LUNAR ORIENTALE BASIN: INTEGRATED LUNAR AND PLANETARY EXPLORATION OBJECTIVES. James W. Head, Department of Geological Sciences, Brown University, Providence, RI 02912 USA (james_head@brown.edu).

Introduction: The Orientale basin (Fig 1), due to its relative youth and its near-pristine condition, has historically been viewed as a laboratory for the study of large impact basins [1]. New data from the armada of spacecraft exploring the Moon have provided a firm basis for proposing Orientale as a robotic and human exploration destination that can bring together numerous fields of study in lunar science and help to resolve some of the most fundamental outstanding lunar and planetary evolution problems, as follows:

Impact Basin Formation: What is the nature of the basin-forming process, the origin of the prominent basin rings (Cordillera, Outer and Inner Rook and inner depression) and the major associated units (from the exterior inward, the Hevelius Formation, the Montes Rook Formation and the Maunder Formation). What is the proportion of primary ejecta and local material as a function of increasing range? Is the Maunder Formation properly interpreted as an impact melt sheet, and what are its constituents?

Depth of Sampling and Crustal Stratigraphy: How deep did the Orientale basin sample? What is the fate of the most deeply sampled material? What are the implications for current models of crustal stratigraphy?

Provenance of Highland Breccias: The current range of characteristics of highland breccias can be placed in the context of actual basin deposits, and *in situ* collection can provide a new framework for the highland breccia samples.

Production of Differentiated Rock Suites in Basin Melt Seas: Recent studies suggest that the basin interior depression is the result of a collapsed nested melt cavity that may have left a sea of impact melt at least several kilometers deep [2]. How would such deep melt seas undergo differentiation and what is the range of igneous melt-rock types produced by such differentiation? How do these compare to rocks thought to represent pristine highland magmatic melts.

Volcanism: Sampling and radiometric dating of the sparse basaltic fill in Mare Orientale, Lacus Veris and Autumni, and the dark pyroclastic ring can provide insight into the onset and duration of mare volcanism, and its relationship to the basin-forming event.

Tectonism: What is the origin of the faults around the interior depression and the graben and wrinkle ridges on the Orientale basin interior? Is the interior of the basin still seismically active?

Geophysics and Gravity: What is the three-dimensional structure of the crust and the crust-mantle boundary beneath the Orientale basin, and what are the implications for basin excavation and collapse? What is the explanation of the negative gravity annulus around the positive anomaly beneath the center of Orientale?

Linking Apollo and Luna Sites: Apollo and Luna sample return missions were targeted to a number of basin-related sites at different basins (e.g., Imbrium, Serenitatis, Crisium), and exploration of Orientale at the analogous position of each sample return site can provide context and new insight into the findings there.

Lessons for Planetary Processes: How can exploration of the Orientale basin inform us about other basin-related processes on Mars, Mercury, Venus and early Earth?

Robotic and Human Exploration: The Orientale basin offers an excellent example of how robotic exploration [e.g., geophysical networks, extended (interpolative and extrapolative) rover missions, and sample return missions] can explore a host of major planetary science questions and objectives. As *precursor* missions, these can pave the way for human exploration, during which scientist-astronauts can undertake exploration that humans can best accomplish. Parallel human-robotic partnerships can be designed for this phase. Subsequent robotic *successor* missions can then be dedicated to follow-up questions raised by analysis of samples and data on Earth, and to further extrapolation and interpolation to increase the scientific return for this important data base.

[1] Spudis, P. D. *The Geology of Multi-Ring Basins*. Cambridge Univ. Press, Cambridge, (1993). [2] Head, J. W. *Geophys. Res. Lett.* **37**, doi: 1029/2009GL041790 (2010).

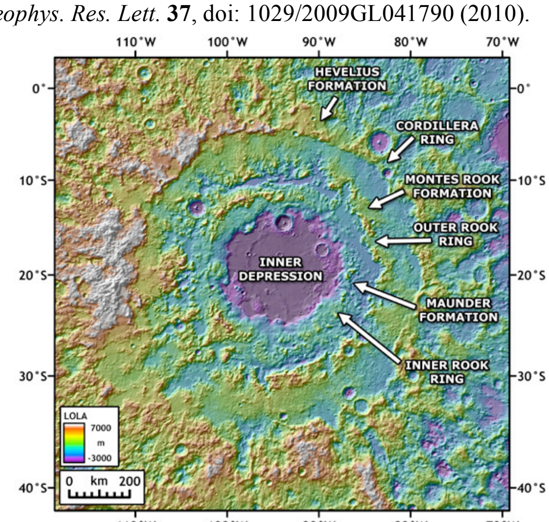

Fig. 1. LRO Lunar Orbiting Laser Altimeter (LOLA) gridded topography map of the Orientale basin.