



Using PDS Geosciences Node Analyst's Notebooks

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52nd DPS Meeting
29 October 2020
3:00 – 4:00 pm EDT

<https://an.rsl.wustl.edu>

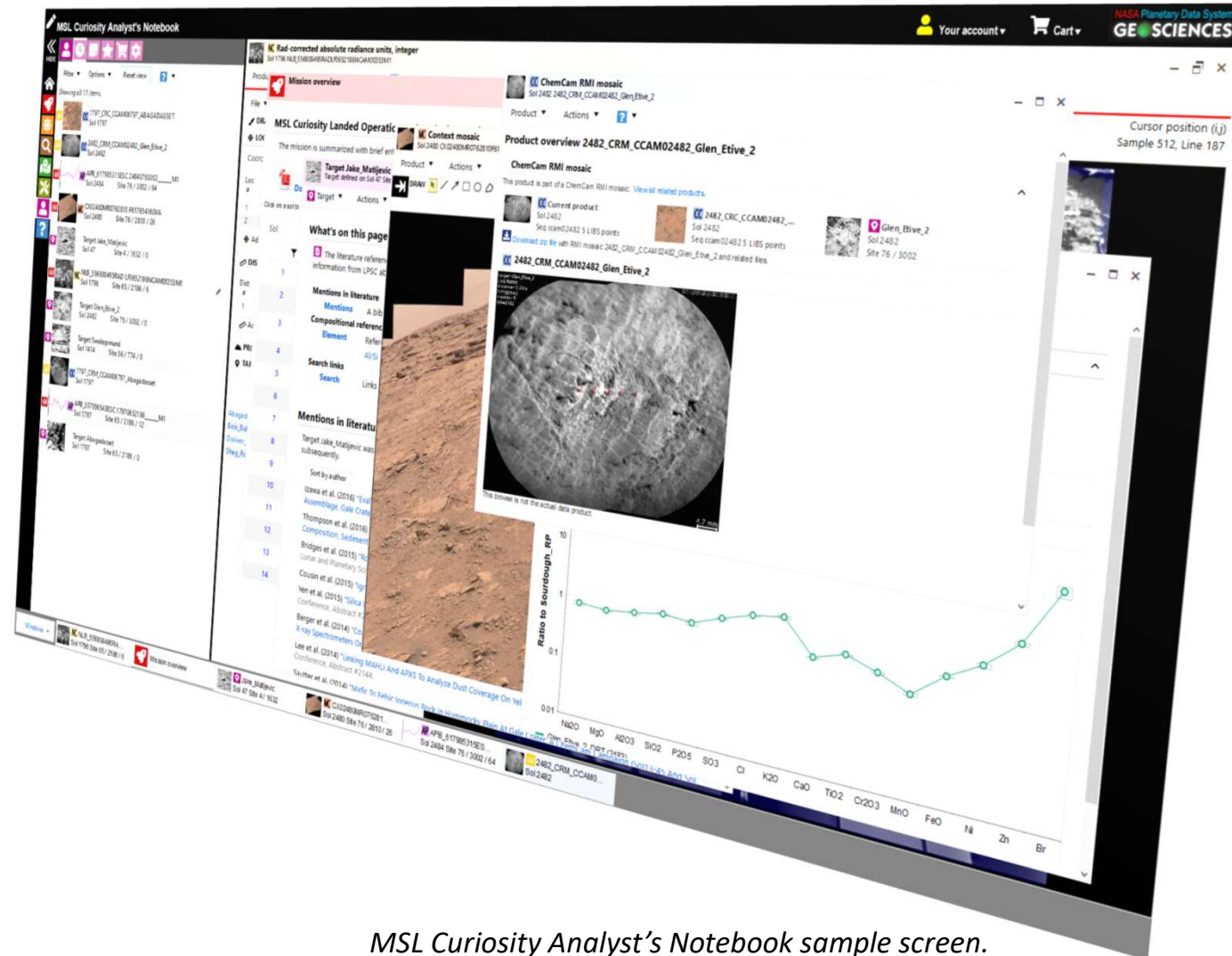
Agenda

- Analyst's Notebook introduction
- Use cases
 - Creating the MER Spirit and Opportunity contact science target database
 - Working with the MSL Curiosity AN
- Open demo and discussion

Analyst's Notebook

<https://an.rsl.wustl.edu>

- Provides integrated access to data, documentation, observation planning and targets for data from landed missions InSight, MSL, MER, Phoenix, LCROSS, and Apollo
- Mars 2020 Rover and Dragonfly to be added
- Public version accesses released data
- Team-only version ensures capture of science intent and operational context
- Data may be searched, displayed and downloaded via a shopping-cart model



MSL Curiosity Analyst's Notebook sample screen.

