

PDS ANALYST'S NOTEBOOK FOR CURIOSITY AND PERSEVERANCE ROVERS. T. C. Stein, F. Zhou; McDonnell Center for Space Sciences, Dept. of Earth, Environmental and Planetary Sciences, Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, tstein@wustl.edu, feng.zhou@wustl.edu.

Introduction: The Planetary Data System (PDS) Analyst's Notebook (AN) [1] is a mission discovery tool containing peer-reviewed, publicly available data delivered by the instrument teams to the PDS archive, enhanced by documentation describing operational characteristics, processing methodology, and data formats (an.rsl.wustl.edu). These archive components are enriched by a suite of value-add components, including faceted search, interactive maps, image measurements, sample return science, and daily operations reports, among many others.

Notebooks are accessible for NASA landed missions, including Mars 2020 Perseverance rover, Mars InSight Lander, Mars Science Laboratory Curiosity rover, Mars Exploration Rovers Spirit and Opportunity, Mars Phoenix Lander, and the lunar Apollo and LCROSS missions.

Public AN contents are updated commensurate with PDS archive releases, and its capabilities are regularly reviewed and updated based on feedback from the user community. A Team AN for MSL, with restricted access, is updated daily and provides important input on data representation and mission-specific functionality for AN development. This abstract summarizes the current state of the AN for the MSL and Mars 2020 missions.

Notebook Summary: Content within the AN is organized into sections, mirroring the structure of a physical notebook. These sections are Mission, Sol, Search, Maps, Sample Science (for Mars 2020 only), Resources, User Management, and Help.

Users can customize their experience through a complimentary account, ensuring a synchronized experience across various devices and browsers. This account efficiently manages the user's viewing history, image annotations and measurements, personalized bookmarks, and data orders. The account name and password remain consistent across all Notebooks that support accounts. Data and documents can be ordered using a cart paradigm akin to common e-commerce websites.

Populating the Notebook: New data products, documentation, traverse data, and support files are incorporated daily into the MSL science team's version of the AN. 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 version of the AN contains peer reviewed, released data and is updated coincident with PDS data releases as defined in mission archive

plans. In addition, data provided by the instrument teams and are accompanied by documentation describing data format, content, and calibration.

Data products supporting both operations and science are included in the AN. The operations versions are generated to support daily mission planning and operations. 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. Notebooks contain archive data set documents along with daily (per sol) reports that are not archived. The latter 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, and they are reviewed by science team members prior to release.

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 Mars 2020 projects.

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

Science Targets and Sample Science. Objects of interest that have been classified as targets by the science team are included in the MSL AN. The location and a finder image for each target are given, as well as a list of additional images of the target when available. The Mars 2020 AN is awaiting a planned target archive produced by the science team that remains in preparation.

A Sample Science section is included in the Mars 2020 AN, containing relevant metadata about each collected sample and links to thorough Initial Reports archived by the science team. Pre-release reports are available for some acquired samples, serving as placeholders while the sample dossier is prepared by the science team. Also in preparation, under separate funding from the Mars Sample Return Program, is the Sample Science archive of the Three Forks Depot [2] that will be added to the AN when completed.

Navigating through the Notebook: Users may navigate between AN themed section, described below, and open multiple windows within a single framework.

Mission. Tabular listings provide an overview of surface operations and time conversions by sol. The MSL AN also includes a listing of science targets with quick access links to details for each.

Sol. AN content is grouped by sol and type within this section, allowing users to quickly scan and drill down to specific data, documents, planned observations, targets and mosaics. Detailed information is displayed as items are selected by the user.

Data products are listed 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. Derived data are also linked when available. Images can be viewed full size, showing the location of science targets when known.

Maps. The rover traverse is plotted on a HiRISE basemap with contours using corrected drive telemetry provided by the project. Traverse, science target, and sample science locations can be selected to access corresponding data. Rover telemetry data and maps can be downloaded via the map settings or Resources section.

Searching. The AN offers faceted search on data products, daily reports, 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. Daily reports documents may be searched by type, and time, filename. In addition, free text searches are supported. In the MSL AN, targets may be searched by name, time, and location, as well as for links to APXS, ChemCam, and image data and literature references. Searches can be bookmarked for later recall.

Resources. Data set documents and references to published mission papers, DOIs, and map traverse data 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: Public ANs 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.

Image Measurement and Drawing Tools: The AN assists users with image analysis via the included Image Tool. Measurement tools provide location and distance measurements for images, including mosaics, with stereo coverage from the Hazcam, Navcam, and Mastcam instruments. In addition, elevation profiles may be created. Data values are obtained from paired visible and XYZ archive data products generated by science teams. Measurement data can be downloaded as a spreadsheet or a GIS shapefile.

Drawing tools allow the user to add shapes and text to any 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 when users are logged in, and annotated images may be downloaded.

Data download: Data and documents may be downloaded directly from the AN or ordered using a cart paradigm. 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 and Feedback: AN development in support of Dragonfly Mission surface science and science operations began in late 2023.

Notebook functionality is driven by suggestions from mission teams and the user community, and feedback continues to be sought. User support is available within the AN from the Help section's feedback form, by email to an@wunder.wustl.edu, or using the PDS Geosciences Node forum.

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References: [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414. [2] Christian, J. R., et al. (2024) LPS LV.