

Data Visualization with the PDS Analyst's Notebook Image Viewer

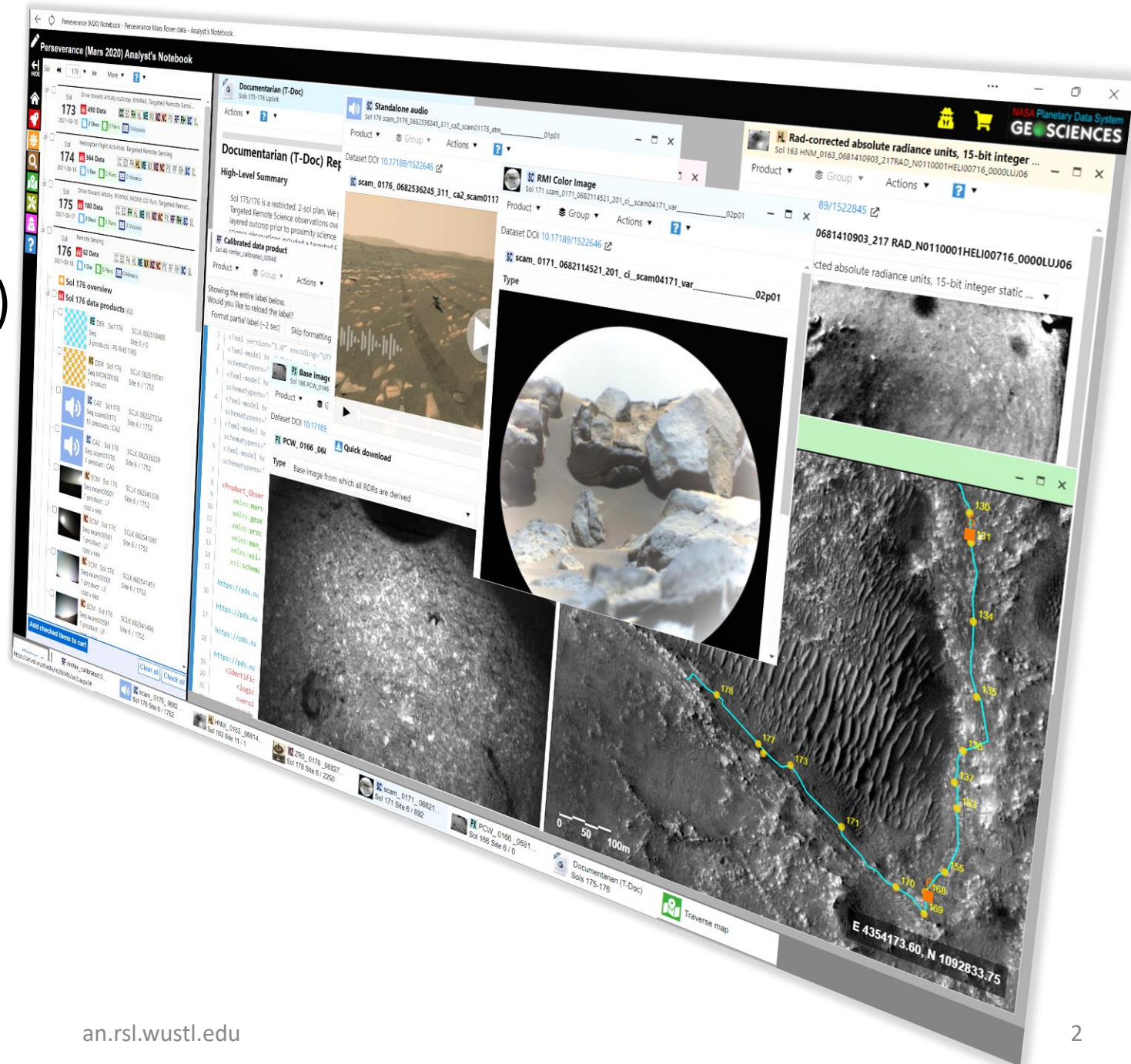
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Analyst's Notebook

The Planetary Data System (PDS) Analyst's Notebook (AN) is an interactive web application containing peer-reviewed, publicly available data delivered by the instrument teams from NASA's landed missions to Mars and Earth's Moon, supported by documentation describing context for the observations, processing methodology, and data formats.



AN Image viewer

- The Image viewer supports data visualization of archive images.
- Available for
 - Mars 2020 Perseverance rover
 - MSL Curiosity rover
 - MER Spirit and Opportunity rovers
 - InSight lander.