<https://an.rsl.wustl.edu>

Notebook components

Standard PDS Release

Archived Data

- Standard EDR and RDR data products

Documentation

- Software Interface Specification
- Spacecraft and instrument reports

Calibration Data

- Calibration reports and data

Additional data and tools in the Notebook

Special Products

- Additional products of interest
- Science team supplemental products

Documentation

- Daily operations reports
- Science team reports
- Historical reports

Resources

- Historical mission overview
- Science paper references
- Links to additional resources

Value Added Elements



Suite of tools and data representations that enhance archive use

- Data, document, and target search
- Interactive maps
- Context mosaics
- Image measurement
- Data transformation
- Cross instrument data browsing
- Integrated plans / timeline

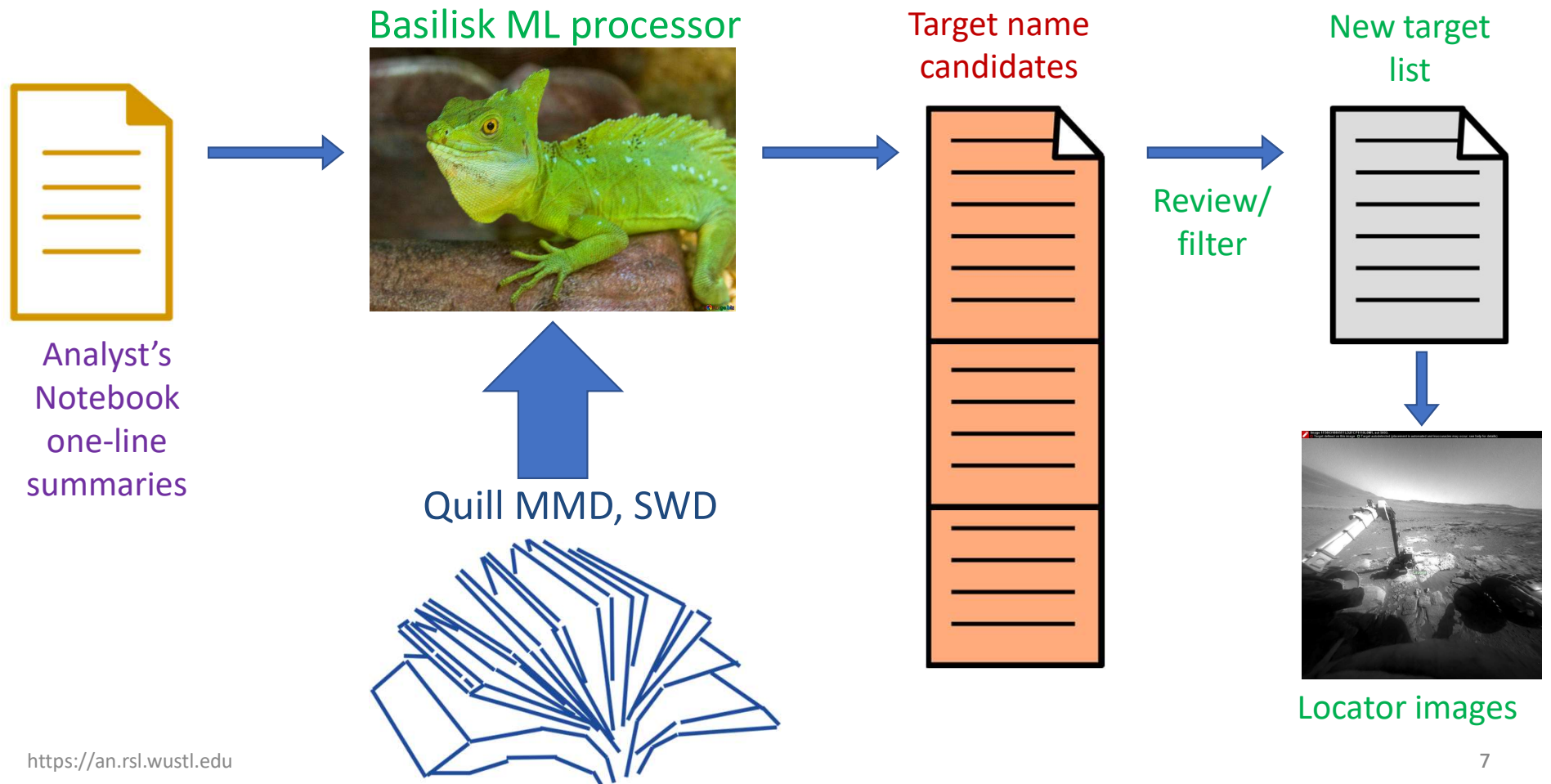
MER contact science target archiving and localization task

