

**PDS ANALYST'S NOTEBOOK: CURIOSITY CHEMCAM RMI MOSAIC AND MARS TARGET ENCYCLOPEDIA INTEGRATION AND INTERFACE UPDATES.** T. C. Stein<sup>1</sup>, R. E. Arvidson<sup>1</sup>, W. Rapin<sup>2</sup>, K. L. Wagstaff<sup>3</sup>, D. Delapp<sup>4</sup>, R. C. Wiens<sup>4</sup>, and O. Gasnault<sup>5</sup>, <sup>1</sup>Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, tstein@wustl.edu, arvidson@wustl.edu, <sup>2</sup>wrapin@caltech.edu, <sup>3</sup>kiri.l.wagstaff@jpl.nasa.gov, <sup>4</sup>ddelapp@lanl.gov, rwiens@lanl.gov, <sup>5</sup>olivier.gasnault@irap.omp.eu.

**Introduction:** The PDS Analyst's Notebooks (AN) [1] for Mars Science Laboratory (MSL) [2] and Mars Exploration Rover (MER) [3] provide integrated access to peer-reviewed, released data delivered by the instrument teams, supported by documentation describing data format, content, and calibration and providing insight into why and how particular observations were made.

New instrument data, documentation, traverse data, and support files are incorporated on a daily basis into the 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 versions of the MSL (Curiosity rover) and MER (Spirit and Opportunity rovers) AN (<http://an.rsl.wustl.edu>) contain peer-reviewed, released data and are updated coincident with PDS data releases as defined in mission archive plans. All data and documents have been ITAR cleared.

Observation planning and targeting information is extracted from mission science plans, including instrument settings and observation parameters. Source commands are linked with resulting data products, albeit with limits due to the absence of round trip data tracking.

In this paper, we focus on integration of Curiosity's ChemCam [4] Remote Micro-Imager (RMI) mosaics and Mars Target Encyclopedia literature references, as well as updates to the AN user interface.

**ChemCam RMI Mosaics:** Although not archive products, RMI mosaics produced by the ChemCam team have been added to the MSL AN. Annotations on the mosaic image denote locations of ChemCam LIBS data elemental abundance acquisition. The RMI image taken after LIBS acquisition is on top to show the laser pits. In addition, some mosaics have accompanying locator images called "contour images" that show the mosaic footprint drawn on a Mastcam image to provide context. Each mosaic is associated with a specific ChemCam target.

Fig.1 shows an RMI mosaic annotated with the locations of 9 LIBS observation points and a contour image with the mosaic location. Each image can be viewed full size in the AN. Users can download a zip file containing all of the pertinent data: mosaic, contour image, PDS labels, and LIBS data for any given mosaic. The

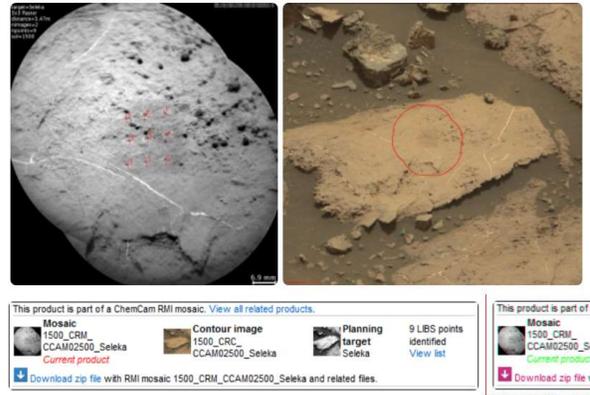


Fig. 1. Sol 1500 ChemCam RMI mosaic showing LIBS data acquisition points (upper left), mosaic footprint (upper right), and Notebook clipping (bottom) with links for viewing and downloading associated RMI and LIBS data.

mosaic image's PDS label includes a mapping for each LIBS location to the SCLK (spacecraft clock) value of the corresponding LIBS data product in the archive.

**Mars Target Encyclopedia Integration into the MSL Notebook:** The Mars Target Encyclopedia (MTE) is a reference database containing compositional information about surface science targets (such as rocks and soils) from the Curiosity mission [5]. The initial set of literature references in the MTE was derived from ~100 abstracts from LPSC 2015 and 2016 abstracts using information extraction methods. These abstracts were chosen based on a keyword search for "ChemCam". Named entity recognition was used to find targets, elements, and minerals within the abstract text. Detected elements, minerals, and targets were further analyzed to determine whether a statement about the geochemical composition of the target was present. Manual review of the extracted relations ensures high quality.

