

# **PDS Geosciences Node Technology and Lessons Learned**

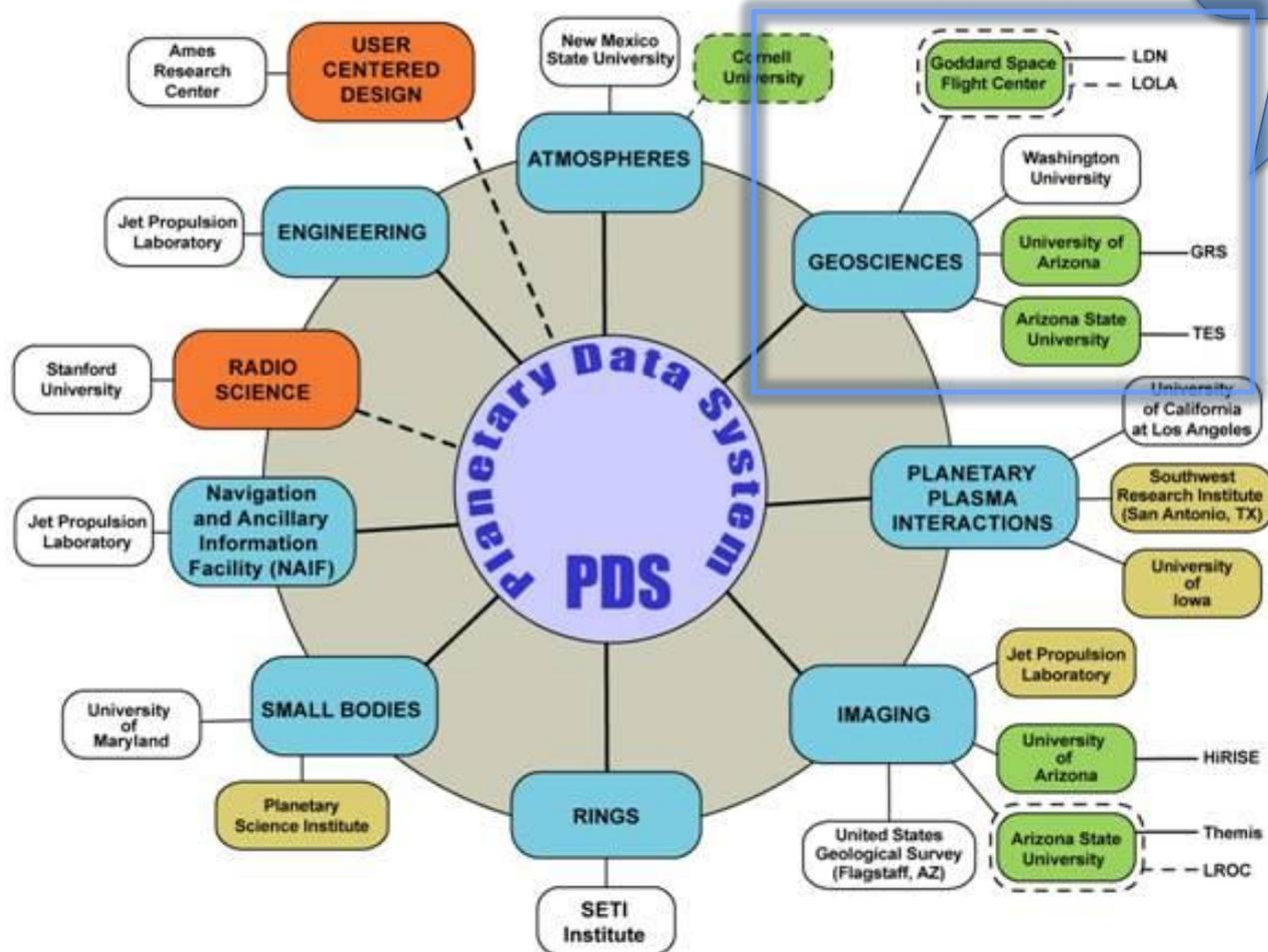
IPDA 7<sup>th</sup> Steering Committee Meeting  
12 July 2012

# What is the Geosciences Node?

- The Planetary Data System (PDS) is a NASA organization that archives science data from NASA's planetary missions.
- PDS responsibilities are:
  - To help NASA missions and other data providers to organize and document their digital planetary data,
  - To collect complete, well-documented planetary data into archives that are peer-reviewed,
  - To make the planetary data available and useful to the science community,
  - To ensure the long-term preservation and usability of the data.

# NODES/SUBNODES/DATA NODES

Function



The Geosciences Node is one of the Discipline Nodes of the PDS.

- Approx 8 FTEs
- Active since the beginning of PDS
- Worked to develop PDS and member of Pilot PDS project
- Geosciences Node Manager co-authored CODMAC (Committee on Data Management and Computation) report in 1982.



*The Geosciences Node is located at Washington University in St. Louis*

# What we do

## **For data providers** (currently 40+)

- Guide archive design and documentation
- Conduct peer reviews and delivery tests
- Validate, distribute, and preserve archives

## **For missions that we lead** (currently 9)

- All of the above
- Help write Mission Archive Plans, set schedule
- Coordinate archiving across all involved PDS Nodes
- Report archive status to mission PSG

## **For users** (~250,000 unique visitors in FY11)

- Provide access to all data holdings on our web site
- Provide special services such as the Analyst's Notebooks and the Orbital Data Explorer
- Provide expert help in response to requests

# Archives holdings by mission

- Active
  - Lunar Reconnaissance Orbiter
  - Mars Reconnaissance Orbiter
  - Mars Exploration Rovers
  - Mars Odyssey
  - Mars Express
  - MESSENGER
  - Laboratory, field, and telescopic data
- Future
  - Mars Science Laboratory
  - GRAIL
- Completed Missions
  - Apollo
  - Mars Global Surveyor
  - Lunar Prospector
  - Chandrayaan-1
  - Clementine
  - LCROSS
  - NEAR
  - Magellan
  - Mariner 9
  - Mars Pathfinder
  - Mars Phoenix Lander
  - Viking Orbiter and Lander

# Geosciences Node holdings and usage

- The Geosciences Node currently has online about 140 TB of data\* in more than 290 data sets from 22 planetary missions and Earth-based experiments.
- Our online holdings will continue to grow over the next few years.
  - MRO holdings will increase by more than 1 TB per month
  - LRO deliveries add more than 2 TB per month
- Our web site receives an average of about 12,000 visits per month from over 50 countries.
- About 500 GB to 2 TB of data per month are downloaded from the Geosciences Node.

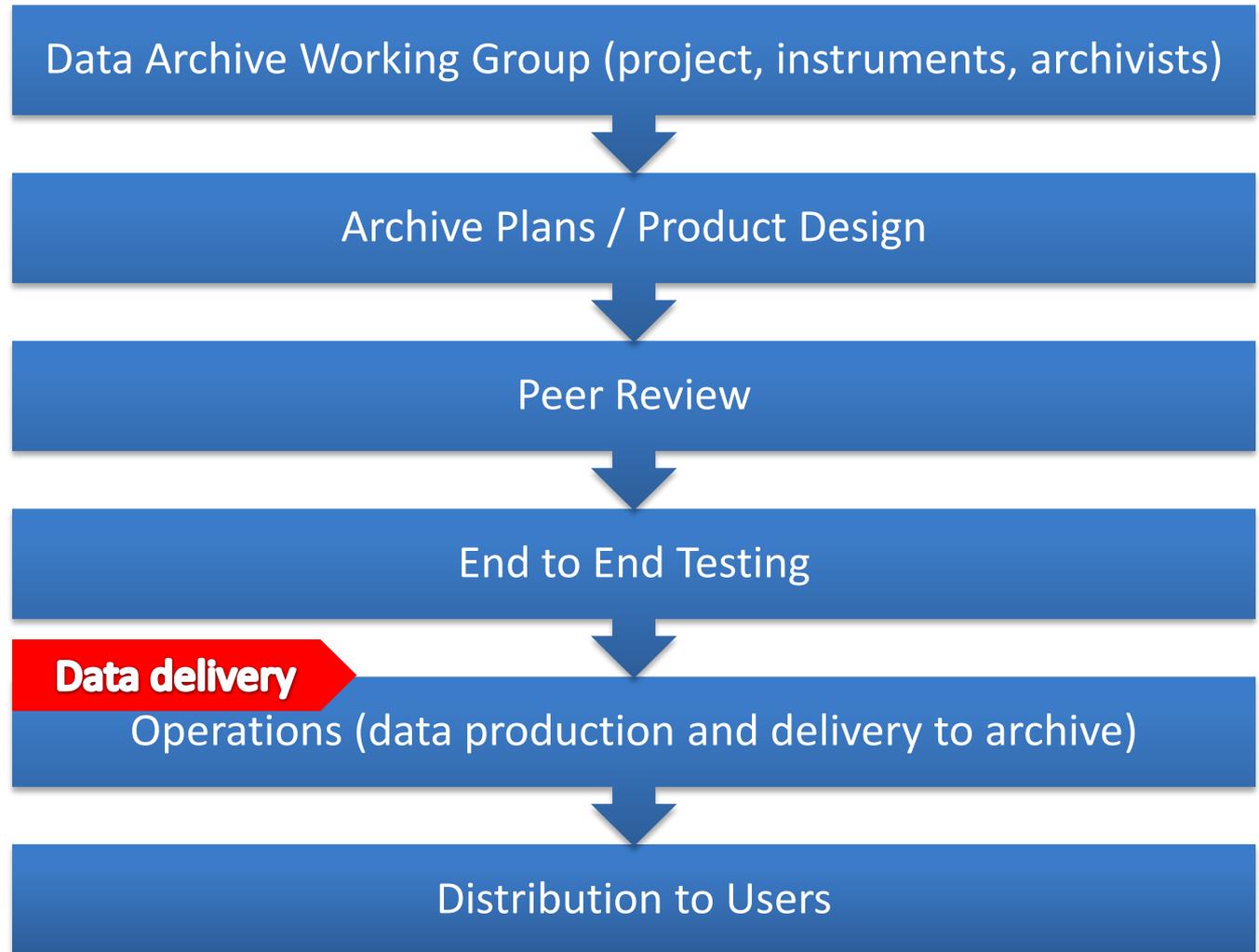
*\*Size of archives, not including working space and value added non-archive products*

