior and crustal processes, as well as volcanic and tectonic activities remain. Here we highlight some recent progress and possible objectives that LRO could address with another extended mission. Many objectives might be met using multiple instruments onboard LRO, or through comparison with data from other missions.

Recent and Ongoing Investigations: In ESM4, LRO collected data to investigate landforms with unusual compositions and/or physical properties, including the KREEP basalts of the Apennine Bench Formation that appear to be unique volcanic materials [e.g., 1]. Improved Christiansen Feature (CF) maps from Diviner thermal data and Kaguya near-IR data resulted in some silica-rich locations being recently identified [2]. Also being studied are the non-mare or light-toned massifs of possible silicic volcanism, such as the Lassell massif, among others [e.g., 3-4].

LRO data are also revealing the diversity, volumes, and timing of pyroclastic eruptions [e.g., 5-11]. As more data are collected, knowledge of many relatively small landforms, including ring-moat dome structures, irregular mare patches, and lunar pits, continues to evolve [e.g., 12-14]. Context for samples returned by the Chang'e-5 mission is provided by LRO and will aid detailed analyses [e.g., 15-17]. LRO data are also contributing to the determinations of young mare ages elsewhere [e.g., 18-19], and how the final mare eruptions were distributed and their composition. These and other investigations are revealing the complexity and range of magmatism on the Moon, from primary crust formation to later volcanic eruptions.

In ESM4, LRO also collected data to investigate the relationship of mafic rocks to primary crust formed from the lunar magma ocean [e.g., 20]. Possible exposures of mantle in basins, such as the South-Pole Aitken, are also revealing the Moon's structure [e.g., 21-22]. Likewise, investigations of interior structure, magmatism, and any surface expressions continues to progress, including new insights into the magmatic processes associated with floor-fractured craters, which often host pyroclastic materials [e.g., 23-26]. Other studies include exploring the relationships between basins and later volcanic materials [e.g., 27-30].

Surface expressions of crustal stresses are also being analyzed, including seismic activity some of which might be ongoing, as well as regional extensional stresses related to basins [e.g., 31-34]. These and other investigations making use of LRO data demonstrate the wide-ranging value of collecting a cornerstone dataset, gathered over a decade-plus baseline.

Future Potential: Additional LROC, Diviner, Mini-RF, LOLA, CRaTER, and LAMP observations of compositional anomalies, exposures of primary crust or mantle, silicic exposures, volcanic materials, and tectonic features will aid further investigations into their origins, timing, composition, physical properties, and degradation over time. A fifth extended mission for LRO would span Sept. 2022 to Sept. 2025 and include the planned landings of several Commercial Lunar Payload Services (CLPS) providers as well as the Artemis III South Pole landing. Thus, LRO stands ready to collect new data needed to answer evolving science questions as well as provide additional orbital context for the forthcoming era of lunar exploration.

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