- At end of MER mission, target information was spread throughout the science team's Quill, Maestro, and rover planner files
- Task: develop an authoritative target name and location database
 - Capture any aliases:
e.g., IceCream & OneScoop, RaspberryNewton & Filling
 - Retain geological context of contact science and remote sensing targets
 - User friendly
 - Available to the public

Task process

- Generate a preliminary list of target names using team instrument lists and plan summaries from the Analyst's Notebook (AN)
- Utilize machine learning:
 - Search for target names not referenced in the preliminary list
 - Annotate instances of target names in Mission Manager reports
- Review of machine learning results
- Derive coordinate information from team reports and rover planner files
- Add targets to MER AN
- Use AN target autodetect function to find best locator frames
- Archive target data in PDS

MER target archiving overview



Sample machine learning output for Opportunity rover

Quill typos or naming variants (OLS)

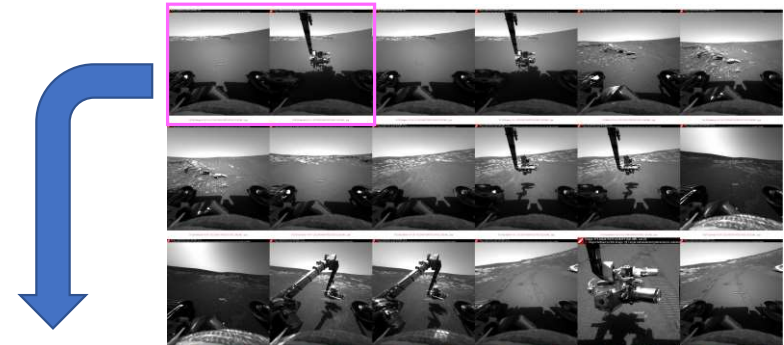
- Baobob, Boabab ([Baobab](#))
- Bristol_Well, Bristol_Wells ([Bristol Well](#))
- Chocolate_Chip, ChocolateChip
- Diamond_Jennes ([Diamond Jenness](#))
- LaJolla, La_Jolla, LaJoya, La_Joya ([LaJoya1](#))
- Lemon-Rind, Lemon_Rind ([LemonRind](#))
- Maestre_Diago, Maestre_Diego
- Pierre_Penault, Pierre_Penaut, Pierre_Pinaut (for [Pierre Pinaut](#))
- Siahs_Swamp, Siah's_Swamp (for [Siahs Swamp](#))
- Stewart_Island (for [Stuart Island](#))

Reviewed the first 1000 candidates

- Kept 643, with some edits:
 - Ash-meadows -> Ash Meadows
 - Bounce-Rock-Rag -> Bounce Rock
 - ...
- Omitted e.g.:
 - Buckland(12
 - Calibration_Target
 - Diagnostics_Continuing
 - Eating_Johnson
(target is "Liver Eating Johnson")

Selecting locator images

- Use AN target autodetect function to find best locator frames



MER contact science target database released

MER Contact Science Target List Bundle

This bundle contains a detailed chronology of contact science (CS) activities and targets conducted by both MER rovers. The term contact science encompasses measurements executed by any of the instruments on the rovers' Instrument Deployment Device (IDD), namely the Alpha Particle X-ray Spectrometer, Mossbauer, Microscopic Imager, and Rock Abrasion Tool. The data were compiled and archived by the PDS Geosciences Node.

Bundle root directory	urn-nasa-pds-mer_cs_target_list
Document collection	document
Data collection	data
Context collection	context

Opportunity (MER) Analyst's Notebook

The screenshot displays the Analyst's Notebook interface, which includes a list of targets on the left, a central image of the Martian surface, and a right-hand panel with various data and analysis tools. Red arrows point from the target list to the corresponding target in the image and the data panel.

