

Lunar Science for Landed Missions Sites Visualized with NASA's Moon Trek Portal

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Abstract

The Lunar Science for Landed Missions Workshop, held in January 2018 at NASA Ames, asked the important question, “Where should we explore next on the Moon?” Representatives from NASA, other international space agencies, commercial exploration companies, and the international lunar science and exploration communities gathered to present and debate the scientific and exploration relevance of a range of potential future lunar landing sites. From this workshop, a list of representative high-value sites was reported. In this presentation, we will present the sites and summarize their individual merits as described in the workshop report. We will augment this with detailed visualizations of each of the sites through the capabilities of NASA's Moon Trek (<https://trek.nasa.gov/moon>) data visualization and analysis portal with the goal of highlighting each site's outstanding geomorphological features along with of the scientific and exploration contexts of each site.

1. Lunar Science for Landed Missions Workshop

On January 10-12, 2018, NASA's Solar System Exploration Research Virtual Institute (SSERVI) and the Lunar Exploration Analysis Group (LEAG) hosted the Lunar Science for Landed Missions workshop at NASA Ames Research Center. Interest in the workshop was broad, with 110 people participating in person and 70 people joining online. This workshop defined a set of targets that near-term landed missions could visit for scientific exploration. The scope of such missions was aimed primarily, but not exclusively, at commercial exploration companies with interests in pursuing ventures on the surface of the Moon. Contributed and invited talks were presented that detailed many high priority

landing site options across the surface of the Moon that would meet scientific goals in a wide variety of areas, including impact cratering processes and dating, volatiles, volcanism, magnetism, geophysics, and astrophysics. Representatives from the Japan Aerospace Exploration Agency and the European Space Agency also presented about international plans for lunar exploration and science. A published workshop report summarizes the set of landing sites and/or investigations that were presented at the workshop that would address high priority science and exploration questions [1].

2. Solar System Treks Overview

The Moon Trek portal is a component of NASA's Solar System Treks Project (SSTP, <https://trek.nasa.gov>). NASA's Solar System Treks program of lunar and planetary mapping and modeling produces a suite of interactive visualization and analysis tools. The project is managed by NASA's Solar System Exploration Research Virtual Institute and developed at NASA's Jet Propulsion Laboratory. These tools enable mission planners, planetary scientists, and engineers to access mapped data products from a wide range of instruments aboard a variety of past and current missions, for a growing number of planetary bodies. While originally initiated for mission planning and science, this technology has demonstrated great benefits for public outreach.

The portals provide easy-to-use tools for browsing, data layering and feature search, including detailed information on the source of each assembled data product. Interactive maps, include the ability to overlay a growing range of data sets including topography, mineralogy, abundance of elements, and geology. They provide analysis tools that facilitate measurement and study of terrain including distance, height, and depth of surface features. They allow

users to easily find and access the geospatial products that are available. Users have the ability to drill down to find the PDS data used to produce the geospatial products. Data products can be viewed in 2D and 3D, and can be stacked and blended together rendering optimal visualization that reveals details that no single data set can show. Data sets can be plotted and compared against each other. In addition to keyboard and mouse control, standard gaming and 3D mouse controllers allow users to maneuver first-person visualizations of flying across planetary surfaces. The portals also provide users the ability to specify any area of terrain for generation of STL/OBJ files that can be sent to 3D printers to make 3D models.

The new Virtual Reality Extension is an exciting addition to the Solar System Treks. Users can draw a path across the surface using the browser interface. A QR code is then generated which is read by the user's smart phone. Placing the phone in an inexpensive set of Google Cardboard-compatible goggles, the user then flies along their specified path in virtual reality.

Along with the web portals, the project supports additional clients, web services, and APIs that facilitate dissemination of planetary data to a range of external applications and venues.

As of abstract submission in May, 2019, six portals were available to the public to explore the Moon, Mars, Vesta, Ceres, Titan and IcyMoons (Saturn's moons Dione, Enceladus, Iapetus, Mimas, Phoebe, Rhea, and Tethys). Two new portals for Ryugu and Bennu are being prepared for initial public release. Additional portals for other bodies are in development and planning stages.

3. Site Descriptions/Visualizations

This presentation will present each of the landing sites highlighted in the workshop report. For each site, we will provide a brief overview of the location's relevance to key science themes as defined in the 2007 National Research Council Scientific Context for the Exploration of the Moon (SCEM), the 2017 LEAG Specific Action Team Report Advancing Science of the Moon (ASM - SAT), which assessed progress made in achieving the science goals laid out in the SCEM), and Vision and Voyages for Planetary Science in the Decade 2013–2022 (Decadal). We will also provide a brief summarization of the location's relevance to exploration themes as defined by the Strategic Knowledge Gaps LEAG - SAT SKG

document available at
<https://www.nasa.gov/exploration/library/skg.html>.

For each site we will then present a Moon Trek visualization of the location taking advantage of Moon Trek's ability to generate high-resolution interactive 3D flyovers of lunar terrain. These combine nadir-pointing imagery from a variety of instruments with digital elevation models allowing us to re-project views from any chosen locations and trajectories.

The goal of this presentation is to share and facilitate appreciation of each site's outstanding geomorphological features along with the scientific and exploration contexts of each site.

Acknowledgements

The authors would like to acknowledge the leadership of SSERVI and LEAG for conducting the Lunar Science for Landed Missions workshop. The authors would also like to thank the Planetary Science Division of NASA's Science Mission Directorate, NASA's SMD Science Engagement and Partnerships, the Advanced Explorations Systems Program of NASA's Human Exploration Operations Directorate, and the Moon to Mars Directorate for their support and guidance in the development of the Solar System Treks.

References

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