# Scheduled data releases

	2012			2013			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GRAIL			●				●
LRO	●	●	●	●	●	●	●
Mars Odyssey	●	●	●	●	●	●	●
MER	●	●	●	●	●	●	●
MESSENGER		●		●		●	
MRO	●	●	●	●	●	●	●
MSL				●	●	●	●

# Data archive life cycle

Lessons learned from archiving experience have helped formulation of standard practices for interfacing with missions related to archive production.



# Lesson learned #1



**Garbage in = Garbage out**

# Lessons learned from projects

- Start planning for the data archives early in the project lifecycle.
  - Archiving group and project should begin process as soon as possible
- Have an archive person from the mission (Project Scientist or designee) to work with the lead PDS node to coordinate work across teams such as
  - Completing ICDs (Interface Control Documents) and SIS (Software Interface Specification) documentation
  - Schedules
  - Delivery tests
  - Action items, etc
  - Archive person should be well-informed about mission schedules and milestones relevant to archive work -- e.g. peer reviews should be done in time for software to be completed for an operations readiness test.
- If an organization other than the instrument teams is making data products (e.g. mission operations center), get them involved early on
  - Include these facilities in ICDs

# Lessons learned from data archiving

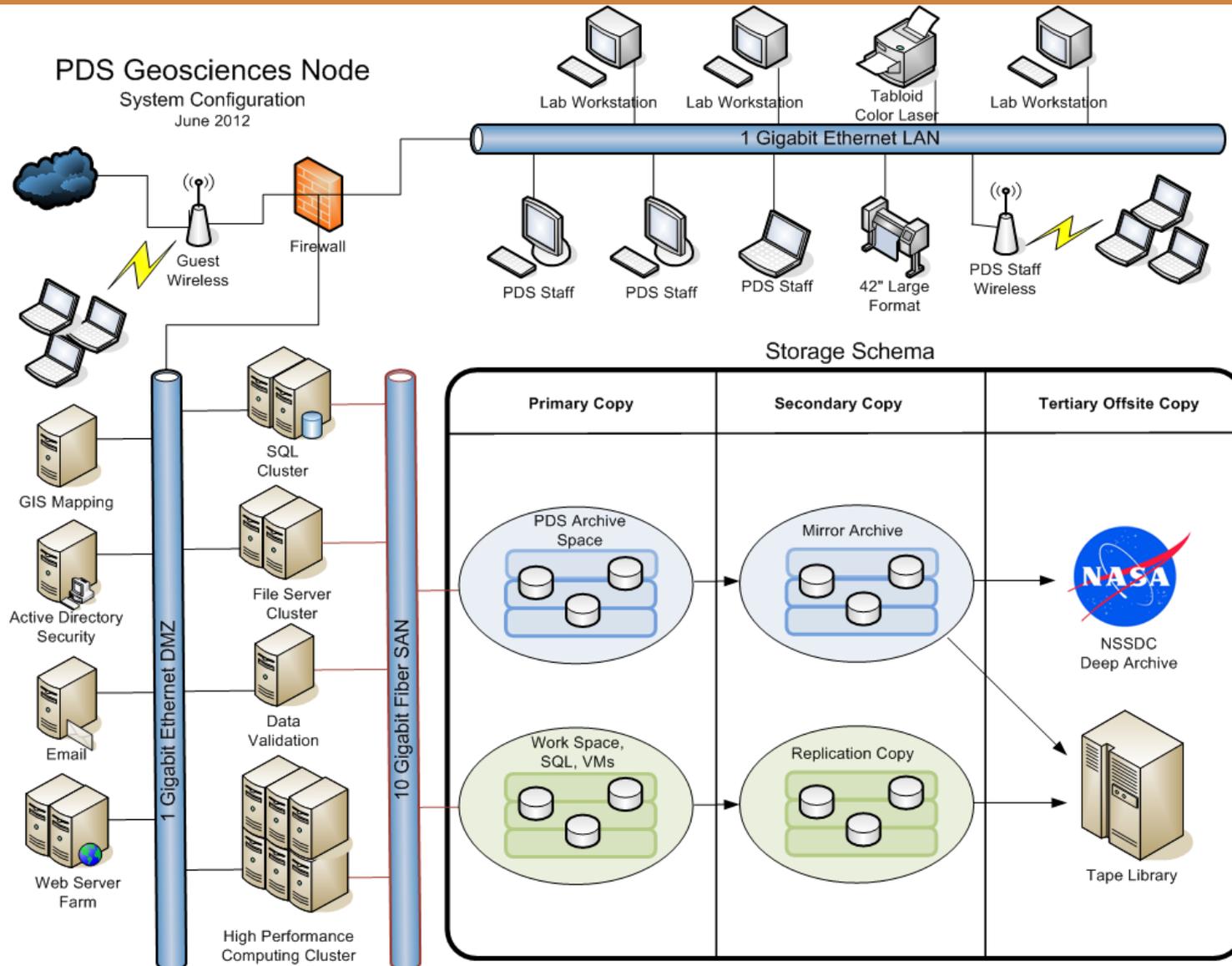
- 1. Good software tools are essential.
  - No point having standards if there are no tools that apply them or benefit from them.
- 2. Archive team must have balanced skill set
  - Having PDS reps with experience in both science and archive systems is very helpful. Having all that plus actual experience working for a mission is ideal.
- 3. Keep the big picture in mind and do not get bogged down in details.
  - The big picture is how do we archive the highest quality data and make it easy for users to use it. This has to be explained to data providers so that they understand why they are being asked to adhere to standards. Curiously, there are some people in PDS to whom neither of these things is the highest priority (quality data or ease of use); instead they focus all their energy on the third part of our charter: establishing archive standards. That is a head-in-the-sand approach.