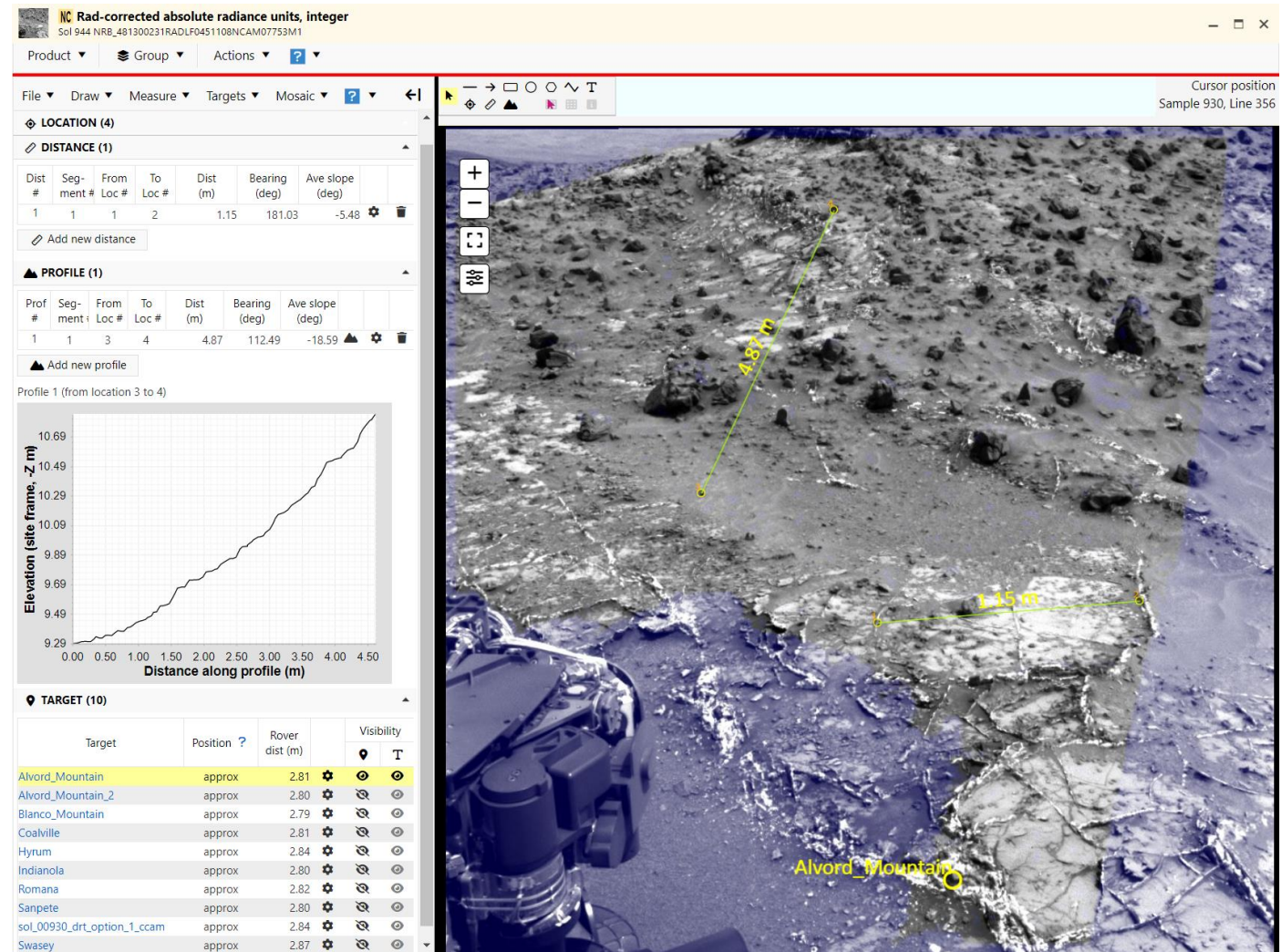


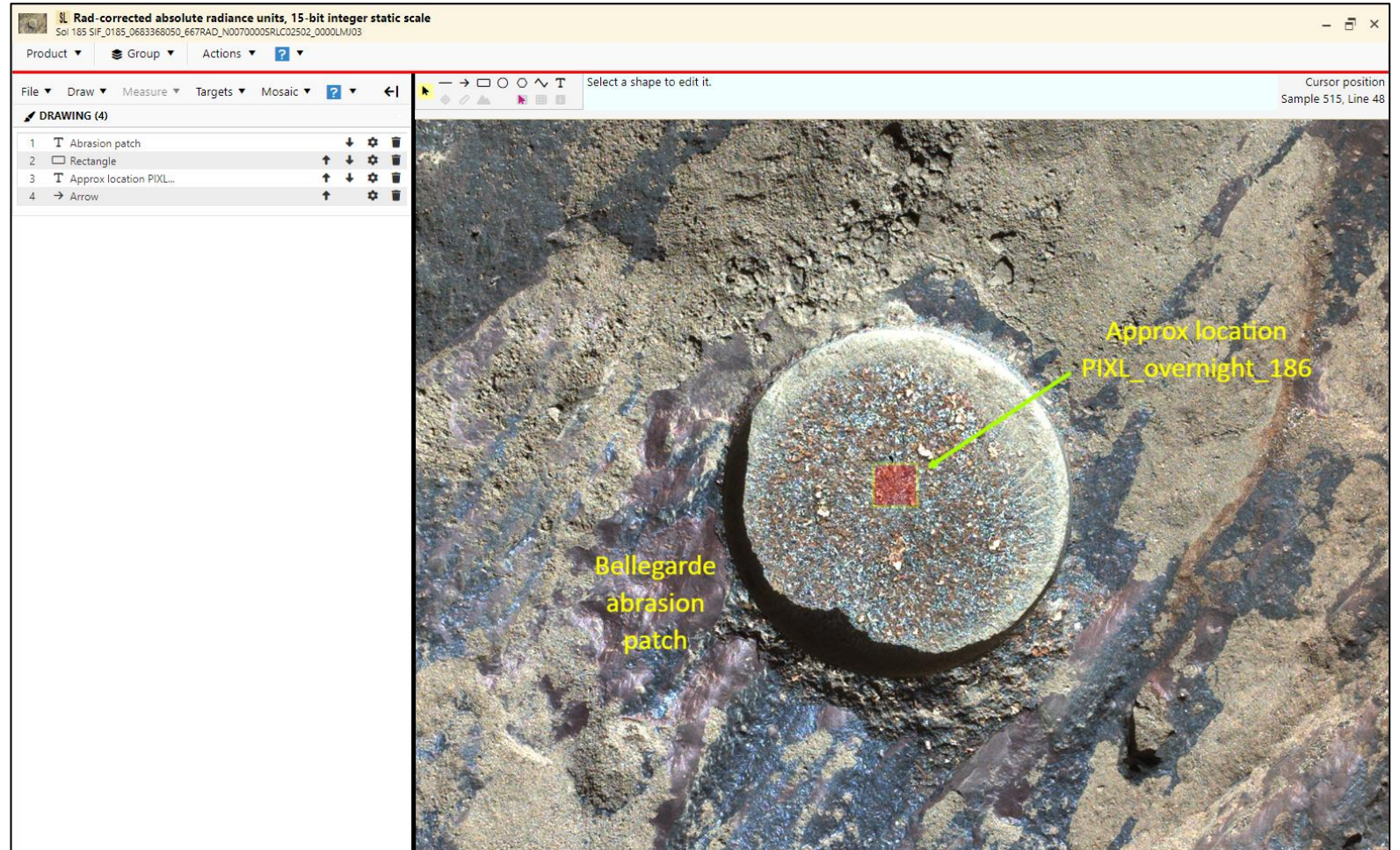
Image Viewer screen capture from the Opportunity Notebook.