MER Opportunity Analyst's Notebook sample screen.

PDS Geosciences Node web site

https://pds-geosciences.wustl.edu/missions/mer/mer_cs_targets.htm

<https://an.rsl.wustl.edu>

MSL Curiosity rover Analyst's Notebook demo

- Getting started with the Notebook
- Target search
- APXS concentration data
- ChemCam RMI mosaics
- Literature references
- Images of targets

Targets

- Defined by science team during operations planning.
- Captured within planning tool.
 - Metadata include position in image coordinates on finder frame.
- May be used in science operations plan.
- Actual target position may vary from plan.
 - Possible repositioning due to instrument reachability.
 - Target name may be modified in plan.
 - Target definition in planning tool is not updated.

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The screenshot displays a software interface for target management. At the top, it shows 'Target Cumberland' defined on Sol 185 Site 6 / 0. Below this, there are sections for 'Data - 5 related products found', 'Literature references', and 'Cumberland'. The 'Data' section lists several products with their respective Sol numbers, SCLK values, and sequence numbers. The 'Literature references' section indicates 34 references for this target. The 'Cumberland' section features a large grayscale image of a rocky terrain with several labeled points: 'Cumberland' (a red circle), 'Kazan', 'RMI05', 'RMI06', 'Narrows3_CGAM', and 'RMI07'. Below the image, there is a note stating 'This browse is not the actual data product. The location of the target Cumberland (red circle) and any other objects defined as features on this image are shown.' and links to view the full resolution version and open the locator image.

Target Cumberland
Target defined on Sol 185 Site 6 / 0

Target Actions ?

Data - 5 related products found

Product Type	Sol	SCLK	Seq
Locator image	173	412866868	ncam00322
Data product	291	423361945	apxs00028
Data product	292	42369566	apxs00028
Data product	488	440781134	apxs00028
0187_CRM_CCAM01187_Cumberland	187		ccam01187 16 LIBS points

Literature references
View 34 literature references for this target

Cumberland

This browse is not the actual data product.
The location of the target Cumberland (red circle) and any other objects defined as features on this image are shown.
[View full resolution version showing target](#)
View 321 images with this target
[Open locator image NLA_412866868RADLF0060000NCAM00322M1](#)

Target-data links

- MSL AN target search includes filters for
 - Name, sol
 - Data: APXS concentration and ChemCam RMI mosaic
 - Literature references: elements and minerals, mentions

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The screenshot displays the 'MSL Curiosity Analyst's Notebook' interface. The top navigation bar includes a pencil icon, the title 'MSL Curiosity Analyst's Notebook', and a 'HIDE' button. Below this is a toolbar with icons for search, filters, recent, and help. The main area is divided into 'FILTERS' and 'RESULTS' sections.

FILTERS section:

- Name**: A search bar with a dropdown arrow.
- Sol**: A bar chart showing data points for various sols, with a range from 1 to 2224.
- Data links**:
 - AP APXS concentration (15)
 - CC CC RMI contour image (15)
 - CC CC RMI mosaic (15)
- Lit refs**:
 - Has lit refs (15)
- Element in lit ref**:
 - al (0)
 - aluminum (0)
 - barium (0)
 - bromine (2)
 - ca_poor (0)
 - [Show all 45 items](#)
- Mineral in lit ref**:
 - akaganeite (1)
 - alkali (0)
 - anhydrite (2)
 - apatite (0)
 - augite (1)
 - [Show all 40 items](#)