# Lessons learned from data archiving

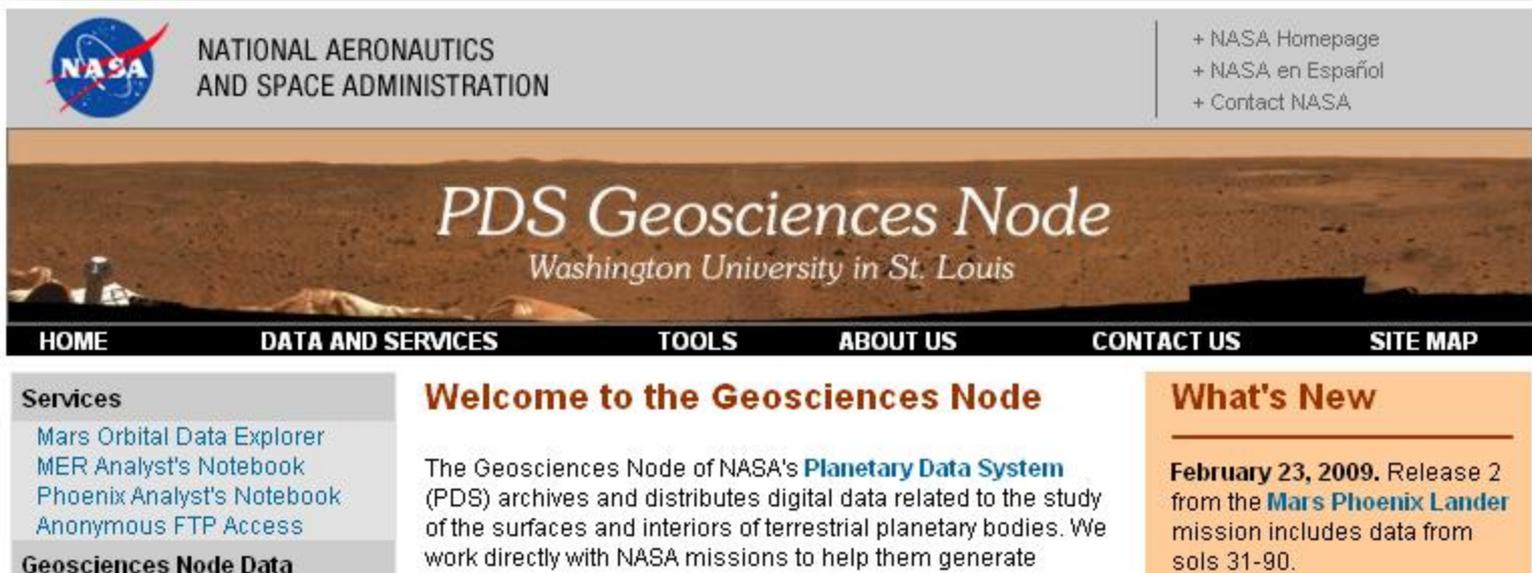
- 4. Have mission do end-to-end delivery tests.
  - It's what makes the data providers finally connect the dots.
- 5. Expand mission archiving standard practices to individual-provider data sets.
  - We have good practices for archiving mission data, but we need to develop a set of standard practices for individual-provider data sets such as laboratory spectra. There will be more and more of these.
- 6. Increase leverage for getting archive work done.
  - PDS does not have much leverage with missions to get the archiving work done. We have no carrot and no stick. It's necessary (but not always sufficient) to have one person on each instrument team designated as the archive lead, AND one person at a management level designated to oversee the whole mission's archive.

# System configuration



# Geosciences services: web site

- Web site **<http://pds-geosciences.wustl.edu>**
  - Online access to all our holdings, organized in top-down hierarchy of planet, mission, instrument, data set
  - List of tools and services of interest, within and outside PDS
  - “What’s New” updated when new data are available



The screenshot shows the homepage of the PDS Geosciences Node. At the top left is the NASA logo and the text "NATIONAL AERONAUTICS AND SPACE ADMINISTRATION". To the right are links for "+ NASA Homepage", "+ NASA en Español", and "+ Contact NASA". The main banner features a Mars landscape with the text "PDS Geosciences Node" and "Washington University in St. Louis". Below the banner is a navigation menu with links for "HOME", "DATA AND SERVICES", "TOOLS", "ABOUT US", "CONTACT US", and "SITE MAP". The page is divided into three columns: "Services" with links to "Mars Orbital Data Explorer", "MER Analyst's Notebook", "Phoenix Analyst's Notebook", and "Anonymous FTP Access"; "Geosciences Node Data"; "Welcome to the Geosciences Node" with a paragraph about the PDS; and "What's New" with a date "February 23, 2009" and text about the "Mars Phoenix Lander" mission.

# Geosciences services: user forum

**PDS Geosciences** [Sign In](#) [Register Now!](#) [Help](#)

**Forums** [Members](#) [Downloads](#) [Blogs](#)

PDS Geosciences Node Community

### PDS Geosciences Node

Forum	Last Post Info
<b>Announcements</b> Topics: 43 Replies: 3	<b>New Mars Odyssey GRS/HEND data</b> by Susie Slavney 27 June 2012 - 11:58 AM
<b>For data providers</b> Topics: 2 Replies: 0	<b>Planetary Data Workshop: Ca...</b> by Susie Slavney 21 February 2012 - 10:48 AM
<b>For data users</b> Topics: 17 Replies: 46	<b>LEND Data Processing Document</b> by Jennifer Ward 26 June 2012 - 07:29 AM

### PDS Geo Tools

Forum	Last Post Info
<b>Analyst's Notebook</b> Topics: 8 Replies: 14 <a href="#">Announcements</a> <a href="#">Using the Notebook</a> <a href="#">Feature requests</a>	<b>Silverlight problem</b> by calixhwang 23 June 2012 - 05:22 PM
<b>ODE - Orbital Data Explorer</b> Topics: 48 Replies: 11 <a href="#">Announcements</a> <a href="#">Using ODE</a> <a href="#">Feature requests</a>	<b>ODE - New HiRISE DTM Data A...</b> by nayemkhulna 09 July 2012 - 06:42 PM

### Additional Content

#### Latest Files

- CAT (CRISM Analysis Toolkit) History String Description by Jennifer Ward (26 March 2012 - 06:57 AM)
- CAT (CRISM Analysis Toolkit) V7.0 Release Notes by Jennifer Ward (26 March 2012 - 06:45 AM)
- sgs\_read.txt by Susie Slavney (09 November 2011 - 02:41 PM)
- Introduction to CAT by Tom Stein (13 June 2011 - 07:21 AM)
- CAT (CRISM Analysis Toolkit) User's Guide by Tom Stein (13 June 2011 - 07:00 AM)
- CAT (CRISM Analysis Toolkit) Installation Guide by Tom Stein (13 June 2011 - 07:00 AM)
- CAT (CRISM Analysis Toolkit) by Tom Stein (10 June 2011 - 06:18 AM)

#### Recent Topics Added

- ODE - New HiRISE DTM Data Added to ODE** by K.J. Bennett Jul 05 2012 08:41 AM

# Geosciences Services: Analyst's Notebooks

- Web site **<http://an.rsl.wustl.edu>**
- Concept
  - Explore data products in context of mission plans and events, with multiple approaches for selecting and viewing desired data.
- Highlights
  - Contains integrated data, documents, activity sequences, and coordinated observations.
  - Available for MER, Phoenix, Apollo, and LCROSS missions.
  - MER Notebook used daily by rover mission planners.
    - Feedback used to make improvements.
  - MSL Notebook is planned.
  - Virtual Astronaut prototype for Santa Maria crater.