Capabilities

Capability	Applies to...
Pan and zoom	All images
Drawing	All images
Location and measurement	Single frame images from stereo pairs with associated XYZ data <ul style="list-style-type: none">• MER: Hazcam, Navcam, and Pancam• MSL: Hazcam and Navcam• Mars 2020: in development (first XYZ data released 22 March 2022)• Phoenix: in development as part of PHX AN update
	Mosaics with stereo sources <ul style="list-style-type: none">• Most MER and MSL Navcam mosaics
Show science targets	MER and MSL single frame images where target locations are identified
Export annotated image	All images
Export location data	All images with associated XYZ data

Drawing tools

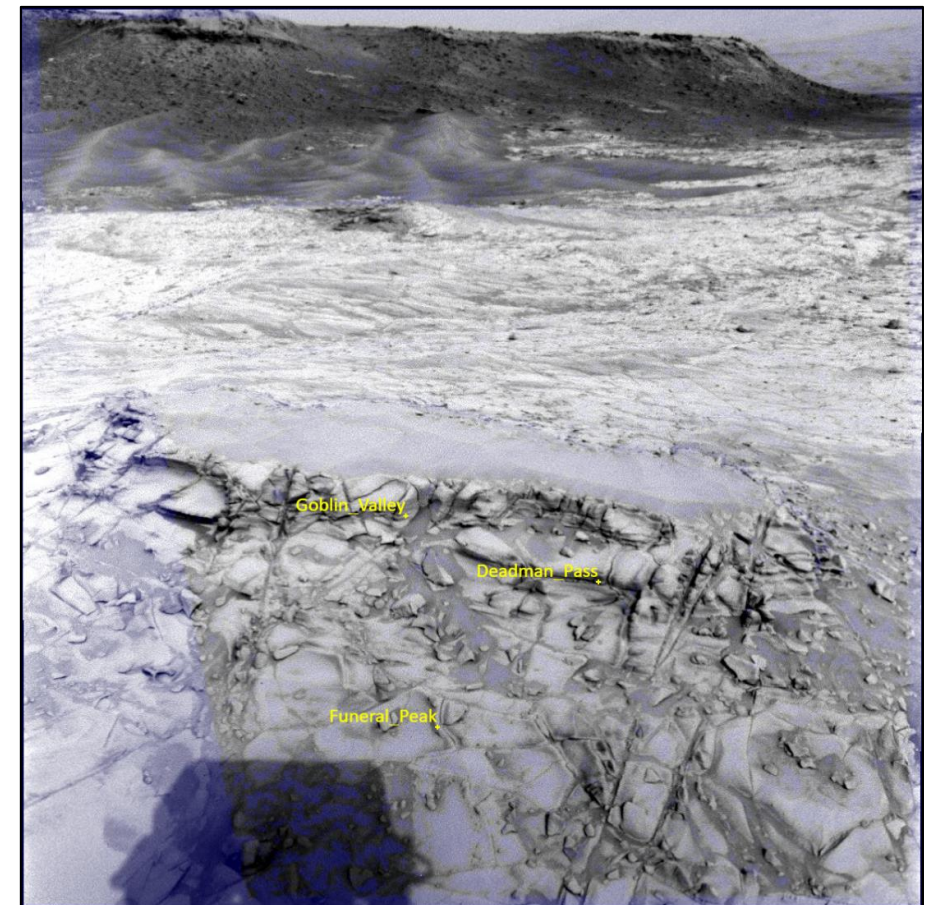
- Seven tools for image annotation: line, arrow, rectangle, ellipse, polygon, polyline, and text.
- Shapes can be modified:
 - Location and size
 - Style (e.g., color, line width, opacity)
 - Drawing order.



