

PDS ANALYST'S NOTEBOOK FOR MSL AND MER. T. C. Stein¹, R. E. Arvidson², and F. Zhou³, ¹Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, tstein@wustl.edu, ²arvidson@wunder.wustl.edu, ³chow@wunder.wustl.edu.

Introduction: The PDS Analyst's Notebook (<http://an.rsl.wustl.edu>) [1] provides access to science information from several of NASA's landed missions: Mars Science Laboratory [2], Mars Exploration Rover (MER) [3], Mars Phoenix Lander [4], LCROSS, and Lunar Apollo surface mission data archives.

The Analyst's Notebook enriches data archives by integrating sequence information, engineering and science data, observation planning and targeting, and documentation into web-accessible pages to facilitate "mission replay". In this paper, we focus on the Analyst's Notebooks for MSL and MER.

Populating the Notebook: The Analyst's Notebooks for MSL and MER contains data, documentation, and support files for a given mission. During active mission science operations, inputs are incorporated on a daily basis into a science team version of the Notebook. This approach assists with data validation and builds on strong collaboration between data producers and PDS archivists that begins soon after mission selection with creation of the project data management and archive plans.

The public versions of the MSL and MER Analyst's Notebooks are comprised of peer-reviewed, released data and is updated coincident with PDS data releases as defined in mission archive plans. All data and documents have been ITAR cleared.

Data. The Notebooks for MSL and MER contain publicly released, peer-reviewed PDS archives from all science instruments. The data are provided by the instrument teams and are supported by documentation describing data format, content, and calibration.

Both Operations Products Generation Subsystem (OPGS) and Science data products are included in the Notebook. The OPGS versions are generated to support mission planning and operations on a daily basis. They are geared toward researchers working on machine vision and engineering operations. Science versions of observations from some instruments are provided for those interested in radiometric and photometric analyses.

Documents. The MSL and MER Notebooks contain data set and sol (i.e., Mars day) documents. The sol documents are the mission manager and documentarian reports that provide a view into science operations—insight into why and how particular observations were made. The reports have not been edited except for grammar and spelling, and to remove spacecraft and instrument sensitive materials.

Data set documents contain detailed information regarding the mission, spacecraft, instruments, and data

formats, including calibration information and errata when provided by the MSL and MER projects.

Science Plans. Observation planning and targeting information is extracted from each sol's science plan and presented in both timeline and list form. Effort has been made to link source commands with resulting data products, albeit with limits due to the absence of round trip data tracking.

Targets. Objects of interest that have been classified as targets by the science team are included in the MSL Notebook. The location and a finder image for each target are given, as well as a list of additional images of the target when available.

Navigating through the Notebook: With the updated interface in January 2017, the Notebook is transformed into a single-page web application (Fig. 1). Users may switch between sections without losing their selections.

Mission Summaries. A searchable and sortable summary table provides an overview of surface operations by sol. Links enable quick access to details for a given sol.

Sol Summaries. The Sol Summaries are the primary interface to integrated data and documents contained within the Notebook. Data, documents, planned observations, targets and mosaics are grouped for easy scanning. Detailed information is displayed as items are selected by the user.

Data products are displayed in order of acquisition, and are grouped into logical sequences, such as a series of image data. Sequences and the individual products that comprise them may be viewed in detail and downloaded, either directly or as part of a cart order.

Detail data product views vary by instrument. PDS labels, data set documents, and activity details are available for all products. In some cases, derived data also are available. Image data are presented in both browse and full-resolution versions.

Maps. The rover traverse is plotted on a HiRISE basemap using the raw and corrected drive telemetry provided by the project. Users may zoom and pan the map. Clicking on a traverse location brings up links to corresponding data.

Searching. The Notebook supports searches on data products, sol documents, and targets. Data products may be searched by time (sol, spacecraft clock time, and UTC date), location (rover-specific site and position), instrument, command sequence, product type, image eye and filter, product type, and product ID. Sol documents may be searched by type, and time, filename. In

addition, free text searches are supported. Targets may be searched by name, time, and location. Searches can be bookmarked for later recall.