MTE results have been integrated into the MSL AN (Fig. 2) to allow users to find what has been published about targets, elements, or minerals of interest. Literature references can be found in the AN using the Target search. For example, one might go to Search > Targets and then choose an Element such as "Fluorine". Search results include targets that contain fluorine, based on the set of published abstracts. Once a target is selected from the result list, a link to references will appear on the target detail page. Each reference includes the document lead author, year, title, and publication. Links to the source documents (PDFs) are included as well. A "Men-

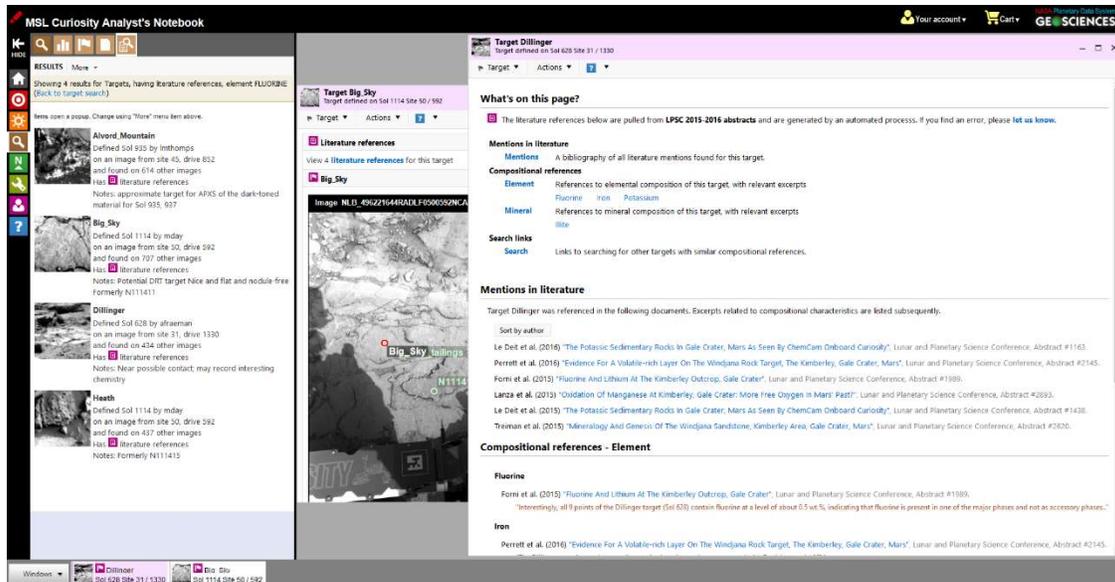


Fig. 2. Example MSL Analyst's Notebook web application view with results from a literature reference search (left side). Detail views of two targets (right side) show target overview and literature reference examples.

tions in literature" list contains all identified references in bibliography form, both compositional references and simple mentions within the text. A "Compositional references" list includes the abstract reference along with excerpts from the text.

**Interface Updates to the MER and MSL AN:** The Analyst's Notebook interface is regularly updated to improve the user experience, with features often added based on user requests. Users now can get 0% or 2% stretched quicklook PNG versions of images that are ordered via the cart system by ticking the appropriate choices in the image settings (available in User > Settings and during the cart checkout process).

Data, document, and target search forms now include a drop down menu with the user's 10 most recent searches. Selecting a recent search repopulates the form with parameter values from that search, allowing the user to make final tweaks to the search before continuing. In addition, search help has been updated, and search results now includes the count of found items.

A history of a user's Notebook activity is maintained to give the user quick access to previous actions, even between sessions and when using other devices (e.g., switching between work and home computers). A user's history is private and is not seen by other users. It is accessed from the User tab. The history list can be filtered to show only specific items (such as targets or documents) or data from a specific instrument (Fig. 3). In addition, users can perform more complex filtering and cull the saved history items by selecting Manage History from the Options drop down.

**Future Development:** Work continues to incorporate additional features, including data transformation

and improved data searches. User feedback should be submitted to [an@wunder.wustl.edu](mailto:an@wunder.wustl.edu) or by using the online form. The MTE will expand to include information extracted from other venues and journal publications.

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**References:** [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414. [2] Grotzinger, J. et al. (2012) doi:10.1007/s11214-012-9892-2. [3] J.A. Crisp, et al. (2003) doi: 10.1029/2002JE002038. [4] Wiens, R.C. et al. (2012) doi:10.1007/s11214-012-9902-4. [5] Wagstaff, K.L. et al. (2018) IAAI-1

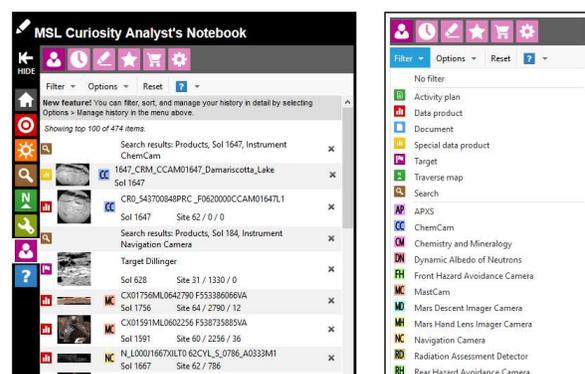


Fig. 3. Notebook clipping showing user history (left) and the options for filtering the history list (right).