MSL ANALYST'S NOTEBOOK: CURIOSITY APXS CONCENTRATION DATA INTEGRATION AND MARS TARGET ENCYCLOPEDIA AND INTERFACE UPDATES. T. C. Stein[1], R. E. Arvidson[1], S.J. Van Bommel[1], K. L. Wagstaff[2], F. Zhou[1], [1]Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, tstein@wustl.edu, arvidson@wustl.edu, vanbommel@wustl.edu, zhou@wustl.edu, [2]Jet Propulsion Laboratory, California Institute of Technology, kiri.l.wagstaff@jpl.nasa.gov.

Introduction: The PDS Analyst's Notebook (AN) [1] for the Mars Science Laboratory (MSL) Curiosity rover [2] provides integrated access to peer-reviewed, released data delivered by the instrument teams, supported by documentation describing context for the observations, together with processing methodology and data formats.

New data products, documentation, traverse data, and support files are incorporated daily 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 version of the AN (http://an.rsl.wustl.edu) contains peer-reviewed, released data and is updated coincident with PDS data releases as defined in mission archive plans. All content has been ITAR cleared.

Observation planning and targeting information is extracted from mission science plans. Source commands are linked with resulting data products where possible, albeit with limits due to the absence of round-trip data tracking.

In this paper, we focus on integration of chemical concentration results derived from archive data by the MSL Alpha Particle X-ray Spectrometer (APXS) [3] team, as well as updates to Mars Target Encyclopedia literature references and the AN user interface.

APXS concentration data: Chemical concentration results derived from archived data by the MSL APXS team have been added to the AN. Each composition is associated with a specific target (i.e., a soil or rock labeled by the science team).

The APXS determines the bulk chemistry of targets on Mars through the complementary use of particle-induced X-ray emission and X-ray fluorescence. The spectrum obtained from interrogation of a target is analyzed using an empirical peak-fitting routine following the proven Mars Exploration Rover APXS method [4].

When placed in contact with a target, the APXS results represent the composition from a circular field of view (FOV) of 15 mm in diameter, increasing with standoff (the distance between a contact-sensing plate on the APXS and its intended target). The center of the Mars Hand Lens Imager (MAHLI) images of APXS targets is not always aligned with the center of the APXS FOV, even when commanded to the same spot. Users interpreting APXS data along with the associated target

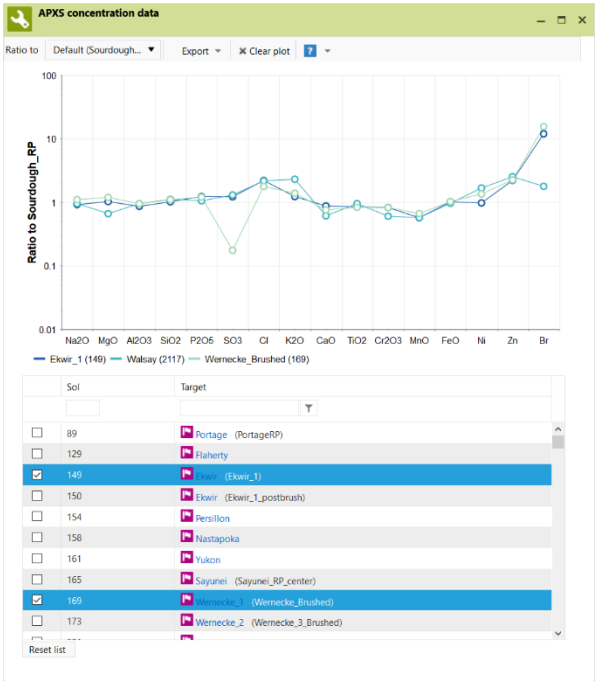

Fig. 1. MSL AN interactive data viewer for APXS concentration data. In this example, data from three targets are plotted against Sourdough_RP (a soil target). The plot and data may be exported.

image(s) should thus exercise caution when inferring the footprint of an APXS measurement. APXS placement has been observed to vary by up to (and possibly exceeding) 50% of the width of the APXS FOV compared to the planned target location or center of the MAHLI image [5].

Data quality: The quality of some APXS measurements is reduced as a result of less-than-ideal measurement conditions or configurations. Measurements under one hour in duration, with a large (>2 cm) standoff, or with warm temperatures (resulting in a FWHM at 6.4 keV of >175 eV) are not included in the AN but are available from the PDS Geosciences Node (in the MSL APXS RDR "extras" data holdings).