Resources. Data set documents and references to published mission papers are contained in the Resources, along with links to related web resources.

Online Help. Guidance is provided through a series of searchable help pages. Topics include release notes, landing site, coordinate frame, instruments, data processing, and data product file naming and structure.

User Accounts: The public MSL and MER Notebooks allow users to optionally create and use personal accounts for an enhanced experience. Using an account gives the user synchronized history, bookmarks, and cart settings across browsers and machines. User history and bookmarks are for individual use only and are not shared or made public. An account is not required for the cart order function.

Context Mosaics: The PDS data archive for MSL includes mosaics generated by the science team from Navcam data. However, sometimes sequences of single frame images are acquired for the purpose of creating a mosaic without a formal data product being archived. For these cases, we have created mosaics from the single frame images to provide context, and have included them in the MSL AN.

Context mosaics, which are not calibrated science products, are created from Navcam, Mastcam and MAHLI images. Projection information for the context mosaics is available in the EXIF data that are part of the embedded JPG file header with each mosaic.

Image Measurement and Drawing Tools: The Notebook assists users with image analysis via the included Image Viewer. (The Image Viewer is accessed from an image product detail page by choosing Product views > Image viewer from the menu bar.)

Measurement tools provide location and distance measurements for images with stereo coverage from the Hazcam, Navcam, and Pancam instruments. In addition, elevation profiles may be created. Data values are ob-

tained from paired visible and XYZ archive data products generated by science teams.

Drawing tools allow the user to add shapes and text to any single-frame image, regardless of stereo coverage. Supported shapes are lines, arrows, rectangles, ellipses, polygons, and polylines. Text may also be added to images.

All annotations are saved for later use and both measurement data and annotated images may be downloaded.

Additional Features: Features continue to be added to the Notebook to improve usability. The additions are based on feedback from the user community.

Data Ordering via Cart. Data and documents may be ordered using a cart paradigm common to commerce web sites. Selected items may be added to the user's cart in the Sol Summaries and Search portions of the Notebook. Users may elect to receive a zip file of data or display a web page of links to requested items.

Data transformation. In addition to PDS versions of data, images may be saved in JPEG format and in stretched or unstretched, lossless PNG format. This option is available on image product detail pages and may also be applied to all images ordered using the cart.

Future Development: A number of Notebook functions are based on previous user suggestions, and feedback continues to be sought. (User feedback should be submitted to an@wunder.wustl.edu or by using the online form.) Work continues to incorporate additional features, especially in the areas of related observations and visualization, as well as data transformation.

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References: [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414. [2] Grotzinger, J. et al. (2012) Space Science Reviews, 170, 5-56. [3] J.A. Crisp et al, JGR, 108(E12), 8061, doi:10.1029/2002JE002038, 2003. [4] Arvidson, R.E. (2008) JPL Document D-29392.

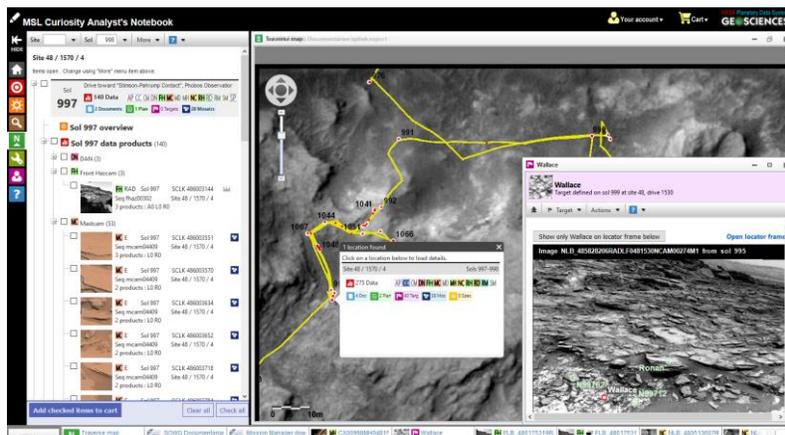


Fig. 1. Example MSL Analyst's Notebook web page.