

Science Intent Capture Architecture for Science Planning on The Mars 2020 Mission

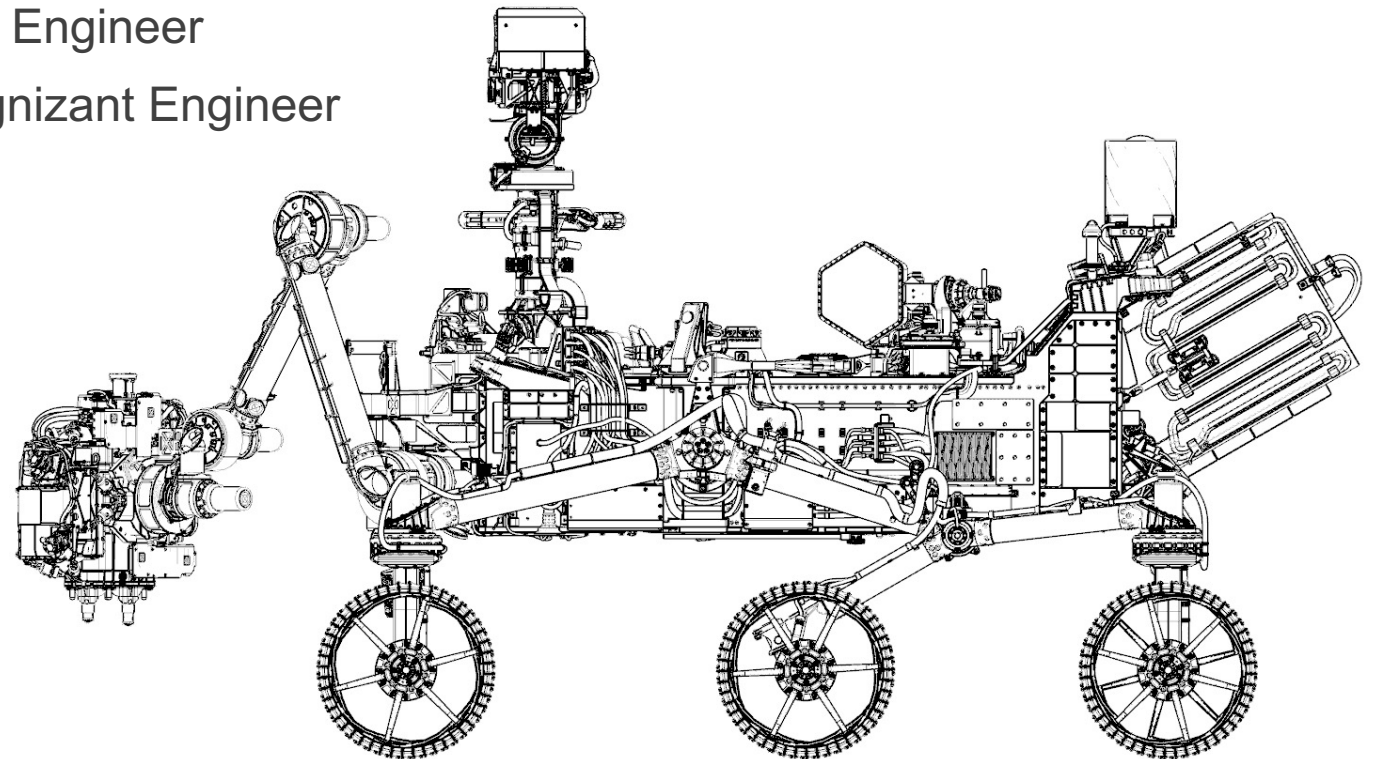
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Feb 23, 2022



MARS 2020
PROJECT

M2020 Science Intent Architecture Overview

Mission Objective: Identify opportunities for, and acquire rock and soil samples during its mission.

Challenge: The different levels of science planning, from high-level strategic mission planning to daily tactical planning, needs to be more closely coordinated than on previous Mars surface missions in order to ensure that the sampling objectives of the mission in Jezero crater are accomplished.

Strategy: Facilitate alignment of the science team around the objectives of the mission so that collaborative decision making can be most efficient and strategic

Solution: A cross-cutting software architecture that links the science objectives for each Campaign to all the pertinent planning and analysis tools so that these objectives are present as guideposts to the Science Team throughout the Science Planning processes.

Priority Challenges

There are 11 key challenges to accomplishing the M2020 mission from a science planning perspective. The approach outlined here is intended to address these from the perspective of tracing science intent.

Strategic > Tactical Interface

1. Balancing having a well-defined plan with improvisation based on new information
2. Tactical has more current data while strategic has more context on big picture goals
3. Large potential mars surface area to explore, small area that can actually be explored during prime mission
4. More time to analyze and reflect during strategic, less time during tactical, when the decisions are most critical

Sol > Sol Handoff

1. Continuity of plan rationale at sol>>sol handoff (what, where, how, why)
2. Density of current state of information at sol>>sol handoff (report update effort, report review effort)
3. Informal, human process at sol>>sol handoff
4. Accumulation of understanding from sol>>sol of multiple science investigations, with transparency to all teams
5. Getting at the most relevant information for decisions each sol, quickly and easily

Analysis > Plan Updates

1. Analysis processing is not always fast enough to effectively inform tactical planning
2. Analysis is not easily accessed across teams, from sol>sol, and location to location