Accessing the data: All APXS concentration data in the AN can be accessed from the Resources tab by clicking on the APXS concentration data link. A window will open with an empty chart and a list of APXS targets (Fig. 1). Users can select up to six targets to plot using the check boxes in the target list. Clicking on a target name in the list will open the detail page of the target. Error bars are displayed when plotting a single

target only. The list of APXS targets can be sorted and searched. Users can download the data as a CSV file for the current plot or obtain the set of all APXS concentration data directly using the Export dropdown in the chart menu.

The Notebook target search can be used to find APXS concentration data associated with a specific target. The search can be refined by specifying a sol range or entering a target name. Upon selecting a target from the results list, details about the target and a link to the concentration data will appear.

Viewing and exporting the data: When viewing plotted APXS concentration data, the chart displays a ratio of selected target compositions to that of a target specified by the user. A typical Mars soil composition, represented by the target Sourdough_RP, is utilized by default. Data can be plotted against any other APXS target composition using the drop-down menu in the toolbar. Both the chart and the concentration data can be exported using the chart menu. The chart can be saved as a PNG or PDF file.

APXS concentration files output from the AN comprise a series of comma separated values, with one row for each target. The data columns are labeled with an appropriate header row and include target name, integration time, and measurement temperature in addition to the chemical compositions of each target listed. Details are provided in the AN online help.

Mars Target Encyclopedia Integration into the MSL Notebook: The Mars Target Encyclopedia (MTE) is a reference database containing compositional information about MSL ChemCam targets extracted from publications [6]. The initial set of literature references in the MTE has been updated and now includes references from nearly 6,000 abstracts from LPSC 2014-2016. Named entity recognition was used to find targets, elements, and minerals within the abstract text, and a machine learning model determined whether a statement about the geochemical composition of the target was present. Manual review of the extracted relations ensured high quality.

MTE results have been integrated into the MSL AN 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. Once a target is selected from the results 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 "Mentions 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.

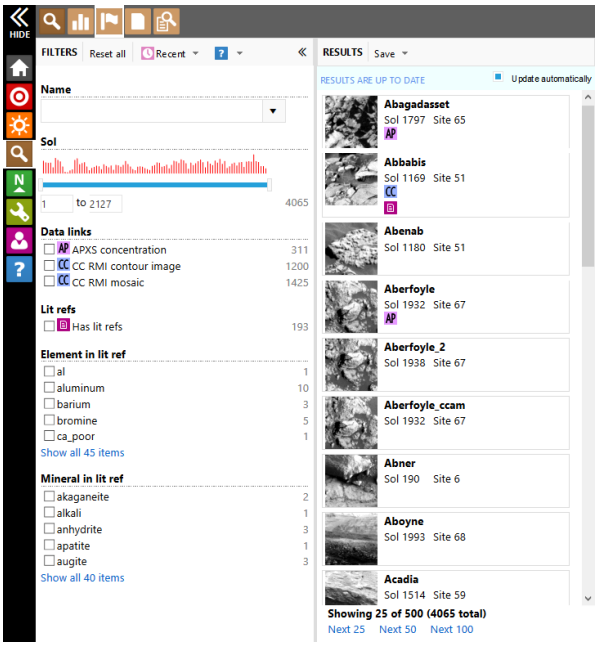

Fig. 2. Target search in the MSL AN. Search results are updated as filters are set by the user. Details are available by clicking on a target of interest.

Interface Updates to the MSL AN: The AN interface is regularly updated to improve the user experience, with features often added based on user requests. The MSL AN now offers faceted target search with results that are updated as the user selects filter values (Fig. 2). Users can search targets by name; sol; presence of APXS concentration data and ChemCam RMI mosaics; and literature references, including specific elements and minerals.

Future Development: Work continues to incorporate additional features, including data transformation and improved data searches. User feedback can be submitted to an@wunder.wustl.edu or by using the online form. The MTE will expand to include information extracted from other venues and journal publications.

Acknowledgement: The Analyst's Notebook is developed through funding provided by the Planetary Data System Geosciences Node. Ongoing cooperation of the MSL and MER science and operations teams is greatly appreciated. Mars Target Encyclopedia work was funded by the JPL AMMOS program, the PDS, and the MSL mission.

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] Gellert, R. et al. (2015) doi:10.2113/gselements.11.1.39. [4] Gellert, R. et al. (2006) doi:10.1029/2005JE002555. [5] VanBommel, S.J. et al. (2016) doi:10.1002/xrs.2681. [6] Wagstaff, K.L. et al. (2018) IAAI-18.