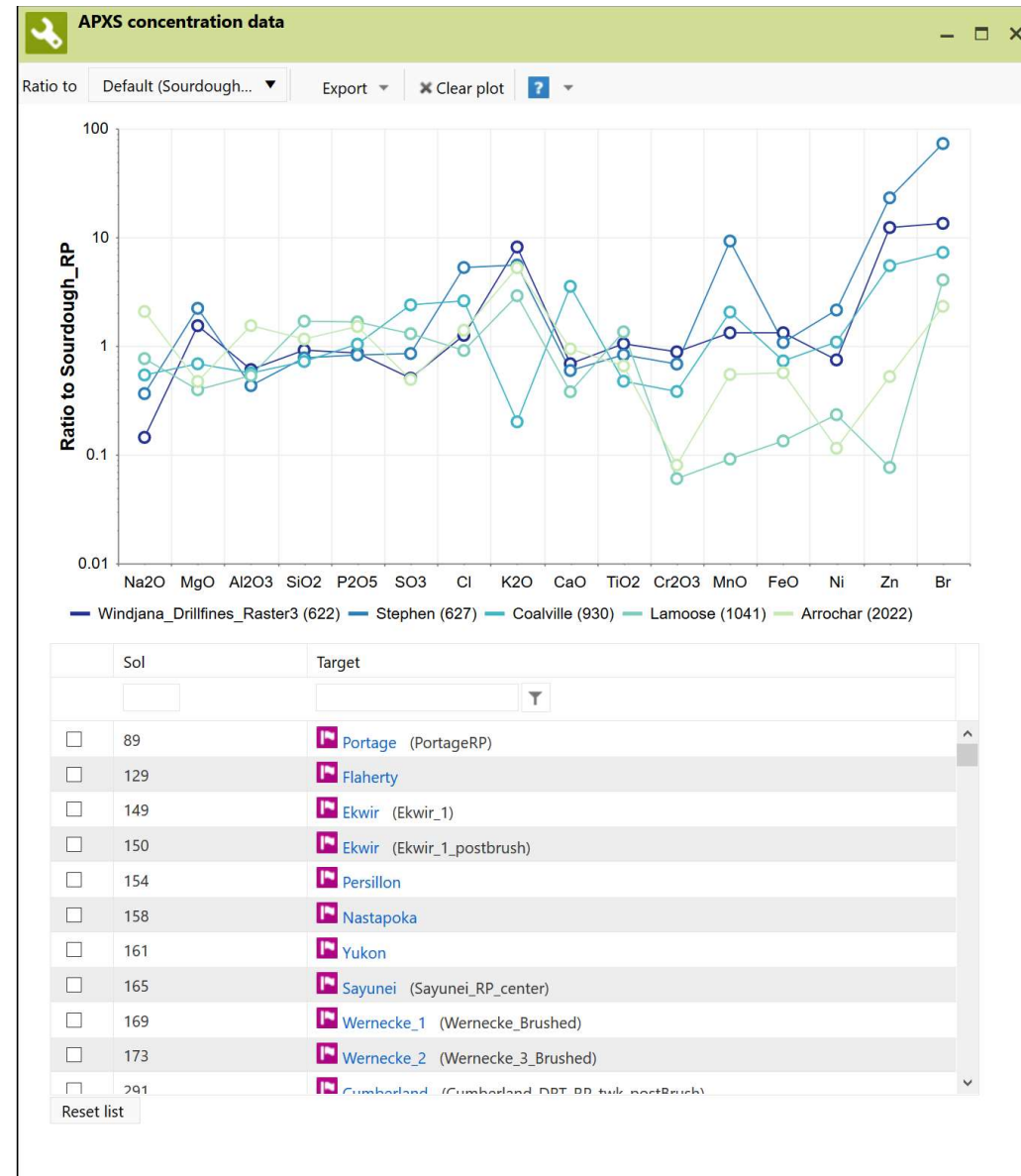
RESULTS section:

- Aillik**: Sol 319 Site 6. Data links: AP, CC.
- Big_Sky**: Sol 1114 Site 50. Data links: AP, CC. Literature refs: E Oxygen, M(5) Anhydrite, Feldspar, Hemati...
- Buckskin**: Sol 1053 Site 48. Data links: AP, CC. Literature refs: E(9) Chromium, Iron, Manganese..., M(6) Anhydrite, Cristobalite, Mag...
- Cody**: Sol 1109 Site 50. Data links: AP, CC.
- Cumberland**: Sol 185 Site 6. Data links: AP, CC. Literature refs: E(8) Calcium, Chlorine, Cl_Rich, Ir..., M(19) Akaganeite, Augite, Basani...
- Hyrum**: Sol 930 Site 45. Data links: AP, CC.
- Lagrange**: Sol 605 Site 31. Data links: AP, CC.

APXS concentration data

- Chemical concentration results derived from archived data by the MSL APXS team.
- Each composition is associated with a specific target.
- The APXS determines the bulk chemistry of targets on Mars through the complementary use of particle-induced X-ray emission and X-ray fluorescence.
- AN users can plot and then download the data for the current plot or obtain the set of all APXS concentration data.

