

**A PLANETARY DATA SYSTEM ARCHIVE OF LUNAR MAPPING AND MODELING PROGRAM PRODUCTS.** P. A. Garcia and C. E. Isbell (Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, Arizona 86001, pgarcia@usgs.gov).

**Introduction:** NASA's Lunar Mapping and Modeling Program (LMMP) was a Lunar Precursor Robotic Program (LPRP) project tasked in 2006 by the NASA Exploration System Mission Directorate (ESMD) Advanced Capabilities Division to create useful cartographic products, and visualization and analysis tools, from past and more recent lunar datasets. Delivery of these products was planned via the LMMP web portal (<http://lmmp.nasa.gov/>) in support of the Constellation Program (CxP) [1-9] as well as other research and potential lunar exploration activities. Primary LMMP goals included providing high-resolution and cartographically controlled data sets for "...landing site evaluation and selection, design and placement of landers and other stationary assets, design of rovers and other mobile assets, developing terrain-relative navigation capabilities, and assessment and planning of science traverses" [7]. For CxP, 50 sites of high scientific interest (CxP regions of interest or ROIs) were targeted specifically by the Lunar Reconnaissance Orbiter Camera (LROC) to obtain high-resolution stereo image coverage so that intensive characterization of each site could be conducted and the information delivered to waiting exploration and science teams [4-6].

We are now preserving these important LMMP data products and associated documentation within a Planetary Data System (PDS) archive. This effort will both preserve and make more accessible the LMMP data products, including controlled orthomosaics, digital elevation models (DEMs), and derived slope, hillshade, and confidence maps for most of the 50 ROIs.

**Significance of LMMP Data Products:** The LMMP data products are important resources in support of current and future scientific research and exploration activities on the Moon and other Solar System bodies. The 50 ROI sites (details provided at workshop) were identified by a Lunar Exploration Analysis Group (LEAG) special action team [6]. Each ROI had scientific or operational characteristics that warranted its selection as a potential site for future robotic or human landings. These sites remain of high science interest to the international lunar science community. For example, detailed site characterization and analyses of remote sensing data for the ROIs at former Apollo landing sites contribute significantly to our understanding of regional and local hazards [10], positions of artifacts and locations of critical components of the lunar geodetic network [11], geologic and geophysical context of samples [12], effects of topography on remotely observed characteristics [13], communications requirements at landing sites [14], and the physical properties of soils [15].

Additionally, LMMP data products can provide valuable knowledge for future landing site planning, and development of surface operations maps on bodies other than the Moon, including asteroids [16, 17] and satellites such as Phobos and Deimos. Finally, future proposals regarding high-interest sites such as the South Pole-Aitken Basin on the lunar far side [18, 19] would benefit from information contained in LMMP products, including detailed information on the topography, slopes and roughness of the surface, crater size and distributions, boulder populations, and hazard conditions [20].

**The LMMP Data Products:** Several different types of data products were produced for the ROIs under the auspices of the LMMP. Institutions involved in the production of LMMP data products include the U. S. Geological Survey, University of Arizona, Arizona State University, NASA Ames Research Center, and NASA's Jet Propulsion Laboratory. The LMMP data collection includes regional and local visible wavelength image base maps of the Moon derived from Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (~50 cm/pixel), Apollo Metric Camera (~20 m/pixel) and Apollo Panoramic Camera (as high as 1-2 m/pixel) data. These high resolution controlled basemaps are essential for visualization and mapping and modeling activities, including orthorectification of images onto DEM surfaces.

The LMMP collection also includes regional- and local-scale DEMs for most of the 50 ROIs. Topographic models provide visual elevation and slope references for science support and mission planners and crew. In addition to the image base maps and DEMs, the LMMP generated products useful for assessing landing safety and/or hazards at each site, including hillshade, slope, and confidence maps. Because these data products are geodetically controlled, the images and other relevant lunar surface data products allow users to correlate at known levels of accuracy the different types of information contained across the various data products.

**The Archive Plan:** A PDS archive provides public access to both data products and accompanying ancillary support files. Archive content will be compatible with the current PDS4 standards, ensuring the long-term usability and preservation of LMMP products. The total estimated digital volume of the select LMMP data products being archived is approximately 700 GB.

*Data and Metadata Conversion.* All archive products will require descriptive PDS labels. For purposes of developing this archive, labels will be generated by parsing and utilizing existing metadata provided by the

LMMP project. In addition, the LMMP products will require conversion from their existing data formats to PDS4 compliant formats.

*PDS label design and generation.* PDS labels are required for describing the content and format of all data products and ancillary files in an archive. PDS labels are generated so as to identify and fully describe the organization, content, and format of data products, documentation, and accompanying ancillary information.

*Documentation, Metadata, and Ancillary Files.* Supplementary reference materials will be formulated and included with the archive products, as required, to improve their long-term value. These documents augment product labels and provide further information for understanding the data and accompanying materials. The design requirements of the PDS4 data model result in high level documentation and cataloging for all aspects of the archive. This content also provides the mechanism by which these data will ultimately be ingested into the PDS system to enable long-term preservation and integrated search and retrieval capabilities via PDS and other related web services [21].

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*Peer Review.* A peer review will be conducted after completion of the archive to ensure the data and supporting metadata are complete, scientifically useful, and in compliance with PDS standards.

*Data Delivery to the PDS and NSSDCA Deep Archive.* The finalized archive will be ingested into the PDS and a copy will be sent to the NASA Space Science Data Coordinated Archive (NSSDCA) for deep archive and long-term preservation.

**Delivery Schedule:** This two-year project began with data conversion testing and preparation along with initial documentation generation in the first year (2016). Development of final products and full archive population are occurring now in year two. Full access to the complete archive [22, 23] is anticipated for September 2017.

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