Science Intent Solution

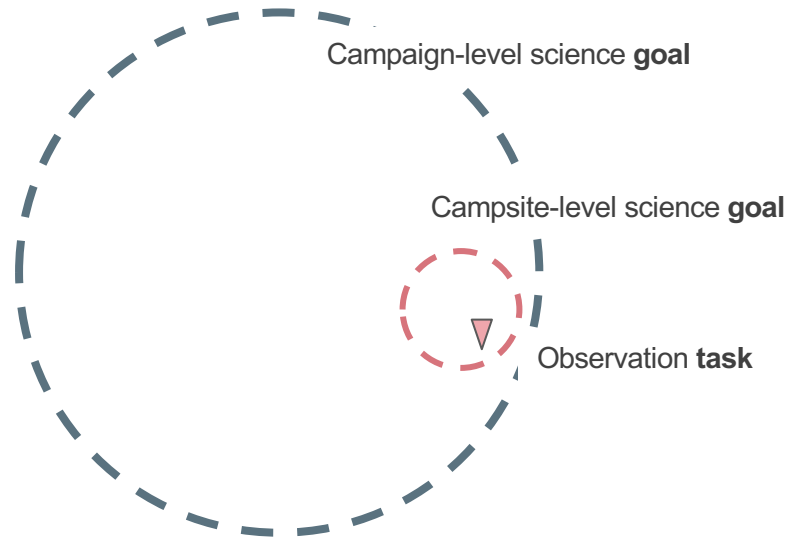
Keep our entire science team, through all planning phases, aligned on what we are doing next, and why, via tools and process.

This solution includes:

- Continuity of science intent capture and communication in planning and analysis workflows
- Close coordination of the science team at all planning phases
- Consistent visibility into goals for each campaign, and how they trace to rationale for observations
- Systematic tracking and communication of ongoing progress towards science goals

...all integrated into existing tools and processes

Science Intent - Goals and Tasks



Goal

High-level science objective that is addressed via observation outcomes.

Task

Investigation of a specific aspect of a Goal, via one or more observations.

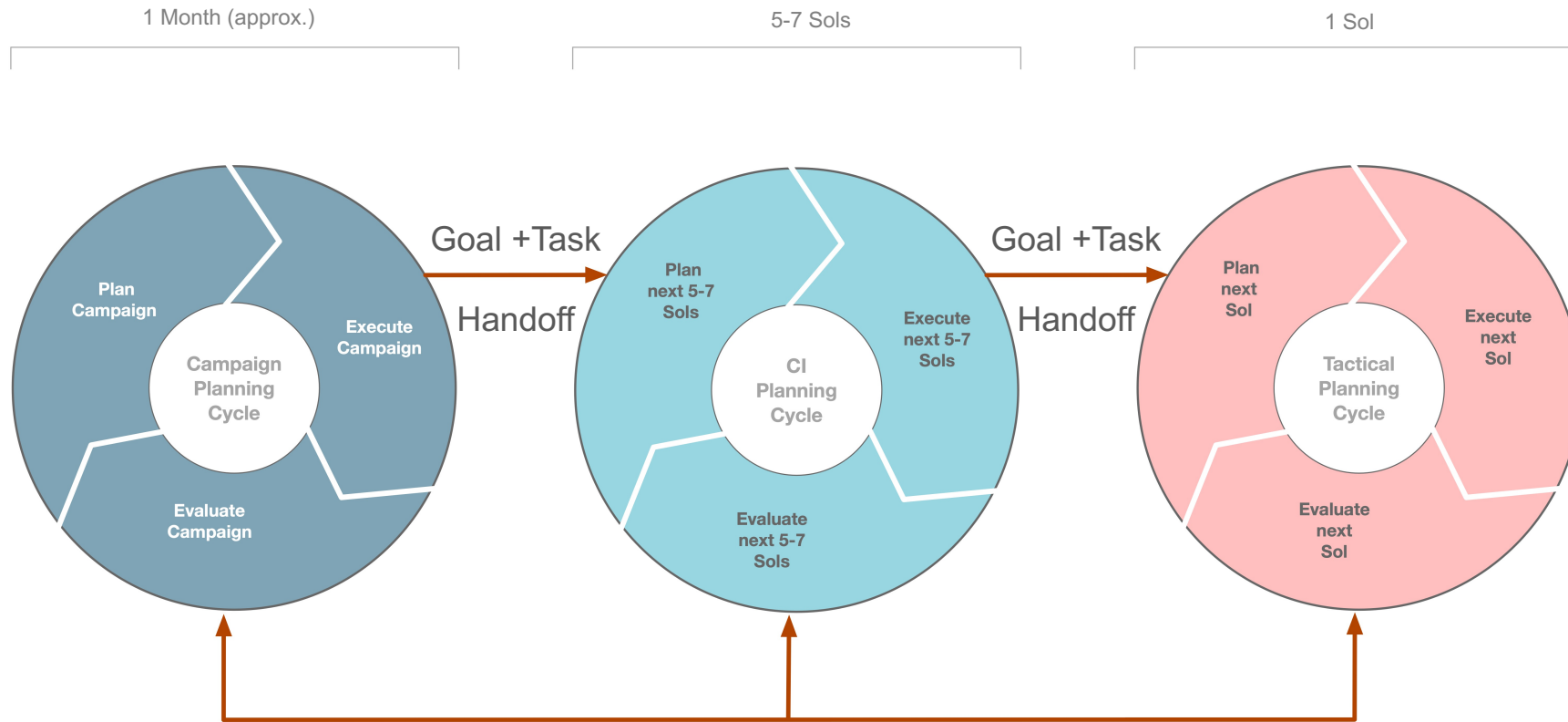
Goals – *written at campaign and campsite scales*

These statements describe the higher-level science questions we want to address at a location, and are used to define the science that will be done at that location.