Location tool

- Define a location by clicking on the image. Image location determined using associated XYZ archive data product.
- Exclusion zones occur where no left/right image overlap exists and where image contrast is insufficient for automated stereo processing to match features.
- Location information includes:
 - Image pixel coordinate
 - Ground location in local, rover, or site frame
 - Distance from rover frame origin
 - Azimuth and elevation relative to head frame.

*Top: exclusion zones are highlighted in purple.
Bottom: sample table of selected locations from Image Viewer.*



LOCATION (4)										
Coordinate frame		Site								
Loc #	Pixel		Location (m)			Rover dist (m)	Az (deg)	El (deg)		
	i	j	x	y	z					
1	746	661	-195.23	2.79	-21.85	1.97	221.20	-49.22	⚙️	🗑️
2	677	603	-195.37	2.84	-21.88	2.00	216.21	-47.29	⚙️	🗑️
3	948	287	-195.74	1.95	-22.08	2.98	228.22	-31.29	⚙️	🗑️
4	823	251	-195.97	2.09	-22.06	2.98	222.01	-30.96	⚙️	🗑️

Location tool

- Find a location from known coordinates
 - Provide (x, y) or (x, y, z) values in Site, Rover, or Local frame.
 - Provide map coordinates as easting and northing.
- The nearest position, if present, will be added to the location list.

Find location

Enter location in:

E m

N m

Z



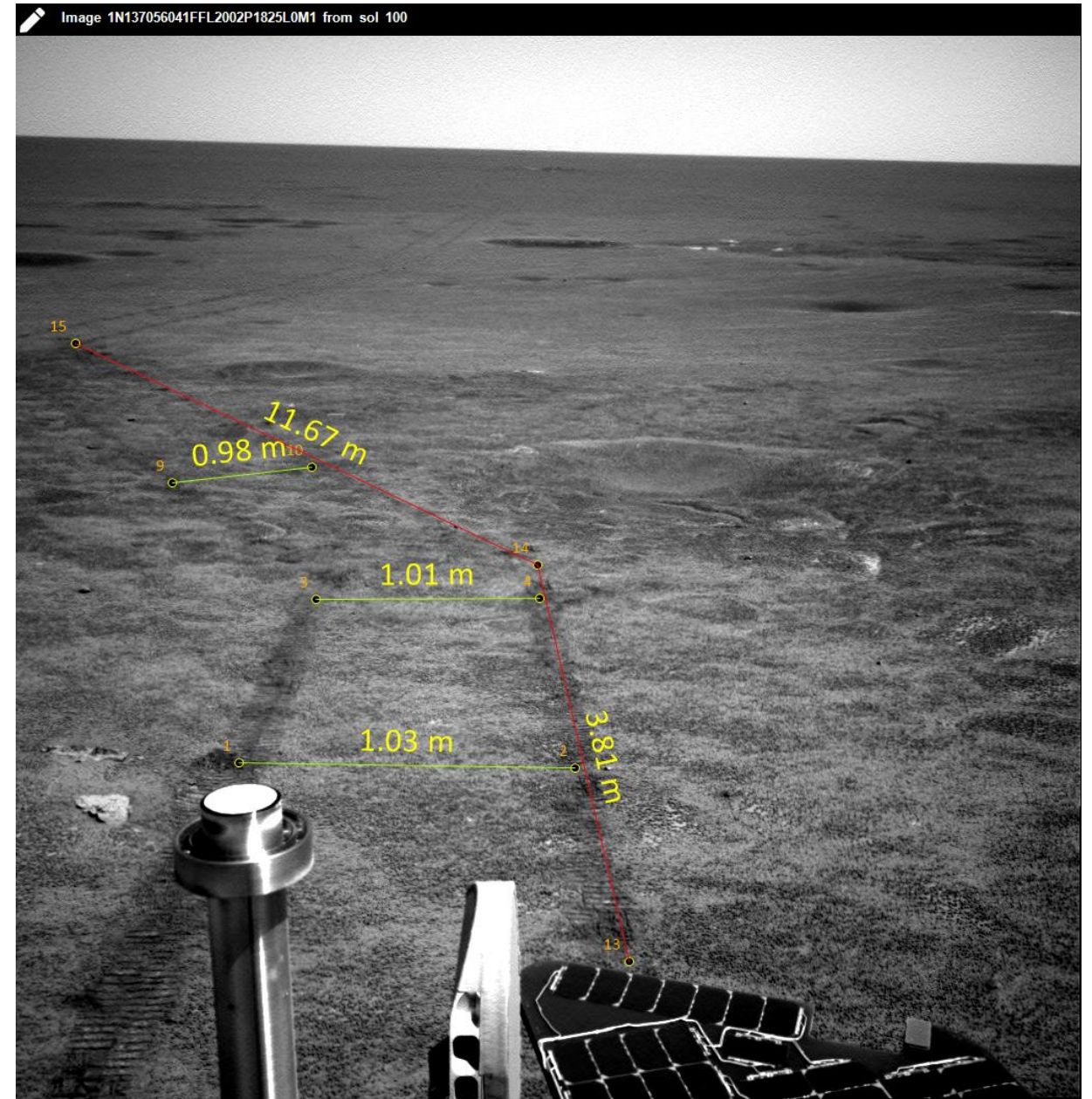
Find location result

Desired location		Found location	
X	-46.97 m	X	-46.97 m
Y	70.00 m	Y	70.00 m
Z	--	Z	-9.10 m
		Δ	0.00 m