# Archive volume components

## Archived Data

- Standard EDR and RDR data products

## Documentation

- Software Interface Specification
- Spacecraft and instrument reports

## Calibration Data

- Calibration reports and data

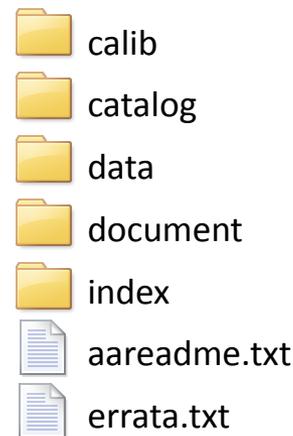


**PDS Archive  
Volume**



**PDS Community**

## Archive volume file structure

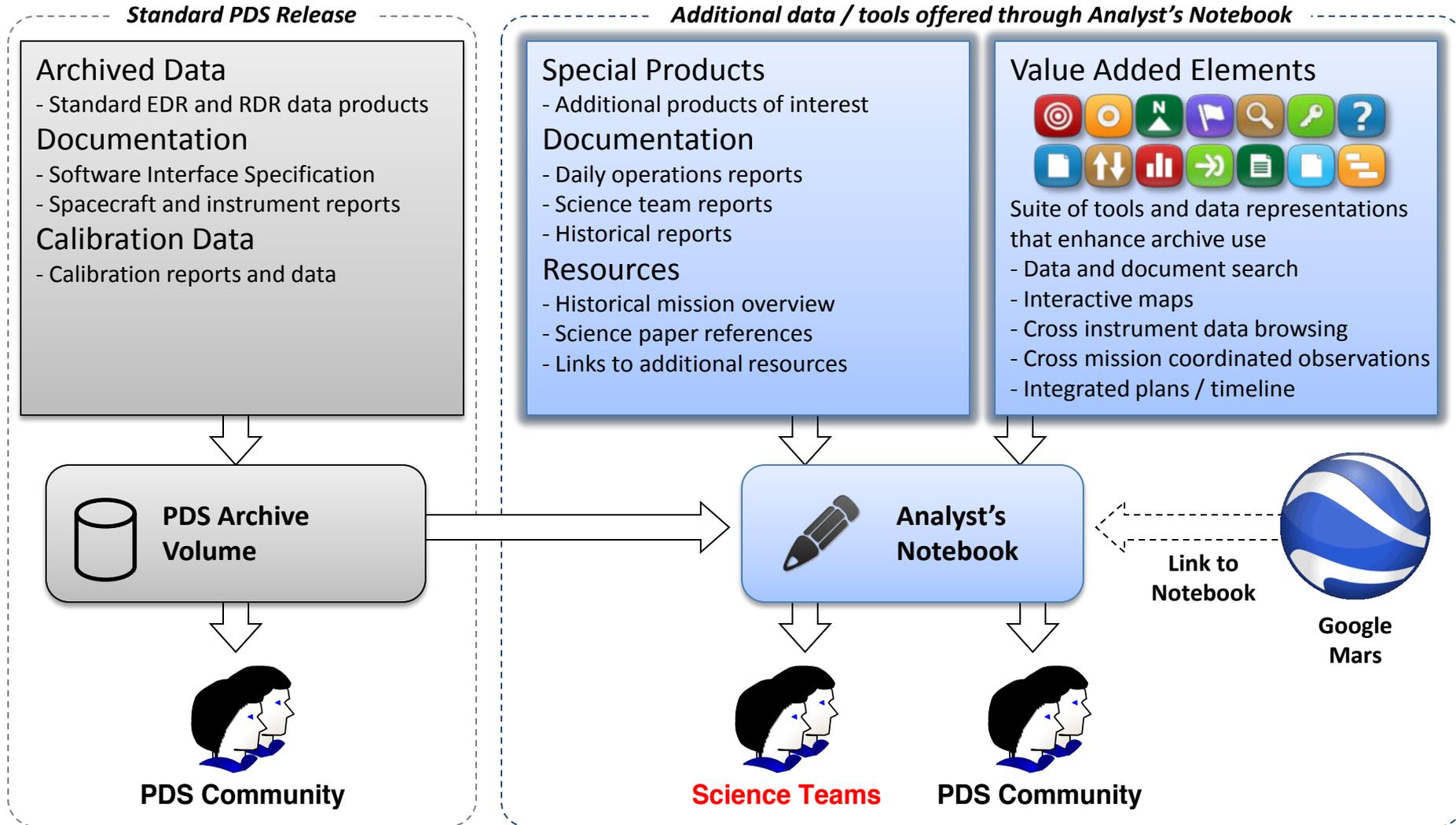


geodata.rsl.wustl.edu - /mer/mer1-m-pancam-3-radcal-rdr-v1  
/mer1pc\_1xxx/data/sol0004/

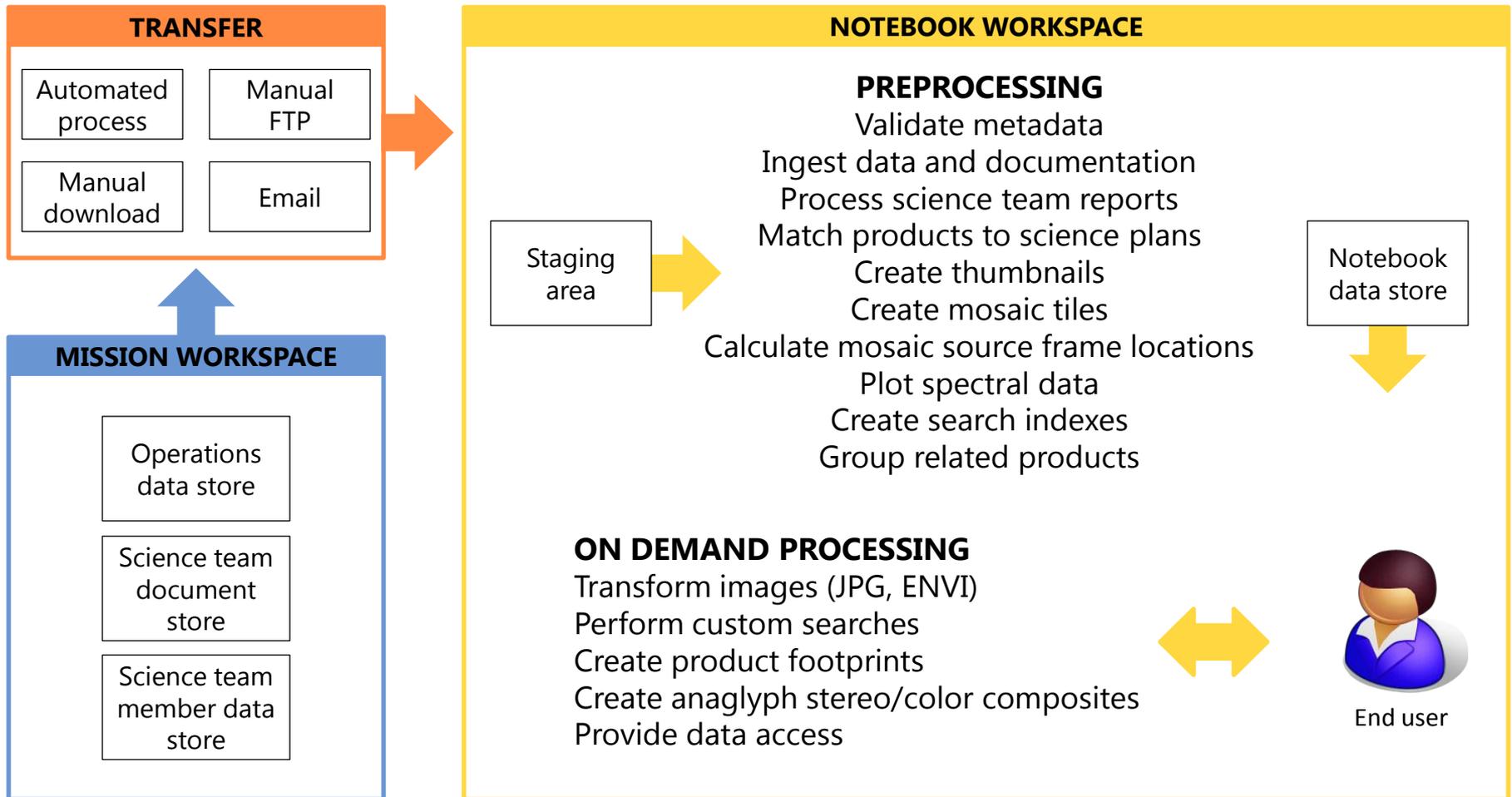
[\[To Parent Directory\]](#)

Wednesday, September 29, 2004 3:18 PM	2142208	<a href="#">lp128532760rad0200p285114cl.img</a>
Wednesday, September 29, 2004 3:18 PM	50048	<a href="#">lp128532760rat0200p285114cl.img</a>
Wednesday, September 29, 2004 3:18 PM	2142208	<a href="#">lp128532801rad0200p285115cl.img</a>
Wednesday, September 29, 2004 3:18 PM	50048	<a href="#">lp128532801rat0200p285115cl.img</a>
Wednesday, September 29, 2004 3:19 PM	2142208	<a href="#">lp128532843rad0200p285116cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50048	<a href="#">lp128532843rat0200p285116cl.img</a>
Wednesday, September 29, 2004 3:19 PM	216320	<a href="#">lp128532898rad0200p285114cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50176	<a href="#">lp128532898rat0200p285114cl.img</a>
Wednesday, September 29, 2004 3:19 PM	216320	<a href="#">lp128532950rad0200p285115cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50176	<a href="#">lp128532950rat0200p285115cl.img</a>
Wednesday, September 29, 2004 3:19 PM	216320	<a href="#">lp128533003rad0200p285116cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50176	<a href="#">lp128533003rat0200p285116cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50148	<a href="#">lp128534453rad0203p260018cl.img</a>
Wednesday, September 29, 2004 3:19 PM	41814	<a href="#">lp128534453rad0203p2600r8cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50432	<a href="#">lp128534453rat0203p260018cl.img</a>
Wednesday, September 29, 2004 3:19 PM	50432	<a href="#">lp128534453rat0203p2600r8cl.img</a>
Wednesday, September 29, 2004 3:20 PM	2142208	<a href="#">lp128534493rad0203p285018cl.img</a>
Wednesday, September 29, 2004 3:20 PM	2142208	<a href="#">lp128534493rad0203p285018cl.img</a>
Wednesday, September 29, 2004 3:20 PM	50432	<a href="#">lp128534493rat0203p285018cl.img</a>
Wednesday, September 29, 2004 3:20 PM	50432	<a href="#">lp128534493rat0203p2850r8cl.img</a>
Wednesday, September 29, 2004 3:21 PM	2142208	<a href="#">lp128534537rad0203p285018cl.img</a>
Wednesday, September 29, 2004 3:21 PM	2142208	<a href="#">lp128534537rad0203p2850r8cl.img</a>
Wednesday, September 29, 2004 3:21 PM	50176	<a href="#">lp128534537rat0203p285018cl.img</a>
Wednesday, September 29, 2004 3:21 PM	50176	<a href="#">lp128534537rat0203p2850r8cl.img</a>
Wednesday, September 29, 2004 3:21 PM	74752	<a href="#">lp128534568rad0203p261013cl.img</a>
Wednesday, September 29, 2004 3:21 PM	50048	<a href="#">lp128534568rat0203p261013cl.img</a>
Wednesday, September 29, 2004 3:21 PM	75520	<a href="#">lp128534606rad0203p261016cl.img</a>
Wednesday, September 29, 2004 3:21 PM	74752	<a href="#">lp128534606rad0203p2610r6cl.img</a>

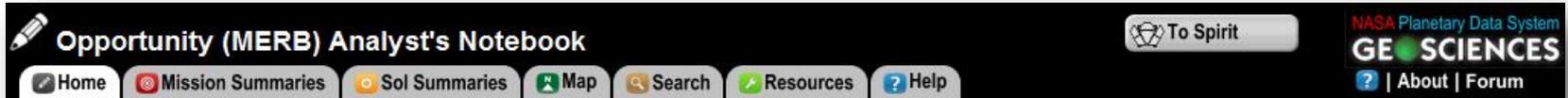
# Analyst's Notebook components



# Populating the Notebook



# Navigating the Notebook



Use the navigation tabs above to explore the MER Mission or preview Notebook functions using the menu below.