Tasks – *written for the scale of observations*

These are a defined set of more granular objectives that, when carried out, will inform our understanding of the broader science question that a Goal describes. Each Task should lead to one or more observations, and tell you the “what” and the “why” – what feature are you observing, with what technique, and why does this help us address the relevant Goal?

Science Intent – Planning Phase Iteration



Goal and Task Iteration Informed by Other Processes

Science Intent — Planning Phases Iteration

Iteration Cycle Context for Goals and Tasks

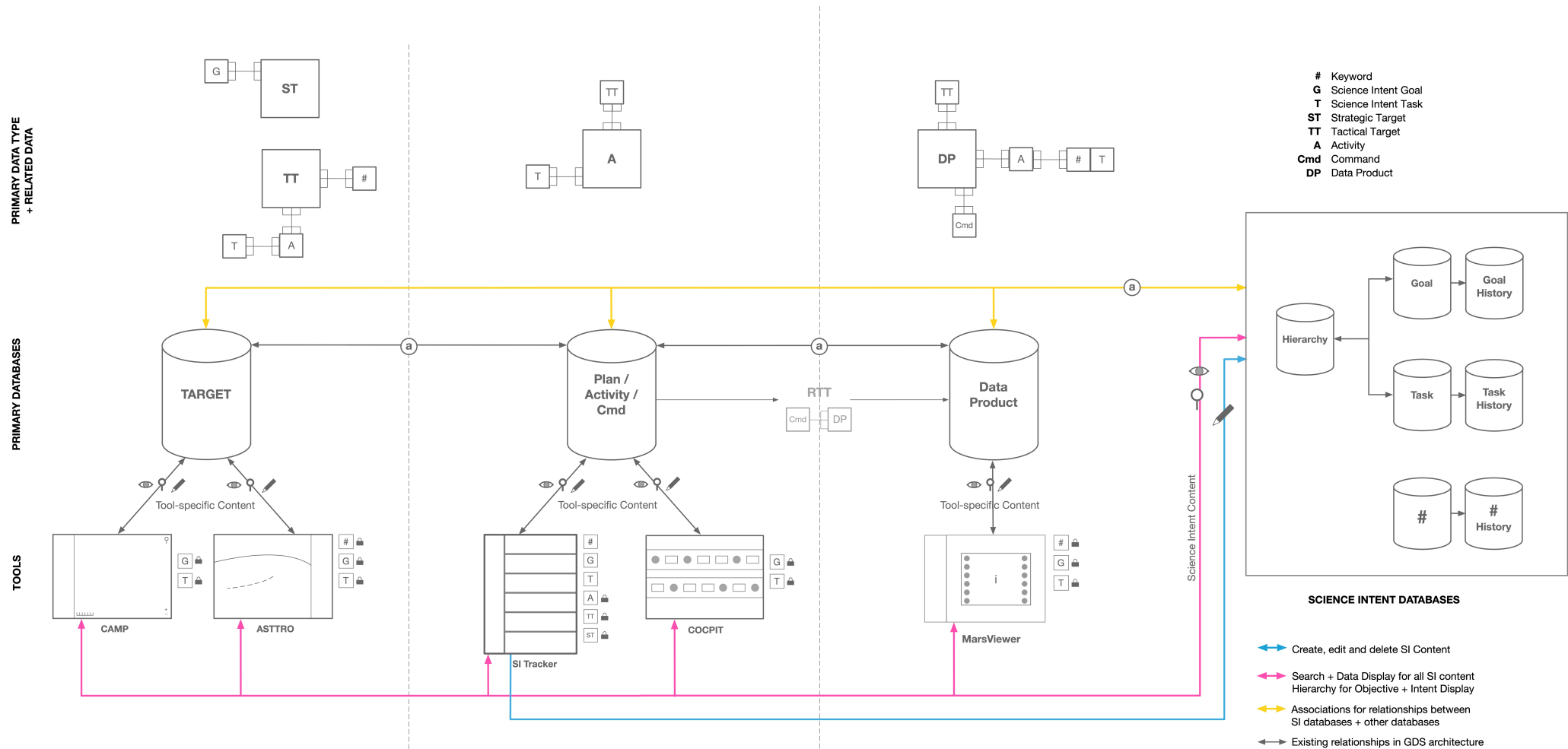
There is iteration in all phases of the planning processes, happening simultaneously in each phase:

- During **Campaign Planning**, a set of Goals and notional Tasks is be defined for the campaign.
- As a product of **Campaign Implementation**, relevant Goals are identified for the next few sols, and a set of Tasks are identified and/or created to address these Goals at this location. New insights from the previously executed Tasks inform each Goal, and also inform the definition of new Tasks if needed.
- On the **Tactical Shift**, the set of Tasks notionally provided by CI is reviewed and mapped to actual Activities and Targets in the plan. As the team makes progress on accomplishing these Tasks and Goals, this progress is documented and accessible, via the tools, in all of the processes so that each planning group has the most recent information to revise their plan.