*Top: desired map location entered by user.
Bottom: location found by Image Viewer.*

Distance tool

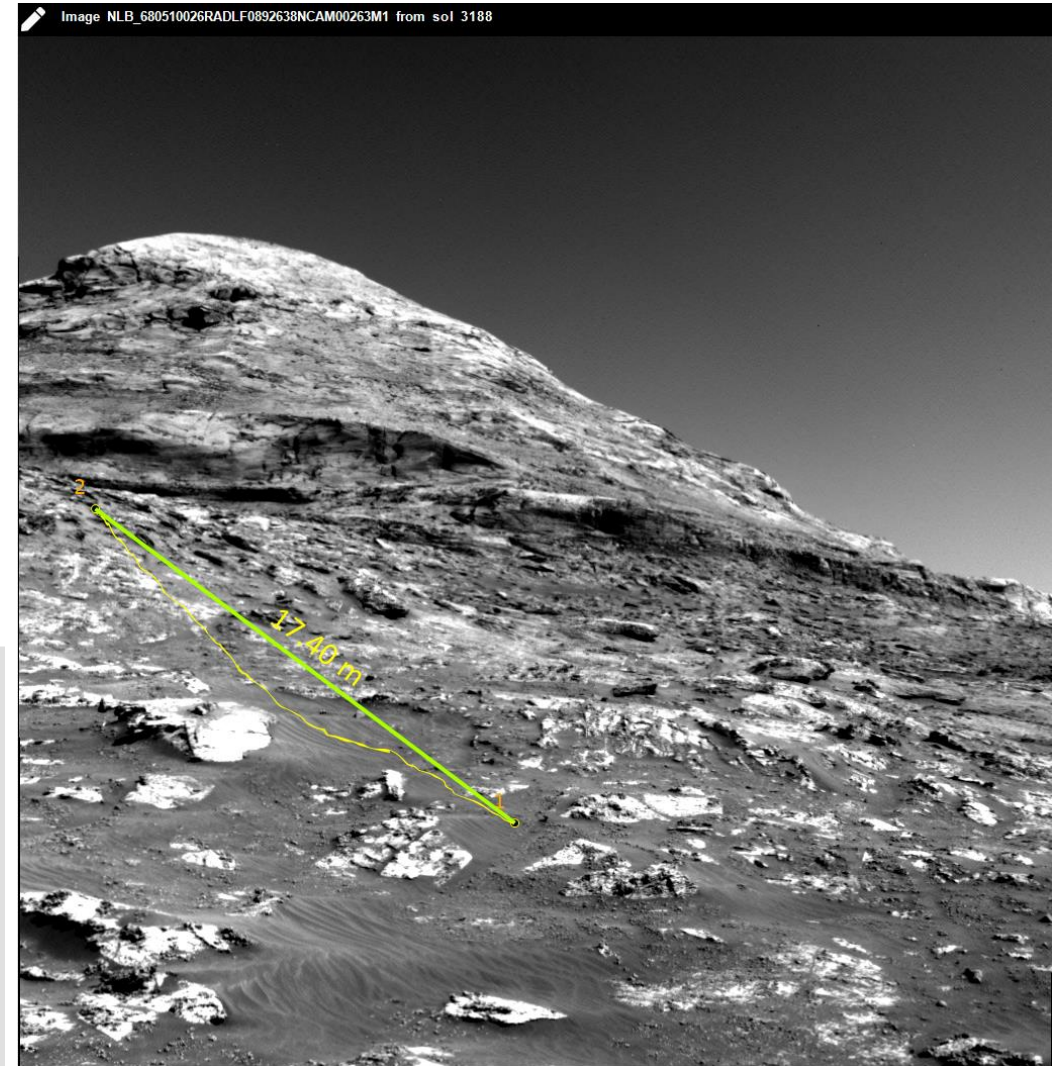
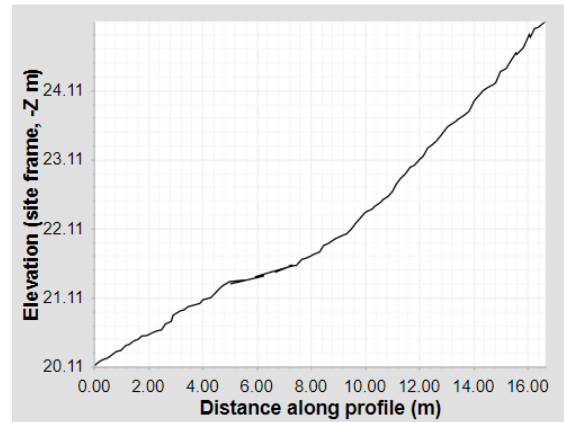
- Distance measurements are made between two points or along a polyline.



