Paper ID: 12328
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Return to the Moon (02)
Scientific Highlights and Lessons from Recent Lunar Missions (1)

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# THE LUNAR EXPLORATION ROADMAP: INTEGRATING SCIENCE, FEED FORWARD ACTIVITIES, AND SUSTAINABILITY INTO SPACE EXPLORATION

**Abstract**

The Lunar Exploration Roadmap (LER) represents a living document developed by the lunar community via the Lunar Exploration Analysis Group (LEAG). The LER is revisited annually and updated as more data becomes available from current missions, as further analyses by LEAG Specific Action Teams impact the roadmap, and as other relevant analyses (i.e. decadal surveys, reports from other Analysis Groups) are reported. The LER is comprised of three themes. 1) Science: this has a long heritage (e.g., NRC studies) and represents community consensus. The LER shows the intimate enabling relationship between science and exploration. 2) Feed Forward: using the Moon to learn how to go to other airless bodies (i.e., Near Earth Asteroids, the moons of Mars) and also to Mars. 3) Sustainability: this highlights the issues needed to make the next era of human exploration beyond LEO sustainable and long term (even permanent). Overall the roadmap is intended to layout an integrated and sustainable plan for lunar exploration that will allow NASA and other Space Agencies to transition from the Moon to other airless bodies and/or Mars (and beyond) without abandoning lunar assets. The LER illustrates that early identification of "commercial on ramps" will create wealth and jobs to offset the initial investment. It also demonstrates the importance of international cooperation in expanding our scientific and economic spheres of influence while enabling an expansion of human and robotic space exploration. Critical in this endeavor is the development of in situ resource utilization (ISRU) technologies. In 2011, the LEAG roadmapping effort focused on developing an enabling set of robotic precursor missions and technology developments and concluded that these need to be focused on a phased approach to ISRU. Phase 1 builds upon orbital data from and requires prospecting on the ground to define the extent of lunar resources previously identified. The next phase requires the best resource to be mined on a pilot scale before phase 3, which is full resource production and utilization. This analysis recognizes that there is significant value in leveraging the International Space Exploration Coordination Group (ISECG) cooperation strategy for international engagement by identifying a core set of instruments, measurements, and capabilities that should be considered for each step in the strategy. It also finds significant value accrues from engagement with commercial industry at the very beginning and within each phase. The most recent version of the LER can be accessed at the LEAG website: http://www.lpi.usra.edu/leag/ler$_draft.shtml$.