

**PDS ANALYST'S NOTEBOOK FOR MARS 2020 PERSEVERANCE ROVER.** T. C. Stein, R. E. Arvidson, F. Zhou, M. Hughes; McDonnell Center for Space Sciences, Dept. of Earth and Planetary Sciences, Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, tstein@wustl.edu, arvidson@wustl.edu, zhou@wustl.edu, mn Hughes@wustl.edu.

**Introduction:** The Planetary Data System (PDS) Analyst's Notebook (AN) [1] for the Mars 2020 Perseverance Rover [2] is an interactive web application containing peer-reviewed, publicly available data delivered by the instrument teams, supported by documentation describing context for the observations, processing methodology, and data formats. The AN for Perseverance ([an.rsl.wustl.edu/m20](https://an.rsl.wustl.edu/m20)) joins the suite of Analyst's Notebooks for NASA landed missions, including Mars InSight Lander, Mars Science Laboratory Curiosity rover, Mars Exploration Rovers Spirit and Opportunity, Mars Phoenix Lander, and the lunar Apollo and LCROSS missions.

**Populating the Notebook:** The Perseverance Analyst's Notebook contents are updated coincident with PDS data releases as defined in mission archive plans. Notebook functionality is enhanced by collaboration between data producers and PDS archivists that begins soon after mission selection with creation of the project data management and archive plans.

**Data.** The Perseverance AN contains, peer-reviewed PDS archives from all science instruments: Mastcam-Z; Mars Environmental Dynamics Analyzer (MEDA); Mars Oxygen ISRU Experiment (MOXIE); Planetary Instrument for X-Ray Lithochemistry (PIXL); Radar Imager for Mars' Subsurface Exploration (RIMFAX); Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals (SHERLOC); and SuperCam. Archives from the engineering cameras (sample cache, hazard avoidance, and navigation) and technology demonstration helicopter also are included.

**Documents.** The Perseverance AN includes data archive documentation and sol-based (i.e., Mars day) documents. The sol documents include the mission lead and documentarian reports that provide a view into science operations—insight into why and how particular observations were acquired. The reports have been edited only for grammar and spelling, and removal of spacecraft and instrument sensitive materials.

Data archive documents contain detailed information regarding the mission, spacecraft, instruments, and data formats, including calibration information and errata provided by the Mars 2020 project.

**Navigating through the Notebook:** The AN content is divided into sections that are modeled after a physical notebook, as described below.

**Mission Summaries.** The mission summary tables provide an overview of surface operations. Information is derived from the mission science and instrument teams reports. The historical overview summarizes Perseverance surface operations with brief entries for each

sol's activity and contains links to the data. In addition, a table of timekeeping values for each sol of surface operations is included. Both tables are sortable and downloadable.

**Sol Summaries.** The Sol Summaries section provides a way to step through surface operations details on a sol-by-sol basis (Figure 1). Data products are arranged 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 shopping cart style order function.

Detailed data product views vary by instrument. DOIs, data set documents, and PDS labels containing metadata about individual observations are available for all products. In some cases, graphs and derived data also are available. Image data may be presented in both browse and full-resolution versions, the latter supported by a custom viewer that supports zoom and pan operations and user-defined annotations.

Within the Sol Summaries, documents from the mission lead and documentarian are viewable, along with a summary of observations for the sol.

**Searching.** The Perseverance AN includes facet-based data search. Data products may be searched by time (sol, spacecraft clock time, and solar longitude), instrument, command sequence, product type, and product ID. Results are updated as filter settings are changed, and searches may be bookmarked for later recall. A keyword- and time-based search is available for sol documents.

**Traverse map.** The rover traverse is plotted on a HiRISE mosaic using locations provided by the mission science team. The map may be panned and zoomed, and map settings may be changed. Clicking on a location in the map links to data products and documents relevant to that position.

**Resources.** Mission and instrument documents are contained in the Resources, along with a list of DOIs for all data sets and links to related web resources.

**Online Help and Support.** Guidance is provided through a series of searchable help pages. Topics include what's new, getting started, using the Notebook, about the missions and data, release notes, and deep dives for power users.

User support is available within the AN from the Help section's feedback form, by email to [an@wunder.wustl.edu](mailto:an@wunder.wustl.edu), or using the PDS Geosciences Node forum linked from the AN help section.

**Additional Features:** Several features have been included as part of the Perseverance AN to enhance the

user experience. Functionality of these features is based on user community feedback, as follows.

**User accounts.** An account is not required to use the Notebook, but using one provides a synchronized experience across machines and browsers. Viewing history, image annotations and measurements, personalized bookmarks, and data orders are maintained between sessions. A user's account name and password are the same for all Notebooks that support accounts.