Profile tool

- Elevation profile between two points or along polyline.
- Elevations calculated along a path as if it were "dropped on the ground" between the two points. The profile is not simply the elevation values of the image pixels under the line drawn on the image.
- Not available for mosaics.

Profile 1 (from location 1 to 2)



Showing science targets

- The Image viewer automatically displays targets on an image when available.
- Targets are categorized by how accurately their position on the image is known.
 - A target's position is listed as “known” for images acquired at the same rover site and drive position as the locator image.
 - For images acquired at other locations, the target's position is listed as "approximate".
- Display style can be modified (symbol, color, font, etc.)
- Not available for mosaics.

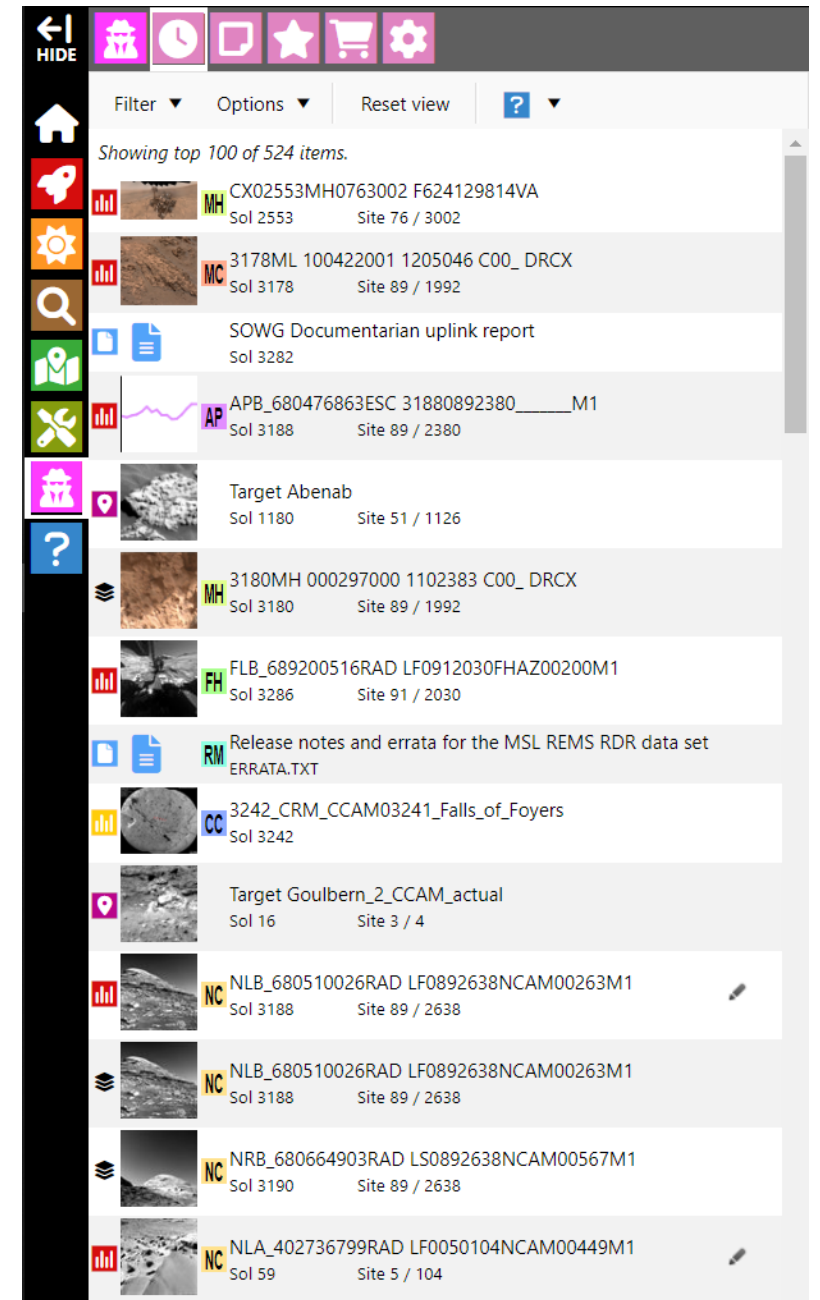
The screenshot shows a software window titled "NC Rad-corrected absolute radiance units, integer" with a file path "Sol 785 NLB_467189461RADLF0440036NCAM00288M1". The interface includes a menu bar (File, Draw, Measure, Targets, Mosaic), a toolbar, and a panel on the left with expandable sections: DRAWING (0), LOCATION (0), DISTANCE (0), PROFILE (0), and TARGET (13). The TARGET section contains a table with columns for Target, Position, Rover dist (m), and Visibility. The table lists 13 targets, with "Afton_Canyon" highlighted in yellow. The main image area shows a grayscale photograph of a rocky, cratered landscape with several targets labeled in yellow and pink text: "Goblin_Valley", "Afton_Canyon", "Deadman_Pass", and "Funeral_Peak". A cursor position indicator in the top right corner shows "Sample 1021, Line 589".

