THE PDS MSL ANALYST'S NOTEBOOK MAP TOOL. Feng Zhou[1], Thomas C. Stein[1], and Paul K. Byrne[1], [1]McDonnell Center for the Space Sciences, Department of Earth and Planetary Sciences, Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, MO 63130, feng.zhou@wustl.edu

Introduction: The PDS Analyst's Notebook (an.rsl.wustl.edu) [1] provides access to science information from several of NASA's landed missions: Mars 2020 [2], the InSight Mars Lander [3], Mars Science Laboratory (MSL) [4], Mars Exploration Rover (MER) [5], Mars Phoenix Lander [6], LCROSS, and Lunar Apollo surface mission data archives.

The Analyst's Notebook (AN) includes 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. In this abstract, we focus on the Map tool of the Analyst's Notebooks for the MSL Curiosity Rover.

Map Tool Overview: The MSL AN Map tool shows the rover's movement over time in the context of the broader area of operations. Waypoint locations and the drive traverse are plotted on a basemap that can be panned and zoomed by the user. A new feature of the Map tool is the inclusion of science target locations on the map. Locations are linked to data products, and the visual appearance of the map can be controlled by the user.

Preparing the Map: The map is composed of multiple layers: a HiRISE basemap, a digital elevation model (DEM) and contour layer, rover waypoints and traverse, and the science targets layer. All layers are published as map services with ArcGIS Server. The map is updated with data provided by the mission science team, coincident with PDS data releases as defined in mission archive plans.

Basemap, DEM, and Contour Overlay. The basemap and DEM layers are derived from MSL science team-produced data available from the PDS Image Annex (Mars MSL Gale merged orthophoto mosaic and DEM [7]). The basemap covers the extent from 137.33°E to 137.45°E and from 4.57°S to 4.80°S. The DEM is clipped to the same extent. The contour overlay with elevation intervals ranging from 2 to 50 meters is derived from the DEM using the ArcGIS 3D analyst tool.

Waypoints and Traverse. The Map tool uses interpolated locations from the Position Localization and Attitude Correction Estimate Storage (PLACES) Archive [8] as source data for waypoints and the drive traverse. Location points are categorized into several levels: Site points, Sol points, Autonav points, and all other points. Site points denote where the rover motion counter was incremented to a new site number. Sol points are labeled where the rover stops driving on a given sol (i.e., a Mars day). Autonav points represent the locations where the rover acquired data during a drive. The remaining points are locations where the rover stopped but instrument data were not acquired. The rover traverse is the line connecting all points, showing the general path of the rover.

Science Targets. The MSL AN includes targets defined by the science team as part of the planning process. Target definitions are provided by the team and include XYZ-locations in local level frame (one of three primary MSL operations coordinate frames, with the other two being site frame and rover navigation frame as described in the PLACES data product SIS [8]) as well as each target's pixel location on finder images. For each target, we compute its location in site frame using a coordinate frame conversion based on the site/drive number at which the target is defined. Then, the target location is converted to map coordinates.

Map Tool Navigation: The Map tool is accessed in the AN via the Map tool button (Figure 1). When opened, the Map tool appears as a location panel (Figure 1, left) and resizable map window (right) with rover waypoints, drive traverse, and contour lines displayed on a HiRISE color basemap. The bottom of the map shows a scale bar and the current map coordinates, which are updated as the user's mouse moves across the map. An overview map is displayed at the top right corner. Buttons in the map's top left corner can be used to adjust the zoom level, reset the map, access map settings, and identify waypoints and targets. The user also can control the map position and zoom level with a mouse. In addition, dropdown selectors in the location panel can be used to reposition the map to a given location based on sol or site.

The map is scale dependent, with finer detail displayed as the map is zoomed in. Contour lines are automatically adjusted as the map is zoomed.

Identify Features. Plotted waypoints can be selected to access popups that show a summary of related information such as data, documents, and targets. When clicking on a popup summary, detailed results will appear in the Location panel to the left. Likewise, science targets can be selected (Figure 2) and the resulting popup summary contains links to complete target information.