Science Intent Architecture Primary Goals

- **Decision making**
Capture science rationale for observations as relates to the broader objectives for each rover location in the team's planning tools. This will help facilitate decision-making about priorities, observation design, and to provide transparency to the team around these rationale.
- **Handoff sol to sol and process to process**
Provide a mechanism for consistent and accessible guidance
- **Tracking Progress**
To provide a central science intent tracking tool to manage and understand the team's progress towards accomplishing science goals at each rover location with links to related targets, plans, and data products
- **DL Analysis context**
Enhance Downlink Analysis of science data by linking science rationale for observations with their associated data products
- **Searchable historical archive**
Record of science rationale mapped to observations at each campaign

Science Intent Architecture



CAMP – Goals for a Campaign


CAMP Surface G6.7b

Strategic Targets: Octavia E Butler Landing Site (name)

Rover Position ▼ RMC sol × 🔍 S 🔄


Layers

🔍

Search Layers

🔍

- ☐ Tactical Targets
- ☒ Strategic Targets
- ☐ Rover Position
- ☐ Van Zyl Overlook
- ☐ Rover Traverse
- ☐ Landing Ellipse
- ☐ Drive Points
- ☐ Heli Flight Zone
- ☐ EDL Hardware
- ☐ LVS Landing Point
- ▶ Names
- ▶ Elevation
- ▶ Mapping
- ▶ Science Team
- ▶ Geology
- ▶ Traverse
- ▶ Basemap



Octavia E. Butler Landing Site

Map Scale ✓

0 100m

Octavia E Butler Landin...
by master
from published



Science Intent


Assigned Filter ×

✓	Goal #84 Title Notes	LS.1: Determine the nature and origin of lithologies in and around Octavia E. Butler Landing	➤
✓	Goal #98 Title Notes	LS.7: Improve instrument performance to increase the science return of the mission	➤
✓	Goal #92 Title Notes	LS.3: Characterize the extent to which rocks exposed in and around Octavia E. Butler Landing have undergone post-depositional modification	➤
✓	Goal #90 Title Notes	LS.4: Prepare for future campaigns with observations beyond Octavia E. Butler Landing	➤
✓	Goal #91 Title Notes	LS.2: Establish stratigraphic relationships amongst the lithologies present in and around Octavia E. Butler Landing	➤


Longitude, Latitude 77.45187244°, 18.44449747°

SI Tracker – Goal + Task Tracking View


G6.8 Tracker Keywords Goals Tasks Connections
 schnadt

Science Intent Tracker 

Octavia E Butler Landing Site

Octavia E Butler Landing Site


campaign overview (7 goals / 41 tasks)
Goals Sols
campaign details >


Goals (7)


Tasks (41 total)

☒ Sort By Status

Goal #84	To Do	In Progress	Done
<div> <div>LS.1: Determine the nature and origin of lithologies in and around Octavia E. Butler Landing</div> <div>To Do</div> <div>5 tasks >></div> </div>	<div> <div>Task #286</div> <div>1. Acquire contextual observations of outcrop structure and stratigraphy</div> </div> <div> <div>Task #265</div> <div>2. Acquire grain-scale texture observations of rocks around the landing site</div> </div> <div> <div>Task #287</div> <div>3. Acquire elemental</div> </div>	Nothing in progress	Nothing done

SI Tracker – Detail View


G6.8 Tracker Keywords Goals Tasks Connections


schnadt

Science Intent Tracker

Octavia E Butler Landing Site

Octavia E Butler Landing Site

[↶ campaign overview](#)

campaign details (7 goals)

Goals
Sols

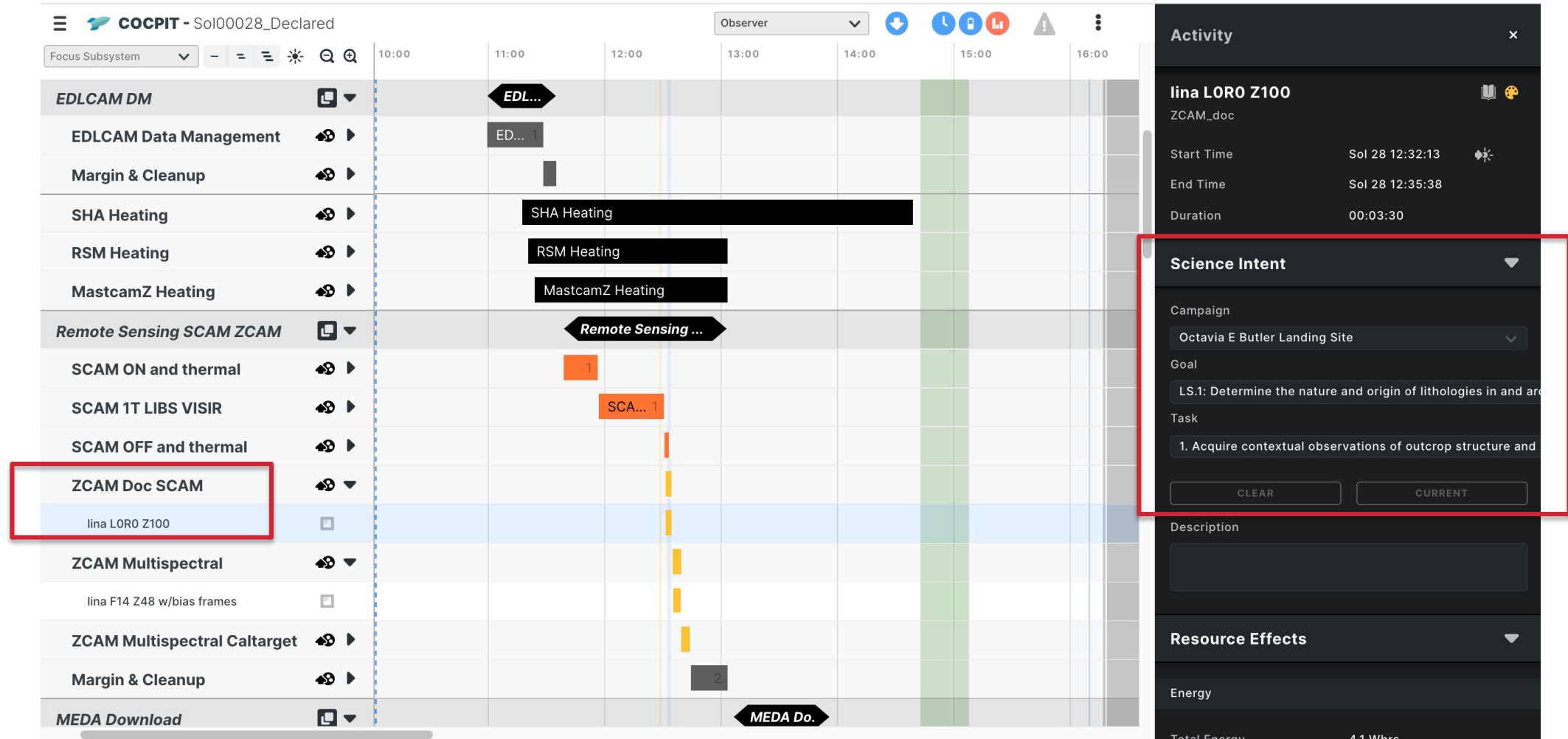
Goal #84
To Do
details »

