THE LUNAR RECONNAISSANCE ORBITER (LRO) NEXT STEPS IN CONSTRAINING LUNAR POLAR VOLATILES. N. E. Petro, Planetary Geology, Geophysics, and Geochemistry Lab, NASA Goddard Space Flight Center, Greenbelt, MD 20771 (Noah.E.Petro@nasa.gov).

Introduction: With over 9 years of observations of the lunar surface and the environment around the Moon, the Lunar Reconnaissance Orbiter (LRO) has generated an unparalleled dataset for investigating the lunar poles [1, 2]. The suite of LRO instruments have provided a rich set of observations at various wavelengths and probing depths of the regolith, which yields a set of constraints on the presence, abundance, and variability of volatiles at and near the poles [3-5]. As LRO prepares to propose for an extended mission (starting in late 2019), we assess where the mission has been (philosophically, and literally) and look to the future for the science focus of the mission.

Science Focus During the Current Extended Mission: The LRO science teams identified three broad science themes, which build on Decadal-relevant science questions: 1) Volatiles and the Space Environment, 2) Volcanism and Interior Processes, and Impacts and 3) Regolith Evolution. A few examples of the science questions we address during the current extended mission are illustrated in Figure 1.

The **LRO Lunar Cornerstone Mission** will answer fundamental questions about the evolution of our Solar System.

present ↑ TIME (4.56 Ga)	Volatiles & the External Environment	Impacts & Regolith Evolution	Volcanism & Internal Processes
Contemporary Processes	*How does the volatile distribution evolve diurnally and seasonally?*	*Is the current impact rate higher than models suggest?*	*Is radiogenic He episodically released from the Moon's interior?*
Evolutionary Processes	*What is the spatial and depth distribution of polar ice?*	*What is the rate of regolith breakdown?*	*When did volcanism on the Moon cease?*
Fundamental Processes		*What is the chronology of early basin formation?*	*Are the gravity anomalies detected by GRAIL expressed in the Moon's tectonic features?*

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Figure 1. During LRO's CM, the science teams a will address a number of science questions directly related to fundamental Solar System science, which cover processes that have acted over billions of years.

LRO's Orbit Enables Fundamental New Science: LRO has maximized its science return by employing a quasi-stable orbit for more than 6 years, which has minimized fuel consumption. In this configuration, which has LRO with a periapsis over the southern hemisphere (Figure 2), enables focused investigations on the region surrounding the South Pole. Going forward, the LRO mission team is evaluating options for future orbits that will maximize science collection capability for future potential extended missions.

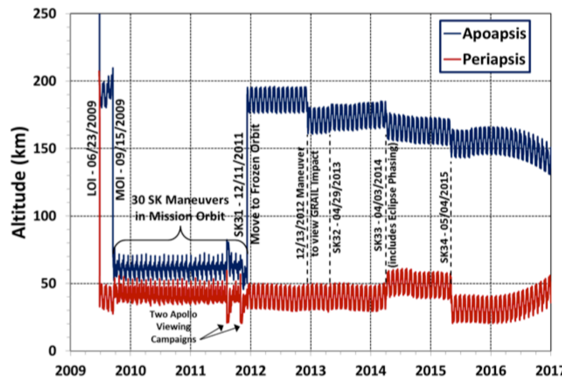

Figure 2. Plot showing the evolution of the LRO orbit since arriving at the Moon in 2009. Since late 2011 LRO has been in a quasi-stable elliptical orbit that allows for a significant reduction in fuel consumption. In this orbit configuration, LRO has made several years' worth of observations over the South Pole.

Future of LRO: The LRO spacecraft has fuel onboard for several more years of observations (~9 additional years), with specific focus of the South Pole. As the LRO orbit evolves, our coverage of the region surrounding the South Pole increases exponentially, allowing for a detailed study of the environment and potential sources/sinks of volatiles there.

References:

[1] Keller, J. W., et al., (2016) *Icarus*, 273, 2-24.
[2] Hayne, P. O., et al., (2015) *Icarus*, 255, 58-69.
[3] Fisher, E. A., et al., (2016) Search for Lunar Volatiles Using the Lunar Orbiter Laser Altimeter and the Diviner Lunar Radiometer, 47, 2574.
[4] Fisher, E. A., et al., (2017) *Icarus*, 292, 74-85.
[5] McClanahan, T. P., et al., (2015) *Icarus*, 255, 88-99.