Notebook overview

Mission summaries

**Sol summaries**

Map

Search

Resources

Help

Release notes

**Sol summaries** provide access to science data, documentation, and sequence timelines for each sol.

Browse versions of data are available, and products may be downloaded.

## What's new in the Notebook

**NEW FEATURE**

### Mosaic Viewer

Interact with the latest traverse maps and mosaics using the new Mosaic Viewer.

[Click here to start!](#)

# Mission summaries

## Phoenix Analyst's Notebook

NASA Planetary Data System

## GE SCIENCES

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Home
Sol Summaries
Mission Summaries
Search
Resources
Help

### Phoenix Mission Historical Overview

? [How to use this page](#)

⊕ Specify columns to show
⊕ Download the table

Sol	Activity	Coordinated Obs	A RA	S SSI	Dig Summary	Dig Location
11	TEGA atmospheric measurement; RA acquire sample with RAC documentation; SSI multispectral spot "Lory" and "Mad Hatter"	<a href="#">Dust/Ice TOD 14:21:45</a>	Acquire "Baby Bear" sample with RAC documentation and move to TEGA-4 delivery pose	13 filter samp site selection	Acquire TEGA "Baby Bear" sample	Wall (Baby Bear)
15	TEGA shake; RA sprinkle test	<a href="#">Vapor Dist. 22:22:23</a> <a href="#">23:28:21</a> <a href="#">03:48:51</a> <a href="#">07:25:46</a>	Sprinkle test	—	Test Sprinkle	—
20	TEGA-4 mid temp ramp; Groom "DodoGoldilocks"	<a href="#">Albedo 15:00:38</a>	Groom "DodoGoldilocks"	SSI change monitoring, Mission success	Extend and "Groom" DodoGoldilocks trench	Wall (DodoGoldilocks2)
22	TEGA-4 high temp ramp; RA trenching in "Wonderland"	<a href="#">Sky brightness 14:20:38</a> , <a href="#">Albedo 14:48:05</a>	Dig "Wonderland" trench	Mission success, Image dump site	Excavate Trench in Wonderland	Wonderland (Wonderland)
32	Scrape "Snow White"	<a href="#">Dust, Ice dist. 14:38:48</a> , <a href="#">(4)3:36:16</a>	Scrape "Snow White"	Mission Success, Ice Structural Column, Preheat test	Dig and Groom Snow White 4	Wonderland (Snow White3)

No Filter

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Is Not Empty

No Filter

Records per page: 5 [Apply Filter](#) | [Hide Filter](#) | [Remove Filter](#) - <<< < 1 | 2 | 3 > >>>

*Phoenix mission historical overview*

# Sol summaries

The screenshot displays the 'Opportunity (MERB) Analyst's Notebook' interface. At the top, there are navigation tabs for Home, Mission Summaries, Sol Summaries, Map, Search, Resources, and Help. The 'Sol Summaries' tab is active. Below the navigation, the 'SOL SUMMARY REPORTS' section provides instructions on how to use the interface. It includes a 'SOL' dropdown menu set to '4' and a 'REPORT' dropdown menu set to 'Data products'. A list of reports is shown, each with a small thumbnail and a brief description of the products. The right side of the interface features a 'SEQUENCE MENU' with options for Overview, Image, Product Documents, and Help. The main display area shows a 'Panoramic Camera Product Sequence P2353' with a large image of the Martian surface, which is a custom anaglyph image with red and cyan color channels.

Opportunity (MERB) Analyst's Notebook

Home Mission Summaries Sol Summaries Map Search Resources Help

NASA Planetary Data System  
GE SCIENCES  
About Comments

To Spirit

SOL SUMMARY REPORTS

Enter sol or select from list. Then select a report to access documents and data.

SOL Sol 3 4 Sol 5

REPORT Data products

1 P 128532760 EFF 02 00 P2851 L4 C1...  
3 products : L456

1 P 128532898 ESF 02 00 P2851 L4 C1...  
3 products : L456

1 F 128533972 EDN 02 00 F0006 L0 M1...  
2 products : L0 R0

1 F 128534090 EDN 02 03 F0006 L0 M1...  
4 products : L0 R0

1 R 128534303 EDN 02 03 P1002 L0 M1...  
2 products : L0 R0

1 P 128534453 ESF 02 03 P2600 L8 C1...  
2 products : L8 R8

1 P 128534493 EFF 02 03 P2850 L8 C1...  
4 products : L8 R8

1 P 128534568 EDN 02 03 P2610 L3 C1  
1 product : L3

1 P 128534606 EDN 02 03 P2610 L6 C1...  
2 products : L6 R6

1 P 128534645 EDN 02 03 P2610 L3 C1...  
3 products : L36 R6

SEQUENCE MENU

Overview

Image

Product Documents

Help

Panoramic Camera  
Product Sequence P2353

*Opportunity data products and custom anaglyph*

# Sol summaries

**Phoenix Analyst's Notebook** NASA Planetary Data System  
**GE SCIENCES**  
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**SOL SUMMARY REPORTS**  
Enter sol or select from list. Then select a report to access documents and data.

SOL [Sol 66](#) 67 [Sol 68](#)

REPORT Timeline

8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00

sky mini)  
e)  
P TECP Wind/Humidity (No RA Move)  
L 30 min lidar v10  
SSI ATM - diurnal nighttime (with water sky mini)  
Water Sky Mini w/ BG Heat  
L 30 min lidar v10  
S SSI ATM - diurnal nighttime (with water sky mini)  
X P TECP Wind/Humidity (No RA Move)  
S Water Sky Mini w/ BG Heat  
RA LPEB preheat  
M PT data xfer and restart v10  
F X W O S R INTEROP: Spi  
T T  
MECA\_OM\_Sol\_A\_opposite subs  
OM Canonical Sol A\_strong\_ma

**SOL 67 OBSERVATION SSI ATM - diurnal nighttime (with water sky mini)**

**Activities and Data Products**

Select an activity or product to view

- SSI\_ON 1 with init [0000]
- SSI\_OD\_6Filter [178A]
  - S SS 067 RAD 902144518\_178A3L3 T1  
1 product : /3
  - S SS 067 RAD 902144805\_178A3L4 T1  
2 products : /45

**Observation**

Name ..... SSI ATM - diurnal nighttime (with water sky mini)

Purpose .....

Custodian .....

Start time (UTC) ..... 2008-08-02T11:31:31

Uplink priority ..... 0

Notes ..... Also has change-monitoring frost spot for Cupboard trench

Phoenix product timeline view

# Station summaries

## Apollo 16 Analyst's Notebook

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**GE SCIENCES**  
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### STATION VIEW

Mission overview ?

Station 10 Station overview

Instruments Samples

-  **Rock 60057**  
Cataclastic Anorthosite
-  **Rock 60058**  
Fragmental polymict breccia
-  **Rock 60059**  
Cataclastic Anorthosite
-  **Rock 60075**  
Fragmental polymict breccia
-  **Rock 60095**  
Glass
-  **Rock 60115**  
Glassy breccia
-  **Rock 60135**  
Cataclastic Anorthosite

### Station 10 - Lunar Module/ALSEP

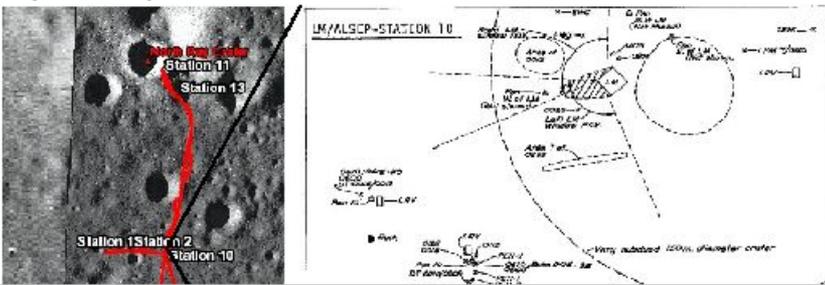
Station 10 includes the area around the Lunar Module (LM). It also includes the area where the astronauts deployed the Apollo Lunar Surface Experiments Package (ALSEP). The ALSEP included the Heat Flow, Passive Seismic, Active Seismic, and Lunar Surface magnetometer experiments. The Solar Wind Spectrometer was also deployed at Station 10. The astronauts also made a Portable Magnetometer measurement, made penetrometer measurements, used the Far-UV camera, collected a Deep Drill core to examine deep lunar stratigraphy, and collected drive core, rock and soil, samples. All activities were documented with photography.