5 tasks

LS.1: Determine the nature and origin of lithologies in and around Octavia E. Butler Landing

Tasks	Notes	Sols	Activities	Targets	Products
<div> Task #286 details » To Do </div> <div> 1. Acquire contextual observations of outcrop structure and stratigraphy </div>	e.g., Navcam, Hazcam, ZCAM, RMI, WATSON	28	lina LORO Z100	lina	MV DD
<div> Task #265 details » To Do </div> <div> 2. Acquire grain-scale texture observations of rocks around the landing site </div>	e.g., ZCAM, RMI, WATSON	15	tselhchee_scam_LORO_Z100	Tselhchee	MV DD
		46	Caltarget F14 Z48 w/ bias L7R7		MV DD
		46	Peppermint and Prickly Pear pavers 25 LORO Z110 w/ 1 LORO Z34	Peppermint	MV DD
		46	Peppermint paver	Peppermint	MV DD

COCPIT – Goal + Task Associated to an Activity



Science Dashboard – Sol-based Context

Science Dashboard

[Logout](#)

ROI: Crater Floor
 Campaign: Octavia E. Butler Landing
 Campsite: -
 Sol Type: SOX 2a

← Sol 28 →

[MEETING TRACKER](#)

Current sol is 47
 Wed, 07 Apr 2021 18:22:58 UTC

Sol 26

Sol 27

Sol 28

Sol 29

Sol 30

T-LTP Sol N Planning Summary

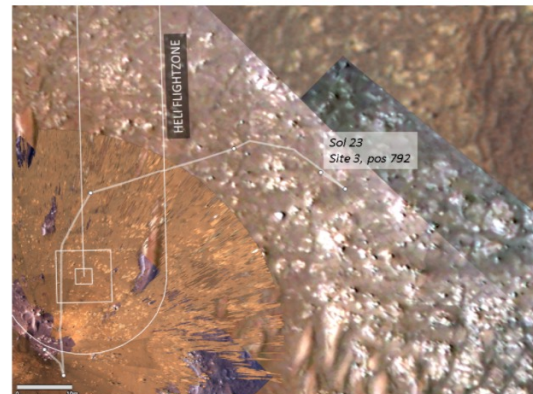
[T-LTP REPORT](#)

We remain 5m back from the belly pan and have focused on closing out SOX2a and one opportunistic science target.

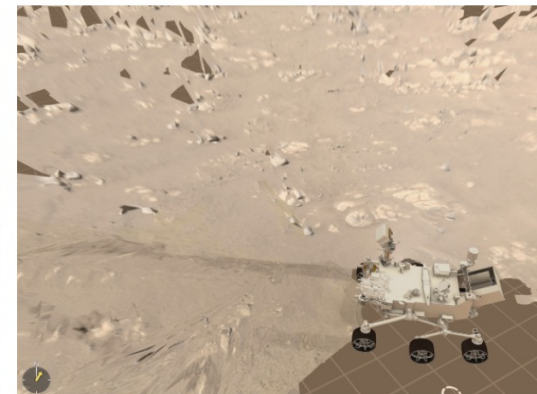
This included RA FCS placement, SHA traverse stow, PIXL MCC test and EDLCAM data management. MEDA (now marked healthy) started an EVEN sol observation table.

The opportunistic science was on a nearby rock (named 'iiná, Navajo for "life"), representative of the dominant local lithotype. It included a 10X1 SCAM RMI/LIBS/VISIR raster with both a ZCAM documentation image as well as a ZCAM multispectral.