Target	Position ?	Rover dist (m)	Visibility
			📍 T
Afton_Canyon	approx	2.81	📍 📍
Afton_Canyon_CCAM	approx	2.84	📍 📍
Anaverde	approx	2.78	📍 📍
Deadman_Pass	known	2.96	📍 📍
Funeral_Peak	known	2.63	📍 📍
Goblin_Valley	known	3.16	📍 📍
Goblin_Valley_MAHLI	approx	3.00	📍 📍
Jail_Canyon	approx	3.00	📍 📍
Old_Dad_Mountain	approx	2.34	📍 📍
Punchbowl	approx	2.44	📍 📍
Punchbowl_CCAM	approx	2.47	📍 📍
Topanga	approx	3.18	📍 📍
Topanga_CCAM	approx	3.17	📍 📍

Saving annotations

- Annotations (drawing and measurement elements) are saved when created.
- Annotations are loaded automatically when the image is subsequently opened in image viewer.
 - User must be signed in with optional account.

Annotated images are identified in the user history by the  icon.



The screenshot shows a user interface with a dark sidebar on the left containing navigation icons (home, search, etc.). The main area displays a list of items, each with a small thumbnail image and text. The items are:

- CX02553MH0763002 F624129814VA Sol 2553 Site 76 / 3002
- 3178ML 100422001 1205046 C00_DRCX Sol 3178 Site 89 / 1992
- SOWG Documentarian uplink report Sol 3282
- APB_680476863ESC 31880892380_____M1 Sol 3188 Site 89 / 2380
- Target Abenab Sol 1180 Site 51 / 1126
- 3180MH 000297000 1102383 C00_DRCX Sol 3180 Site 89 / 1992
- FLB_689200516RAD LF0912030FHAZ00200M1 Sol 3286 Site 91 / 2030
- Release notes and errata for the MSL REMS RDR data set ERRATA.TXT
- 3242_CRM_CCAM03241_Falls_of_Foyers Sol 3242
- Target Goulbern_2_CCAM_actual Sol 16 Site 3 / 4
- NLB_680510026RAD LF0892638NCAM00263M1 Sol 3188 Site 89 / 2638
- NLB_680510026RAD LF0892638NCAM00263M1 Sol 3188 Site 89 / 2638
- NRB_680664903RAD LS0892638NCAM00567M1 Sol 3190 Site 89 / 2638
- NLA_402736799RAD LF0050104NCAM00449M1 Sol 59 Site 5 / 104

Data export

- Download options in the Image viewer:
 - Annotated image as lossless PNG file.
 - Measurement data as Excel workbook:
 - Locations in site, rover, and local frames, along with map coordinates
 - Distances
 - Raw profile data (one sheet per profile).
 - Measurement data in ESRI shapefile format (zip file).
 - Source archive image and metadata label.

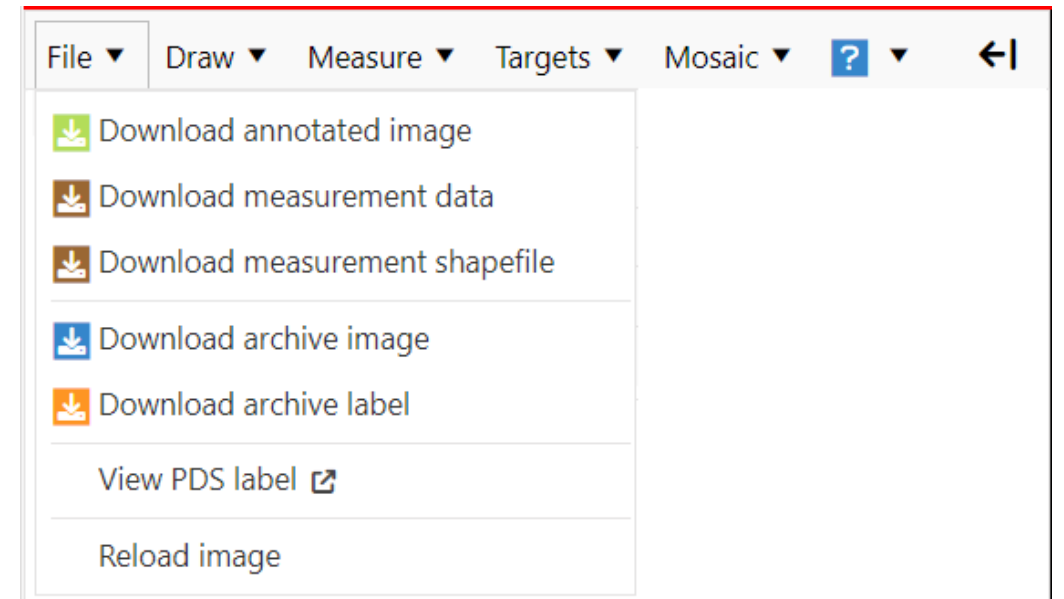


Image viewer use case

Identifying potential Curiosity rover drill sites.

The screenshot shows a software interface for viewing and analyzing a Curiosity rover stereo Navcam mosaic. The interface includes a menu bar (File, Draw, Measure, Mosaic, ?), a toolbar with various tools, and a data table for the marked locations. The data table is as follows:

Loc #	Pixel		Location (m)			Rover dist (m)	Az (deg)	El (deg)	
	i	j	x	y	z				
1	2257	349	-231.37	106.67	-39.29	21.59	107.35	2.56	
2	2426	347	-234.97	106.72	-39.33	23.05	115.74	2.51	
3	2571	351	-237.55	105.55	-39.27	23.36	122.62	2.34	
4	2732	364	-239.61	103.23	-39.01	22.80	130.09	1.76	

Below the table, there is an "Add new location" button. The main view shows a stereo Navcam mosaic of the Curiosity rover on the Martian surface, with four candidate drill sites marked by yellow circles. The interface also includes a "DRAWING (0)" section, a "LOCATION (4)" section, a "DISTANCE (0)" section, and a "MOSAIC AND SOURCES (23)" section.