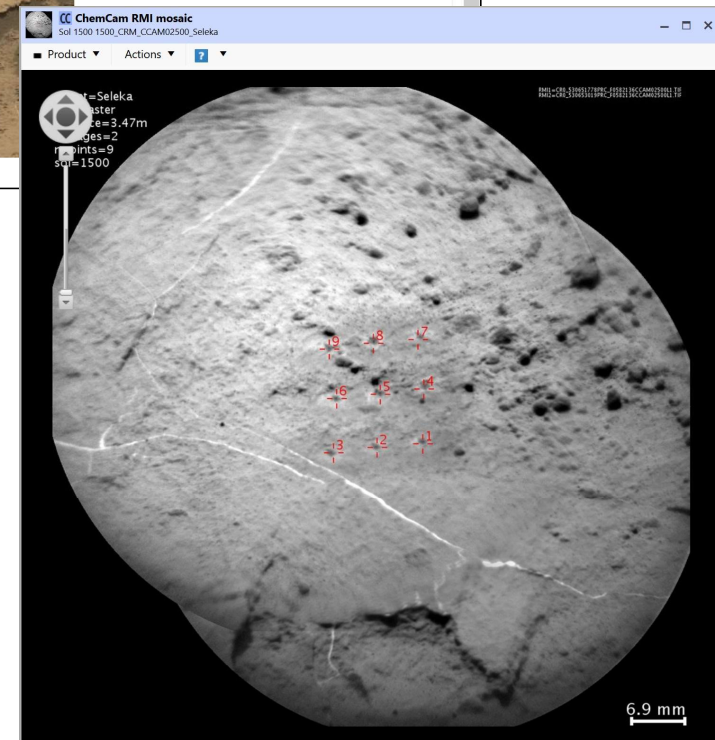
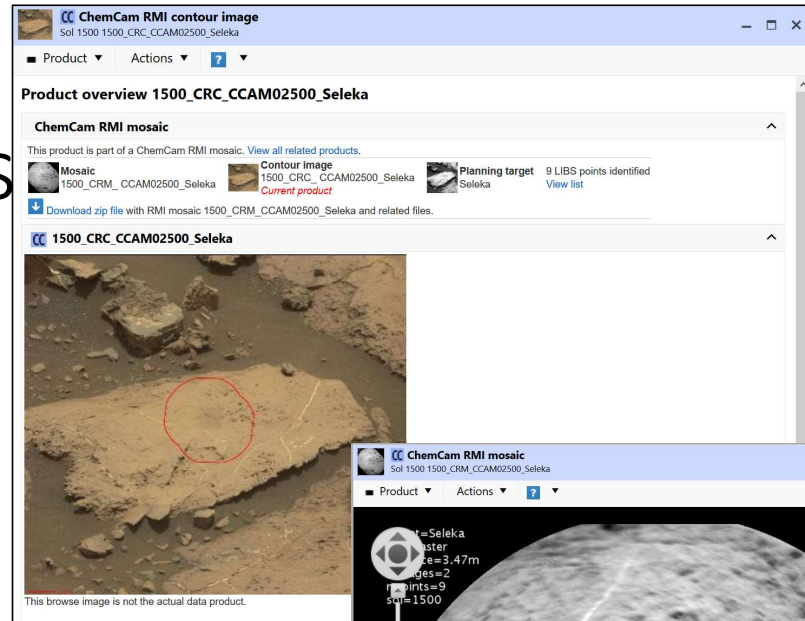
<https://an.rsl.wustl.edu>



ChemCam RMI mosaics

- RMI (Remote Micro-Imager) mosaics produced by the ChemCam team, each associated with a specific target.
- Annotations denote locations of ChemCam LIBS data elemental abundance acquisition.
- Accompanying locator images (“contour images”) show mosaic footprint drawn on a Mastcam image.
- AN users can download zip file containing all pertinent data: mosaic, contour image, PDS labels, and LIBS data for any given mosaic.

<https://an.rsl.wustl.edu>



Target literature references

- From Mars Target Encyclopedia (Wagstaff, et al.)
- Links to the source documents are included.
- Mentions in literature, including simple mentions within the text.
- Compositional references to elements and minerals are listed, including excerpts of the text.