Starting Location

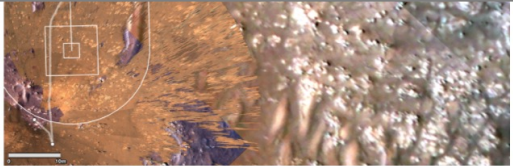
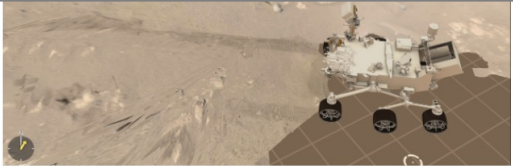


[CAMP](#)



[ASTRO](#)

Science Dashboard – Sol-based Context

CAMP [↗](#)
ASTRO [↗](#)

Planned Activities

Sol00028_Tactical [OPEN PLAN IN COCPIT](#) [↗](#) Last Refresh: Wed, 07 Apr 2021 18:22:25 UTC [Refresh](#) [↻](#)

SCAM OFF and thermal	-	331a1fd92844	ROCKS around the landing site	DD ↗ MV ↗
lina LORO Z100	lina	696571fd-f5b5-481c-9333-331a1fd92844	1. Acquire contextual observations of outcrop structure and stratigraphy	DD ↗ MV ↗
lina F14 Z48 w/bias frames	lina	696571fd-f5b5-481c-9333-331a1fd92844	4. Acquire mineralogy and/or hydration of rocks around the landing site	DD ↗ MV ↗
ZCAM caltarget F14 Z48 w/bias frames	unassigned		4. Acquire mineralogy and/or hydration of rocks around the landing site	DD ↗ MV ↗
MEDA Data Download and OT reactivation	-	-		
FHAZ	-	-		DD ↗ MV ↗

Science Reports

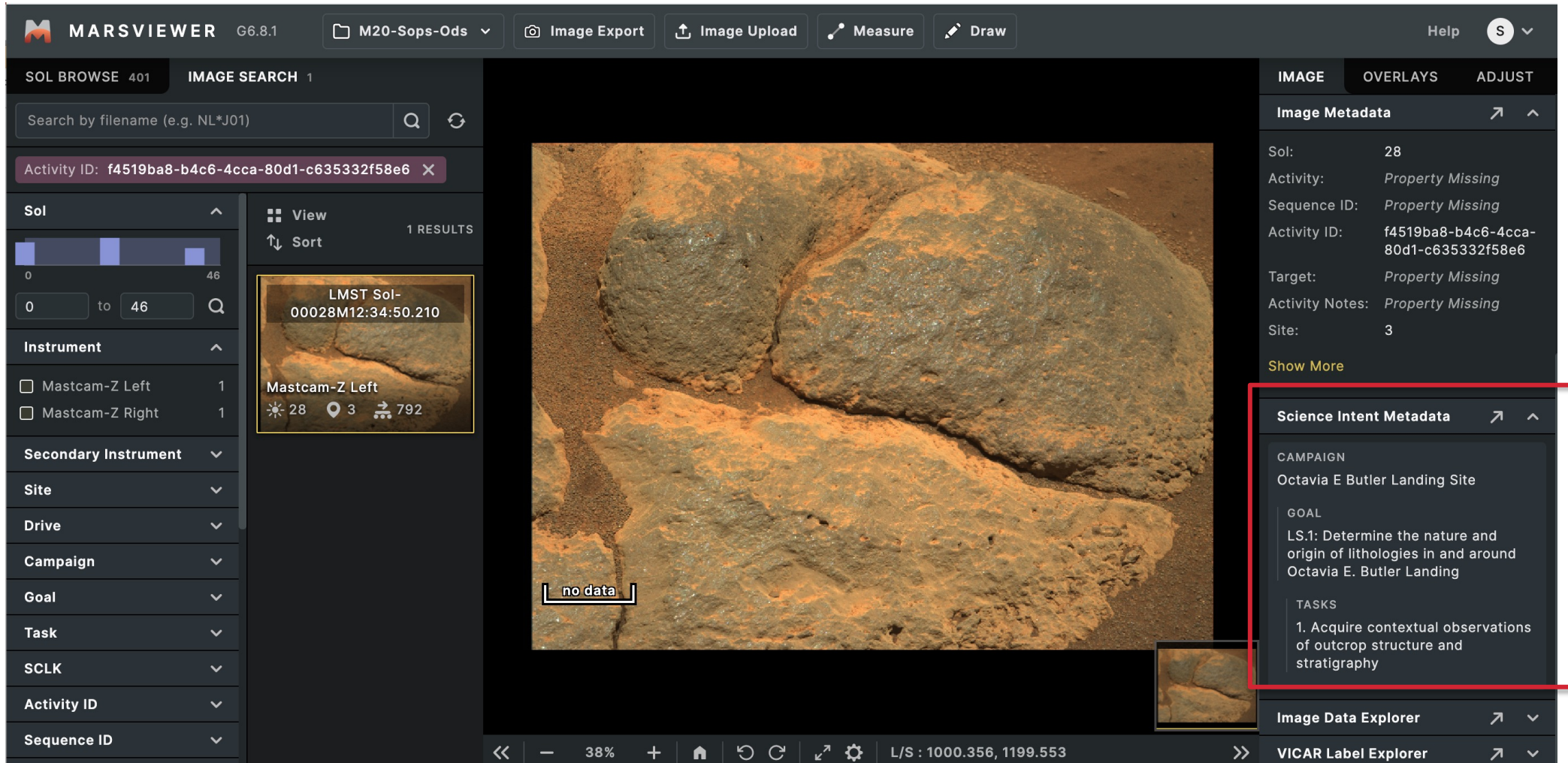
Tactical Reports

[T-Doc](#) [↗](#)
[TSL](#) [↗](#)
[T-LTP](#) [↗](#)
[PILOT/T-SEL](#) [↗](#)
[T-RSS](#) [↗](#)
[Mapping Specialist](#) [↗](#)

