

LUNAR MODELING AND MAPPING PROGRAM PRODUCTS – A PLANETARY DATA SYSTEM ARCHIVE. C. E. Isbell, P. A. Garcia, T. M. Hare, B. A. Archinal, L. R. Gaddis (Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, Arizona 86001, cisbell@usgs.gov).

Introduction: NASA's Lunar Modeling and Mapping Program (LMMP) was a Lunar Precursor Robotic Program (LPRP) project tasked in 2006 by the Exploration System Mission Directorate (ESMD) Advanced Capabilities Division to create useful cartographic products and visualization and analysis tools from past and 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 lunar exploration and research activities. LMMP critical 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 delivered to waiting exploration and science teams [4-6] in a timely fashion. Based on these site characterization products, each of the 50 sites was then to be examined as a potential landing site for further intensive exploration by humans as part of the CxP [1].

We now plan to capture these important LMMP data products and associated documentation within a Planetary Data System (PDS) archive. This effort will preserve and make accessible the LMMP data products, including mosaics, digital elevation models (DEMs), and derived slope, hillshade, and confidence maps for the 50 ROIs for future scientific research.

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 (Figure 1) were identified after an extensive process of input and evaluation by the US national lunar science community [6]. Each ROI had scientific or operational characteristics that warranted its selection as a potential site for future robotic or human landings. While human exploration of the Moon may be delayed, 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], position of artifacts and location 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 invaluable knowledge for future landing site planning and development of surface operational 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] would benefit from LMMP products, including detailed information on the topography, slopes and roughness of the surface, crater size and distributions, boulder populations, and hazard and lighting maps [19].

The LMMP Data Collection: Several different types of data products were produced for the ROIs under the auspices of the LMMP. Institutions involved in generation 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 the Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (~50 cm/pixel), Apollo Metric Camera (~20 m/pixel) and Panoramic Cameras (as high as 1-2 m/pixel). These high resolution controlled base maps are essential for visualization and mapping and modeling activities, including "draping" over surface Digital Elevation Models (DEMs).

The LMMP collection also includes regional- and local-scale lunar digital elevation models (DEMs) for almost all 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 for assessing landing safety and/or hazards at each site, including hillshade, slope, and confidence maps. Because the LMMP 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 total estimated digital volume of the LMMP data products to be archived under this proposal is approximately 700 GB.

The Archive Plan: A Planetary Data System (PDS) archive provides public access to both data products and accompanying ancillary support files. All

archived data and supportive ancillary products will be compatible with the new PDS4 standard, an eXtensible Markup Language (XML) based architecture to ensure long-term usability and preservation of LMMP products.

Data and Metadata Conversion. All archive products will require descriptive PDS labels. In this case, a conversion process will involve the generation of related labels by utilizing and parsing existing metadata as provided by the LMMP project. In addition, the existing LMMP products will require conversion from existing data formats to PDS compliant formats.

PDS label design and generation. PDS labels are required for describing content and format of all entities within an archive. PDS labels will be 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 archive products to improve their long-term utility. These documents augment product labels and provide further assistance in understanding the data and accompanying materials.

PDS4 model design requirements result in high level documentation and cataloging for all aspects of the archive. This intentional content provides the mechanism by which the archive will ultimately be ingested within the PDS to enable long term and integrated search and retrieval capabilities via PDS web services.

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

Data Delivery to the PDS and NSSDCA Deep Archive. The finalized archive will be ingested into the PDS along with a copy sent to the National Space Science Data Center Archive (NSSDCA) for deep archive.

Delivery Schedule: This two-year project starts with data conversion testing and preparation along with initial documentation preparation for the first year. Final products and full archive population will occur in year two. Full access to LMMP data and supporting ancillary products is anticipated for September 2017.

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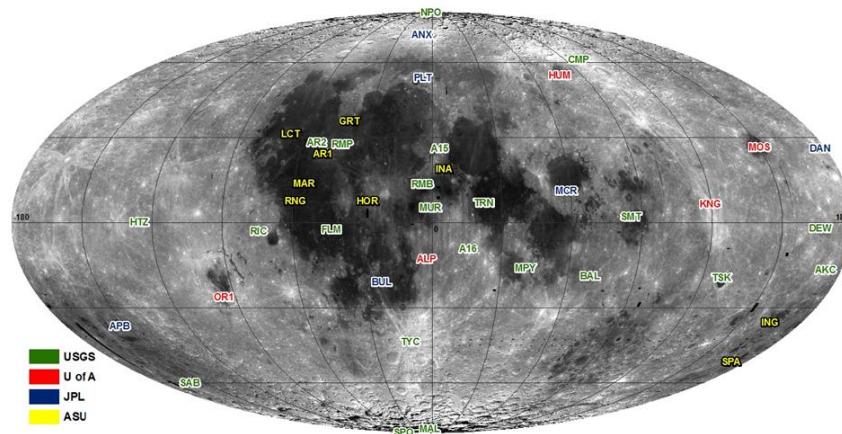


Figure 1: LMMP DEMs and Mosaics local-sites per facility (site name details to be provided at workshop).

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