**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. At checkout, the user specifies whether to receive primary or derived products, sort order, and delivery mechanism. Zip files and a web page of links to requested items are supported outputs.

**Bookmarks.** Users may create a personalized list of favorite data products and documents for later recall using the bookmark function. In addition, custom searches may be saved as bookmarks. User bookmarks are for individual use only and are not shared or made public.

**Known Limitations:** Some features available in Notebooks for other missions are not yet part of the Perseverance AN.

**Lack of image mosaics and radiometrically corrected images.** The mission has not released image mosaics and derived data from the Hazcam and Navcam engineering cameras that are required for the Notebook Image viewer tool measurement functions. We will include these data and enable measurements in the Image viewer tool when they are released.

**Science targets are not available.** Target locations are defined by the science team at a given pixel coordinate within an image. Overwhelmingly, these locator images are the mosaics and radiometrically corrected images that have not been released yet by the mission. Similarly, science sample dossiers with descriptive information about each collected sample have not been released. Targets and sample dossiers will be included in the Notebook when available.

**Limited browse versions of data.** Some data do not show browse versions when previewed in the Notebook. We are working with instrument teams to provide browse versions of non-image data. Despite the lack of browse versions, the archive data are available for discovery and download.

**Future Development:** 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.)

**Acknowledgement:** The Analyst's Notebook is developed through funding provided by the Planetary Data System Geosciences Node. Ongoing cooperation of the Perseverance science and operations teams is greatly appreciated. The Analyst's Notebook is available at [an.rsl.wustl.edu](http://an.rsl.wustl.edu).

#### References:

- [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414.
- [2] Farley, K.A. et al. (2020), doi:10.1007/s11214-020-00762-y.

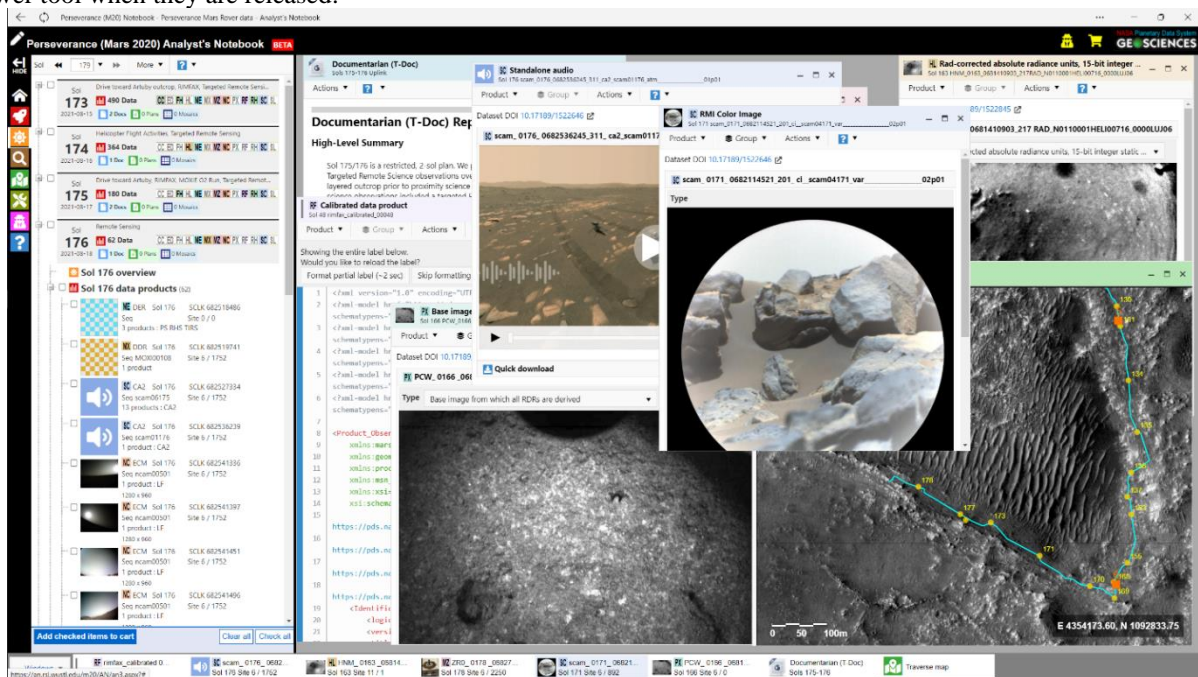


Figure 1. Screen capture of the Mars 2020 Perseverance rover Analyst's Notebook sol summaries section. Several data products are shown as popup windows in the workspace on the right side.