CI Reports

[CI Science Report](#) [↗](#)
[CI-SEL](#) [↗](#)
[CI-RSS](#) [↗](#)

MarsViewer– Goal + Task Metadata on Image




The screenshot displays the MarsViewer web application interface. The top navigation bar includes the MarsViewer logo, version G6.8.1, and various tool buttons like Image Export, Image Upload, Measure, and Draw. The main interface is divided into several sections:




- SOL BROWSE 401**: A sidebar on the left with a search bar and filters for Sol, Instrument, Secondary Instrument, Site, Drive, Campaign, Goal, Task, SCLK, Activity ID, and Sequence ID.
- IMAGE SEARCH 1**: A central search bar with a search button and a refresh button.
- Activity ID: f4519ba8-b4c6-4cca-80d1-c635332f58e6**: A purple banner displaying the selected activity ID.
- View 1 RESULTS**: A section showing a thumbnail of the selected image with details: LMST Sol-00028M12:34:50.210, Mastcam-Z Left, and a sun icon indicating 28 sols.
- Image Metadata**: A panel on the right showing details for the selected image, including Sol (28), Activity (Property Missing), Sequence ID (Property Missing), Activity ID (f4519ba8-b4c6-4cca-80d1-c635332f58e6), Target (Property Missing), Activity Notes (Property Missing), and Site (3).
- Science Intent Metadata**: A panel on the right, highlighted with a red box, showing the campaign (Octavia E Butler Landing Site), goal (LS.1: Determine the nature and origin of lithologies in and around Octavia E. Butler Landing), and tasks (1. Acquire contextual observations of outcrop structure and stratigraphy).
- Image Data Explorer** and **VICAR Label Explorer**: Panels at the bottom right for further image analysis.

The main image area shows a high-resolution view of a Martian rock surface. A small label "no data" is visible in the bottom left corner of the image. The bottom status bar displays the current zoom level (38%) and the image coordinates (L/S : 1000.356, 1199.553).

SI Tracker – Keywords Creation + Management


G7.2 Tracker Keywords Goals Tasks Connections

Keywords

▶ Atmosphere

▶ Biosignatures

▶ Compounds

▶ Elements

▶ General Descriptive

▼ Landscape

▶ Age

Formation

Landscape Features

Landscape Properties

▶ Minerals

▶ Mission

▶ Rocks

+

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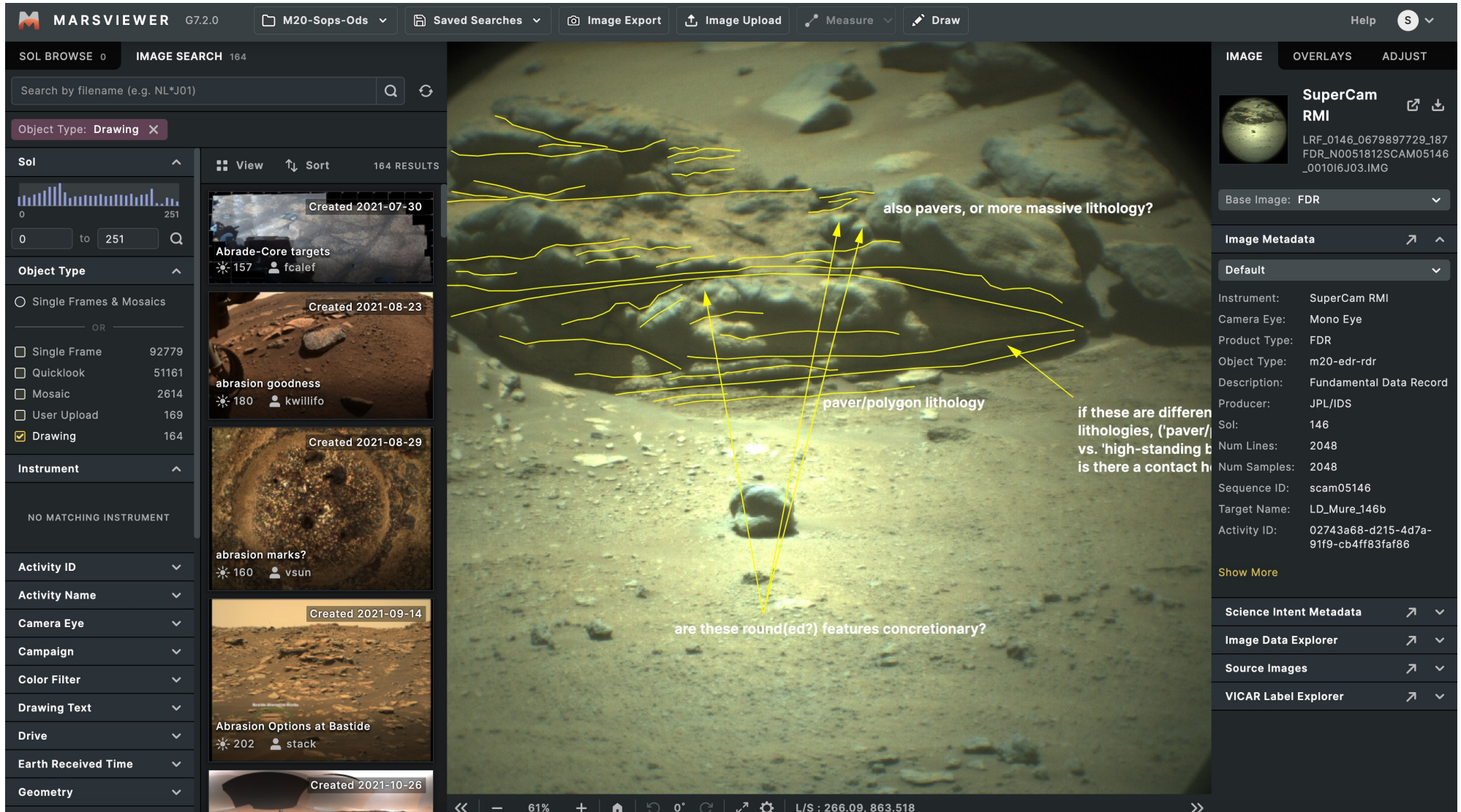
+