#### Panorama



Apollo Surface Panoramas from LPI  
[Click to view full-size image](#)

#### Map and sample locations



The map shows the lunar surface with various stations and sample locations. A red line indicates the path from Station 10 to Station 11 and Station 13. The diagram includes labels for 'LM/ALSEP-STATION 10', 'Station 11', 'Station 13', 'Station 12', and 'Station 10'. It also shows 'Area of rock' and 'Area of soil' near the LM/ALSEP-STATION 10. A note indicates 'Very subdued 100m diameter crater'.

## Apollo rock samples

# Maps

## Spirit (MERA) Analyst's Notebook

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To Opportunity NASA Planetary Data System GE SCIENCES About Comments

### Rover Site Map

Use the Rover Site Map to see nadir view-oriented maps of rover sites. Use the options on the left to control the map. Click on the map to display data products at a given point. The [site map help page](#) describes how to use the map and what assumptions are made in producing the map.

#### Site and Position

Wait for map to update after changing site or position.

Current Site: Site 5 (Sols 39 to 43)

Current Position: Position 0 (Sols 39 to 40)

#### Map Appearance

Data Products: Show for all sols at this site/position

- P Pancam
- FH Front Hazcam
- N Navcam
- RH Rear Hazcam
- M Microscopic Imager

Features: Show for all sols at this site

Map Width: Default

Image Size: Medium

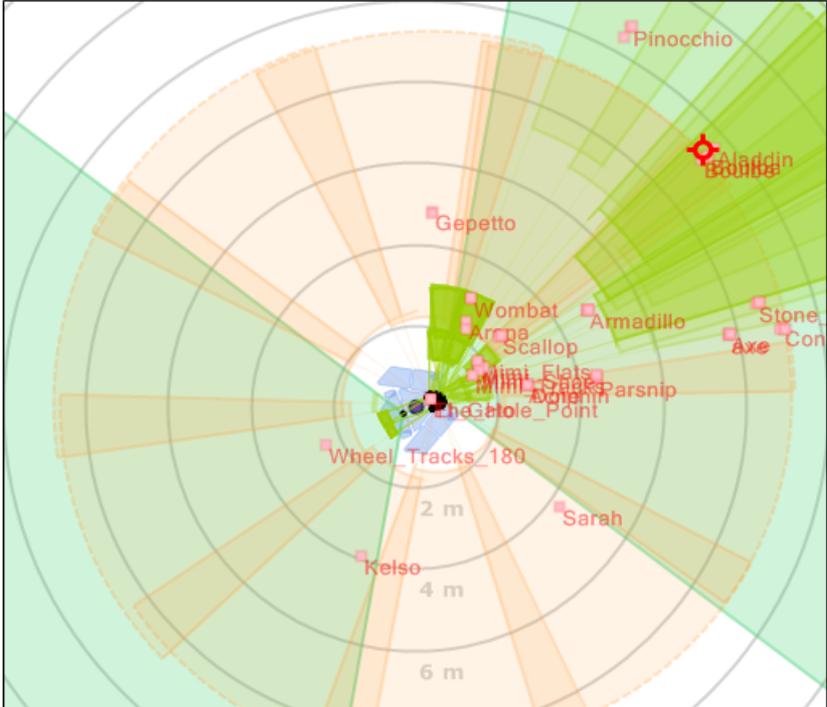
Background:  Show distance rings

Redraw Map

#### Selected Products

Products found:

- Full frame EDR  
2 P 129835149 EFF 05 00 P2396 L2 C1



The map displays a central rover location with various sites marked, including Pinocchio, Gebetto, Wombat, Armadillo, Stone, Con, Axe, Mimi, Flats, Parsnip, The Gate Point, Wheel Tracks 180, Sarah, Kelso, and Scallop. Concentric distance rings are shown at 2 m, 4 m, and 6 m intervals. Product footprints are overlaid on the map, showing the areas where data was collected.

*Spirit rover site map with product footprints*

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# Search

**Spirit (MERA) Analyst's Notebook**

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### Spirit Sol-by-Sol Document Search

Search through the science sol-by-sol documents by entering one or more keywords. Note that "\*" and "?" wildcards are supported.

aladdin

Match:  any search words  all search words

Find this type of file: All

#### Search results for: aladdin in all categories

10 results found.

Refine your search by category:

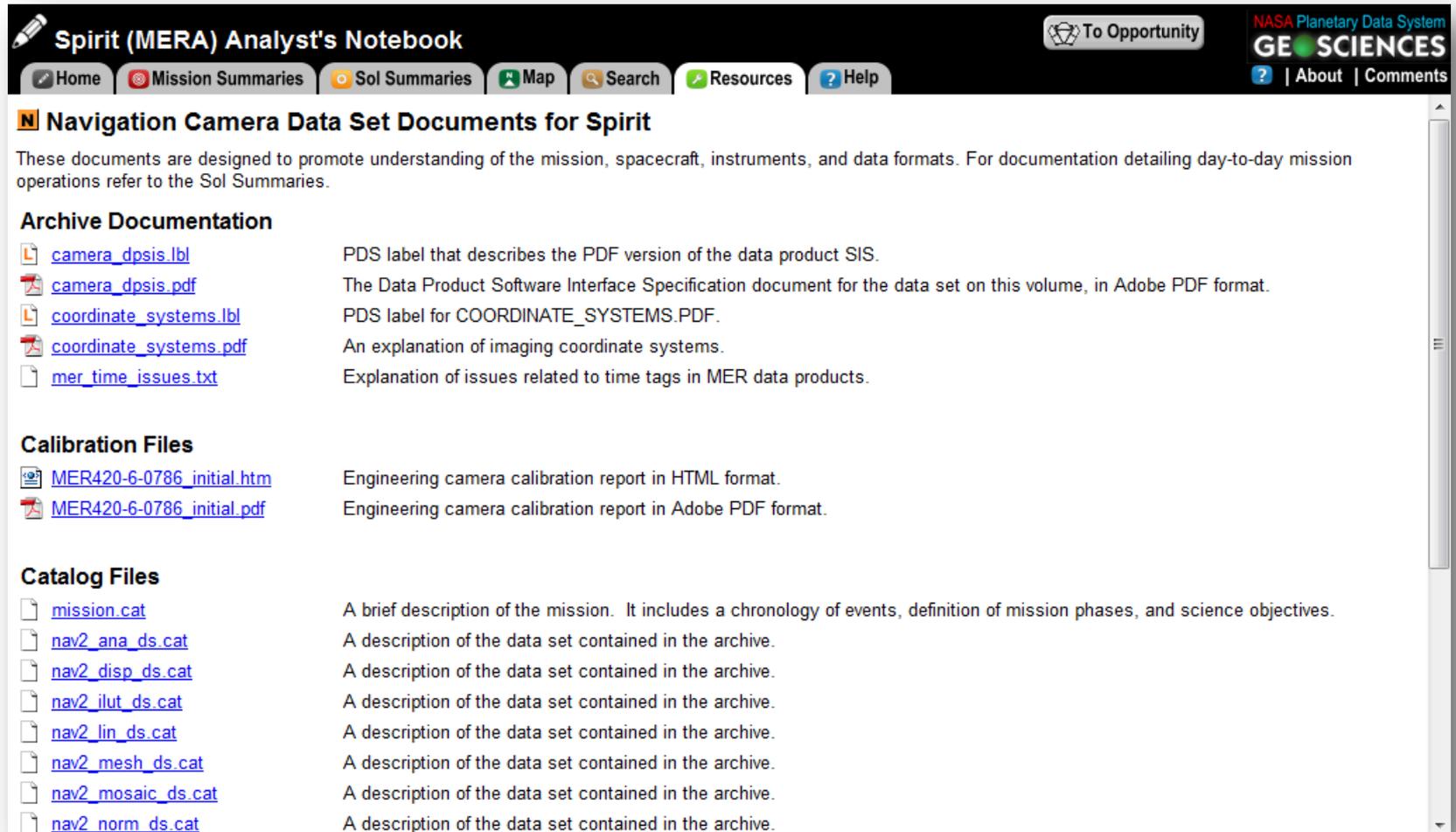
- [Word Documents](#) (1)
- [Excel files](#) (5)
- [PDF Files](#) (2)