Map settings. Figure 2 shows the map display-setting panel once it is toggled. A checkbox before each layer is used to turn on/off the layer. The setting icon on the right expands the setting options for the layer. As shown in Figure 2, for the Sol locations layer, a user can

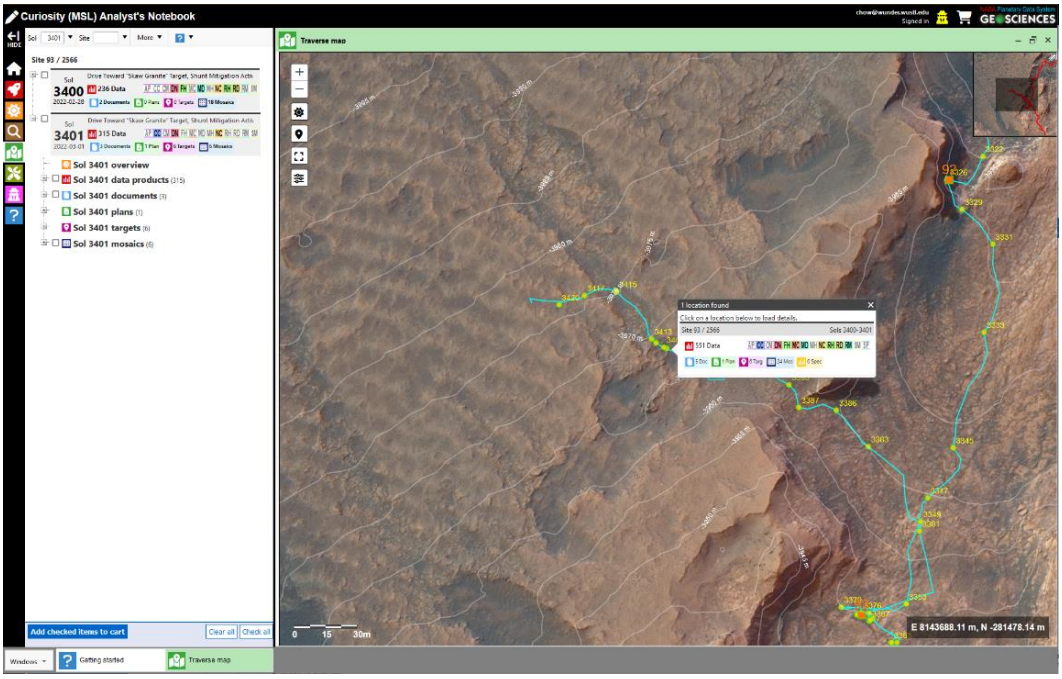

Figure 1. Screen capture of the MSL AN. The Map tool is selected by clicking on the green icon on the far-left column. Visible are the location panel (left) and map window (right). In this example, sol 3401 has been selected from the location panel dropdown and a resulting data summary popup is shown on the map. By clicking on the data summary, details from the location are shown within the location panel.

change the symbol size, type, and outline color and width; the fill-in color and opacity; the labeling text color and size; and the alignment by selecting a value from the dropdowns. These settings options also apply to the Site locations, the Science Target layer, as well as the Autonav points layer (except the Autonav layer does not have labels). For the basemap and DEM layers, only the opacity can be changed. For traverse layer, the user can change the line's color, width, and dash style.

Online Help. Traverse Map help is provided if the question mark icon on the top menu bar in Figure 1 is clicked.

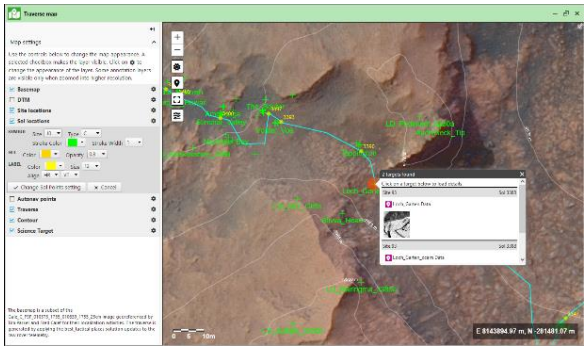

Figure 2. Screen capture of the MSL AN Map tool with the settings panel shown on the left. In the map (right), a popup shows science targets defined at a given location.

Future Development: Work continues to improve the map tool, such as saving a user's map settings for recall during a subsequent session. Relevant MSL AN Map tool features will be implemented in the MER and Mars 2020 Notebooks. The Mars 2020 AN Map tool will include sample science, and targets will be added when available from the science team. Notebook functions are based on previous user suggestions, and feedback continues to be sought. We encourage users to provide feedback via an@wunder.wustl.edu or by using the feedback form on the AN help tab.

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

References: [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414. [2] doi:10.1007/s11214-020-00762-y. [3] doi:10.1038/s41561-020-0544-y. [4] doi:10.1007/s11214-012-9892-2. [5] doi:10.1126/science.1106171. [6] doi:10.1029/ 2002JE002038. [7] Calef III, F. J., & Parker, T. (2016). MSL Gale Merged Orthophoto Mosaic. PDS Annex, U.S. Geological Survey. http://bit.ly/MSL_Basemap. [8] doi:10.17189/1520397.