Curiosity stereo Navcam mosaic from sol 3504 end of drive location showing candidate locations for next drill site.

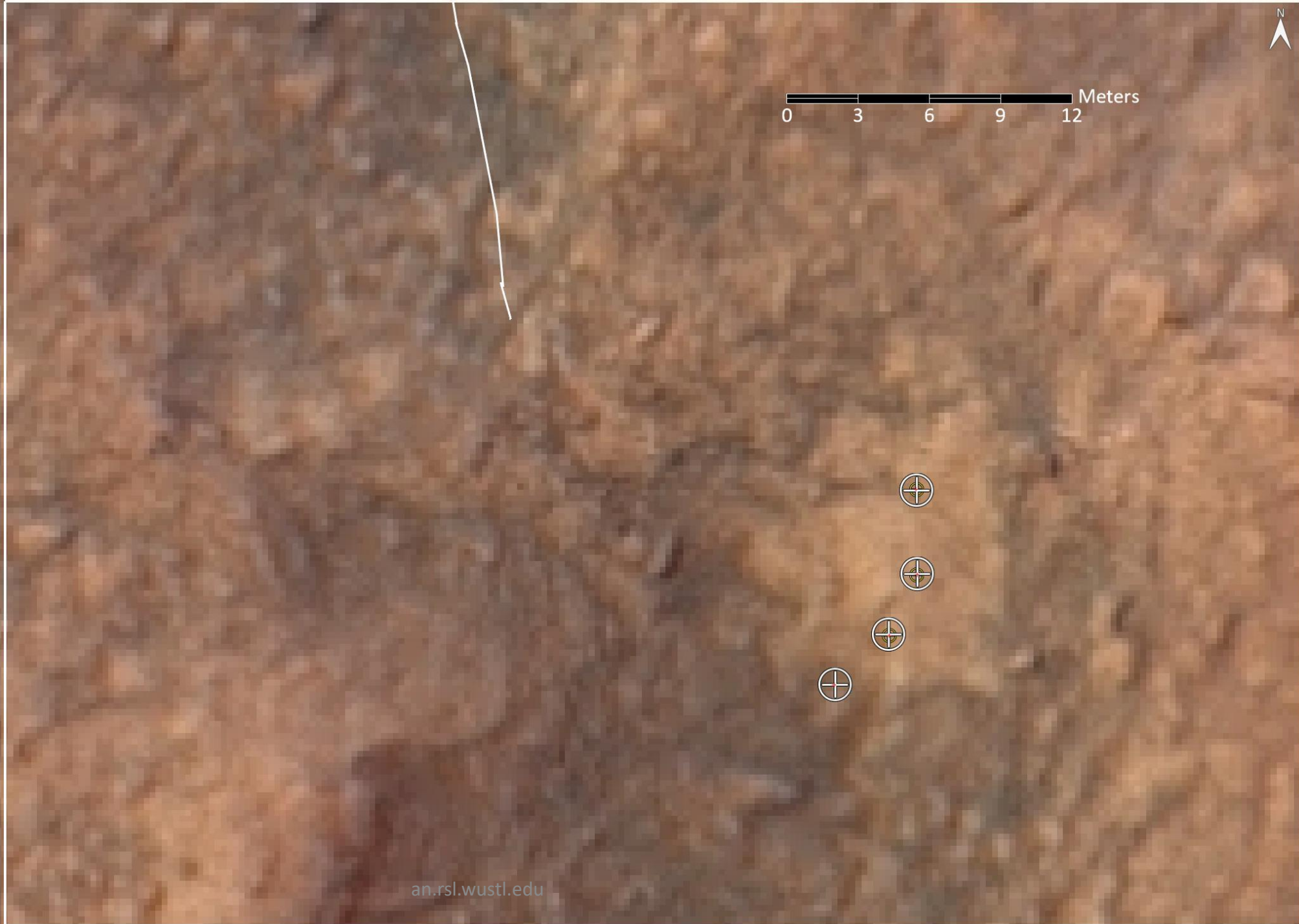
Image viewer use case

Locations exported from Image viewer in Shapefile format and imported into ENVI.

HiRISE mosaic showing traverses of Curiosity Rover through sol 3504

Symbols show locations of possible drill sites transferred from Navcam locations





Detail view

Conclusion

- Image viewer is a data visualization tool within the Analyst's Notebook.
- Location, distance, and profile tools are offered based on availability of supporting XYZ archive data products.
- Science targets are shown where their location is identified.
- Annotations are saved for future use.
- Annotated images and measurement data can be exported for use outside of the Notebook.
- Measurement tools for Perseverance rover and Phoenix lander images are in development.

Acknowledgment

The Analyst's Notebook is developed through funding provided by the Planetary Data System Geosciences Node. Past and ongoing cooperation by rover science and operations teams is greatly appreciated.