+

+

 Add New Keyword

MarsViewer– Annotations, Keywords on Image



The screenshot displays the MarsViewer web application interface. The main window shows a Mars image with several yellow annotations and text labels:

- also pavers, or more massive lithology?** (pointing to a rock in the upper right)
- paver/polygon lithology** (pointing to a rock in the center)
- if these are different lithologies, ('paver' vs. 'high-standing' is there a contact h** (pointing to a rock in the center)
- are these round(ed?) features concretionary?** (pointing to small round features in the lower center)

The left sidebar contains search filters and a list of results:


- SOL BROWSE 0** | **IMAGE SEARCH 164**
- Search by filename (e.g. NL*J01)
- Object Type: **Drawing**
- Sol**: 0 to 251
- Object Type**:
 - Single Frames & Mosaics
 - Single Frame: 92779
 - Quicklook: 51161
 - Mosaic: 2614
 - User Upload: 169
 - Drawing: 164**
- Instrument**: NO MATCHING INSTRUMENT
- Activity ID**: 160 (vsun)
- Activity Name**: Abrasion Options at Bastide
- Camera Eye**: 202 (stack)
- Campaign**: 202 (stack)
- Color Filter**: 202 (stack)
- Drawing Text**: 202 (stack)
- Drive**: 202 (stack)
- Earth Received Time**: 202 (stack)
- Geometry**: 202 (stack)

The right sidebar shows image metadata for the selected image:

- IMAGE** | **OVERLAYS** | **ADJUST**
- SuperCam RMI**
 - LRF_0146_0679897729_187
 - FDR_N0051812SCAM05146_001016J03.IMG
- Base Image: **FDR**
- Image Metadata**
 - Default
 - Instrument: SuperCam RMI
 - Camera Eye: Mono Eye
 - Product Type: FDR
 - Object Type: m20-edr-rdr
 - Description: Fundamental Data Record
 - Producer: JPL/IDS
 - Sol: 146
 - Num Lines: 2048
 - Num Samples: 2048
 - Sequence ID: scam05146
 - Target Name: LD_Mure_146b
 - Activity ID: 02743a68-d215-4d7a-91f9-cb4ff83faf86
- Science Intent Metadata**
- Image Data Explorer**
- Source Images**
- VICAR Label Explorer**

The bottom status bar shows the zoom level (61%) and the location (L/S : 266.09, 863.518).

Rock Atlas – Catalog of features w/ Keywords



[Team Resources](#)
[Strategic Planning](#)
[Pre-Landing](#)
[Working/Planning Groups](#)
[Science Team Meetings](#)
[The Rock Atlas](#)
[EDIT LINKS](#)

The Rock Atlas

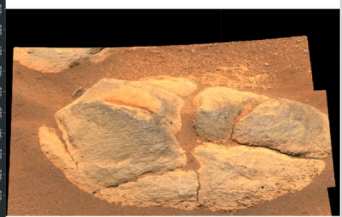
[Team Resources](#)
[The Rock Atlas](#)
[End of Sol Reports](#)
[Spectral Library](#)
[Instrument Resources](#)
[Science Activity Requests](#)
[Science Team Guidelines](#)
[Outreach Materials](#)
[Publications](#)
[Conferences](#)
[Housekeeping](#)
[Student Theses](#)
[Science Team Meetings](#)
[Mars Time](#)
[Recent](#)

[Sample Initial Reports](#)
[SAR Cards](#)
[Blog Library](#)
[Blog List](#)
[Blog Calendar](#)

[Blog Logistics](#)
[Site Contents](#)
[EDIT LINKS](#)

Filter

Sort



Ilina

SOL

28

CAMPAIGN


Octavia E Butler Landing Site

DATA TYPES

IR LIBS RMI

STATUS

Complete



Keyah

SOL

30

CAMPAIGN

Octavia E Butler Lan

DATA TYPES

IR RMI

STATUS

Complete

Ilina

DATA SOURCE/DATE/TIME/COMPOSITION

KEYWORD (FROM KEYWORDS)

low relief

dark toned

dust free

smooth

highly reflective

PIXL MCC

STATU

Con

Hed

SOL

37

CAMP

Oct

DATA

RMI

How Goals and Tasks are Working So Far

Socialization and inclusion in science processes is going well!

Goals and Tasks are being used for:

Identified Goals:

- Decision making
- Handoff sol to sol and process to process
- Tracking Progress
- DL Analysis context
- Archive

Also for:

- Guidance and governance
- Documentation of how plans correspond to mission objectives

“The Goals and Tasks are like the sign posts and fundamental guides for the kinds of activities that are in scope, and they are combined with understanding of what has happened so far and what kinds of observations we haven’t done yet (towards the Goals and Tasks) to define priorities for upcoming sols.”

Science Planner