Did you mean: [Alatna?](#)

- [1. Sol 1](#) [Word Documents]  
... planned sequences except the MiniTES superresolution. However, an error in the MiniTES of **Aladdin** on Magic Carpet pointed the instrument at the sky, so we missed the ...  
28 Jan 2008 - 205k - URL: [http://an.rsl.wustl.edu/mer/pages/mera/docs/0010/SWD/1073921612\\_9749\\_Sol\\_09\\_SOWG\\_Doc\\_Report.doc](http://an.rsl.wustl.edu/mer/pages/mera/docs/0010/SWD/1073921612_9749_Sol_09_SOWG_Doc_Report.doc)
- [2. Sol 9 \(MER A Uplink Report\)](#)  
... rock), a spot on Ichabod Flats in Sleepy Hollow, a spot on **Aladdin** in Magic Carpet, and a 25x25 superresolution raster of Pitch Fork. The ...  
20 Nov 2009 - 8k - URL: <http://an.rsl.wustl.edu/mer/pages/mera/docs/0009/SWD/2C0009SWD.htm>
- [3. Sol 08 SOWG Doc Report](#) [PDF Files]  
... rock), a spot on Ichabod Flats in Sleepy Hollow, a spot on **Aladdin** in Magic Carpet, and a 25x25 superresolution raster of Pitch Fork. The ...  
12 Jan 2004 - 199k - URL: [http://an.rsl.wustl.edu/mer/pages/mera/docs/0009/SWD/1073835730\\_32387\\_Sol\\_08\\_SOWG\\_Doc\\_Report.pdf](http://an.rsl.wustl.edu/mer/pages/mera/docs/0009/SWD/1073835730_32387_Sol_08_SOWG_Doc_Report.pdf)
- [4. Sol 09 SOWG Doc Report](#) [PDF Files]  
... planned sequences except the MiniTES superresolution. However, an error in the MiniTES of **Aladdin** on Magic Carpet pointed the instrument at the sky, so we missed

## *Spirit science report text search*

# Additional resources



**Spirit (MERA) Analyst's Notebook** To Opportunity NASA Planetary Data System  
**GE SCIENCES** ? | [About](#) | [Comments](#)

[Home](#) [Mission Summaries](#) [Sol Summaries](#) [Map](#) [Search](#) [Resources](#) [Help](#)

## Navigation Camera Data Set Documents for Spirit

These documents are designed to promote understanding of the mission, spacecraft, instruments, and data formats. For documentation detailing day-to-day mission operations refer to the Sol Summaries.

### Archive Documentation

 <a href="#">camera_dpsis.lbl</a>	PDS label that describes the PDF version of the data product SIS.
 <a href="#">camera_dpsis.pdf</a>	The Data Product Software Interface Specification document for the data set on this volume, in Adobe PDF format.
 <a href="#">coordinate_systems.lbl</a>	PDS label for COORDINATE_SYSTEMS.PDF.
 <a href="#">coordinate_systems.pdf</a>	An explanation of imaging coordinate systems.
 <a href="#">mer_time_issues.txt</a>	Explanation of issues related to time tags in MER data products.

### Calibration Files

 <a href="#">MER420-6-0786_initial.htm</a>	Engineering camera calibration report in HTML format.
 <a href="#">MER420-6-0786_initial.pdf</a>	Engineering camera calibration report in Adobe PDF format.

### Catalog Files

 <a href="#">mission.cat</a>	A brief description of the mission. It includes a chronology of events, definition of mission phases, and science objectives.
 <a href="#">nav2_ana_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_disp_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_ilut_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_lin_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_mesh_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_mosaic_ds.cat</a>	A description of the data set contained in the archive.
 <a href="#">nav2_norm_ds.cat</a>	A description of the data set contained in the archive.

## *MER Navigation Camera data set documentation*

# Help

The screenshot shows the top navigation bar of the Opportunity (MERB) Analyst's Notebook. It includes a pencil icon, the title "Opportunity (MERB) Analyst's Notebook", a "To Spirit" button, and the NASA Planetary Data System GEOSCIENCES logo with links for "About" and "Forum". Below the navigation bar are tabs for "Home", "Mission Summaries", "Sol Summaries", "Map", "Search", "Resources", and "Help". The main content area is titled "Help Using the Notebook" and contains three sections: "User's Guide", "What's New", and "User Forum". The "User's Guide" section includes links to "Online User's Guide" and "The Complete User's Guide (3.3 MB)". The "What's New" section includes links to "What's new for Spirit" and "What's new for Opportunity". The "User Forum" section is described as an online resource for asking questions and receiving feedback. Below this is a section titled "Help Understanding the Data" with two sub-sections: "Data Set Documents" and "Mission Documentation".

**Opportunity (MERB) Analyst's Notebook** To Spirit NASA Planetary Data System  
GEOSCIENCES | About | Forum

Home Mission Summaries Sol Summaries Map Search Resources Help

## Help Using the Notebook

**User's Guide** The user's guide provides answers to commonly asked questions in addition to detailed information about the data.  
[Online User's Guide](#)  
[The Complete User's Guide \(3.3 MB\)](#)

**What's New** Information on new and updated data, as well as errata and processing notes.  
[What's new for Spirit](#)  
[What's new for Opportunity](#)

[User Forum](#) An online resource where users can post questions and receive feedback from Notebook developers.

## Help Understanding the Data

**Data Set Documents** Data set documents are written by instrument teams and provide technical information about the data. They are accessed from the Resources tab above.

**Mission Documentation** Reports are generated each sol by mission personnel. These documents are grouped by sol and are accessible from the Sol Summaries tab above.

*Help options in the MER Notebook, including user's guide, online forum, and mission documentation*



# Mosaic Viewer



# Virtual Astronaut

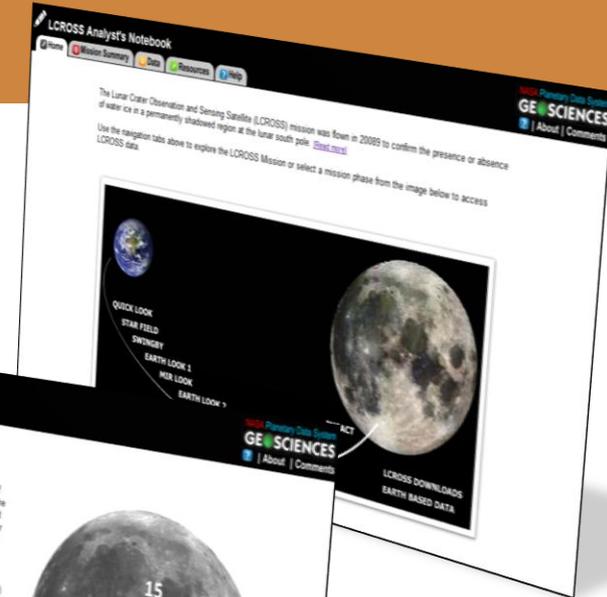
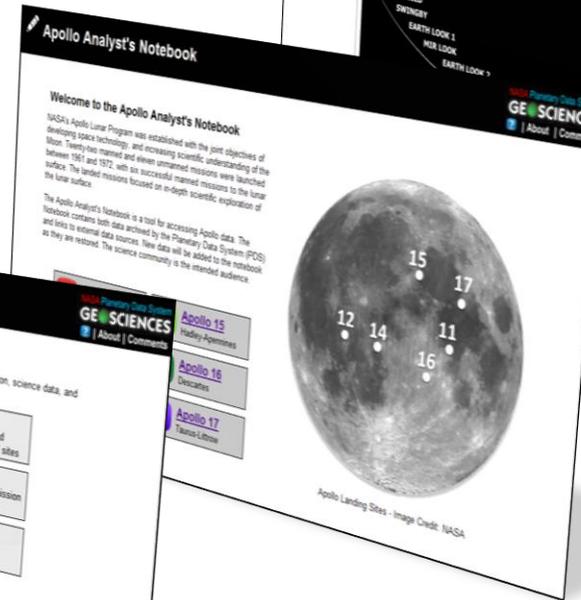
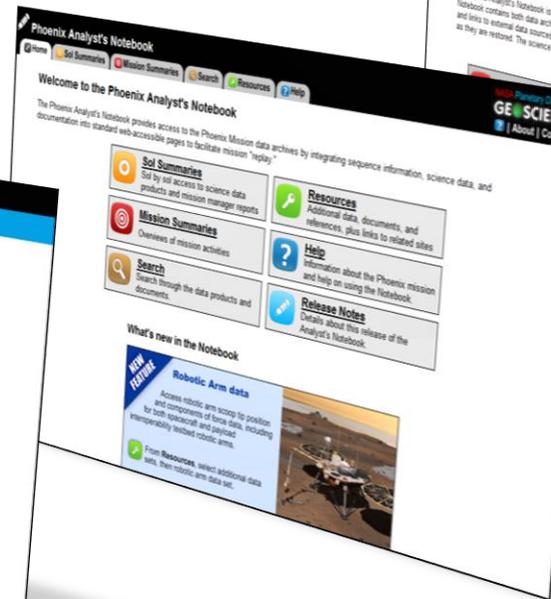
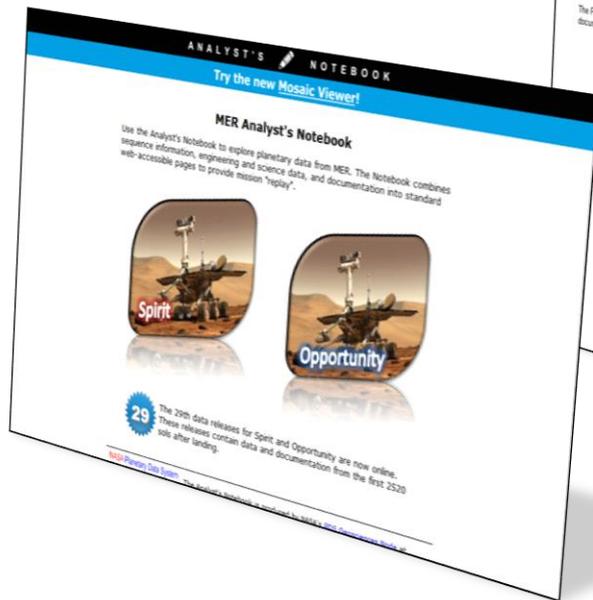