Magnetite

Achilles et al. (2016) "[Mineralogy Of Eolian Sands At Gale Crater](#)", Lunar and Planetary Science Conference, Abstract #2532.

"Interpretation of magnetite as a detrital igneous phase in Cumberland and John Klein is thought to be unlikely [9], based on the surprisingly low abundance of olivine in these mudstones contrasted with their abundant pyroxene and plagioclase and in consideration of reaction models for these two samples that support production of smectite plus magnetite as a result of olivine reaction with trace quantities of O₂ or by production of hydrogen [10]."

Bridges et al. (2015) "[Hematite Formation In Gale Crater](#)", Lunar and Planetary Science Conference, Abstract #1769.

"In previous work we showed that dissolution of approximately 70:20:10 % amorphous material , olivine and whole rock in an open system within the Sheepbed Member mudstone can explain the smectite and magnetite abundances identified by CheMin XRD at the John Klein and Cumberland sites [6]."

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The image shows a screenshot of a Wikipedia article about Magnetite. A red dashed box highlights the 'References' section, which lists various scientific papers and reports. The references include:

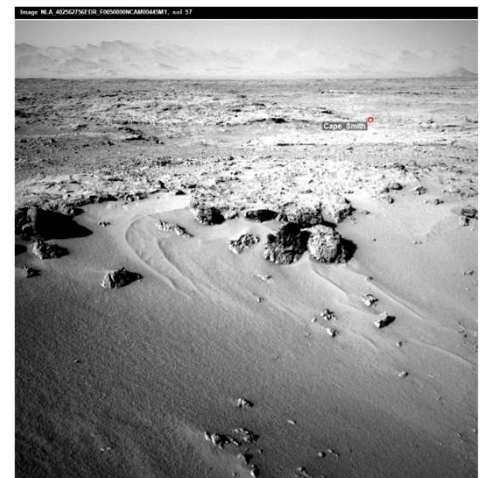
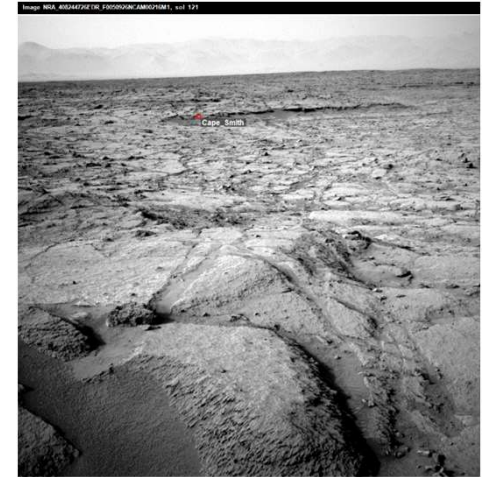
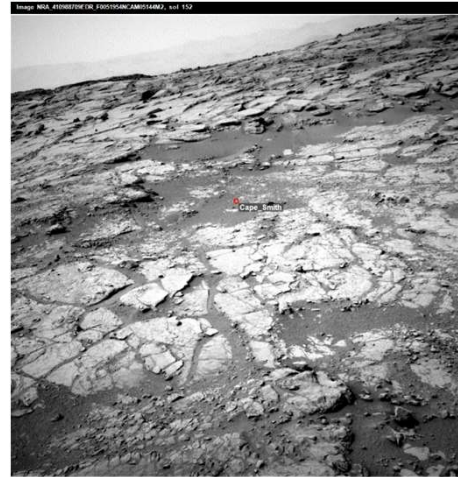
- Achilles et al. (2016) "Mineralogy Of Eolian Sands At Gale Crater", Lunar and Planetary Science Conference, Abstract #2532.
- Bridges et al. (2015) "Hematite Formation In Gale Crater", Lunar and Planetary Science Conference, Abstract #1769.
- Other references include studies on magnetite formation, mineralogy, and geochemistry in various contexts, such as "Magnetite formation in the presence of water" and "Magnetite formation in the presence of water".

Targets on images



MSL target Cape Smith, defined sol 163

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Auto-located on images from previous sols

Links / contact

- PDS Analyst's Notebook
 - <https://an.rsl.wustl.edu/>
- Notebook online help
 - <https://an.rsl.wustl.edu/help/Content/Home.htm>
- Email
 - Tom Stein: tstein@wustl.edu
 - an@wunder.wustl.edu



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