*Virtual Astronaut with Opportunity at Santa Maria crater.*

# PDS Analyst's Notebooks

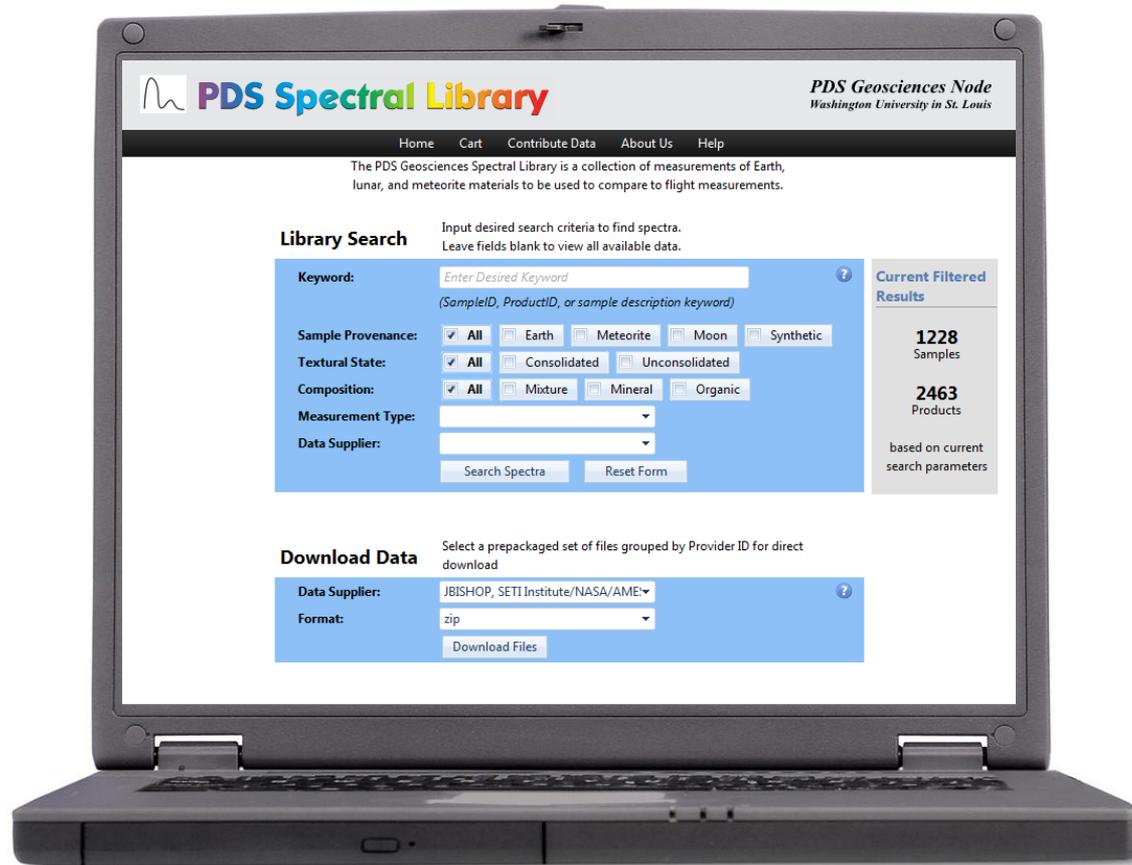
<http://an.rsl.wustl.edu>

Currently available:  
MER, Phoenix, Apollo, LCROSS



In development: MSL, Spectral

# AN Spectral Library



# AN Spectral Library search

**PDS Spectral Library** *PDS Geosciences Node*  
Washington University in St. Louis

Home Cart Contribute Data About Us Help

The PDS Geosciences Spectral Library is a collection of measurements of Earth, lunar, and meteorite materials to be used to compare to flight measurements.

### Library Search

Input desired search criteria to find spectra.  
Leave fields blank to view all available data.

**Keyword:**  ?  
*(SampleID, ProductID, or sample description keyword)*

**Sample Provenance:**  All  Earth  Meteorite  Moon  Synthetic

**Textural State:**  All  Consolidated  Unconsolidated

**Composition:**  All  Mixture  Mineral  Organic

Further filter by mineral types cataloged in the spectral library:  
**Mineral Type:**

**Measurement Type:**

**Data Supplier:**

- Check All
- Reflectance
- Emission
- Raman
- X-Ray Fluorescence
- X-Ray Diffraction
- LIBS
- Microprobe

**Download Data**

**Data Supplier:**  ?

**Format:**

### Current Filtered Results

**25**  
Samples

**47**  
Products

based on current search parameters

# AN Spectral Library results

- Scan search results list
- Review sample measurements
- Download for local analysis

**Search Results List** 2

[← Back to Search Page](#)

Current Search Filter: **Sample Provenance:** Earth **Textural State:** Unconsolidated **Composition:** Mineral **Mineral Type:** Nesosilicate **Measurement Type:** Reflectance

[Add All Results to Cart](#) [Update Cart](#)

Sample ID	Sample Classification	Description	Provider ID	Particle Size Min & Max
<a href="#">1801</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Olivine grains handpicked from 1801 volcanic bomb FOR 82.	JMUSTARD	
<a href="#">Apache</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Fo = c. 92% #1032	JMUSTARD	
<a href="#">Hortonolite</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Hortonolite	Hortonolite is (Fay 50, For 50)	JMUSTARD	
<a href="#">OLV</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Fa 21%	JMUSTARD	
<a href="#">OLV002</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Chrysolite- Cindercone W. of Hale Pohaku, S. flank of Mauna Kea Self collected volcanic bomb	JMUSTARD	
<a href="#">OLV003</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Forsterite	(see also entry for OLV003 size 45-90 microns [SC-EAC-002]) FOR 90.4% -- FAY 9.	JMUSTARD	<= 0.09 mm
<a href="#">OLV005</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Forsterite- St. John_s Island, Red Sea, Egypt (Minerals Unlimited)	JMUSTARD	
<a href="#">OLV007</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Forsterite	An intimate fine-grained mess with mica diopside (?) etc. FOR 96.9% -- FAY 3.1% Clean separate.	JMUSTARD	
<a href="#">OLV01</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Olivine, After Heating	TLROUSH	<= 0.038 mm
<a href="#">OLV010</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Chrysolite	grains show rust, inclusions FOR 88.5% -- FAY 11.5	JMUSTARD	
<a href="#">OLV011</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Fayalite	FOR 0.1% -- FAY 99.9% Smithsonian Inst. #351	JMUSTARD	
<a href="#">OLV012</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Forsterite	Easy to separate -- only minor chromite contamination FOR 91.8% -- FAY 8.2% Ward_s #1360	JMUSTARD	
<a href="#">OLV013</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Forsterite	Forsterite- Navajo Indian Reservation, San Carlos County, AZ Minerals Unlimited [from volcanic	JMUSTARD	
<a href="#">OLV021</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Chrysolite	sample contaminated with chromite as discreet grains & vein fillings separation may not be 100%	JMUSTARD	
<a href="#">OLV023</a>	Earth, Unconsolidated, Mineral, Nesosilicate, Olivine	Roepperite (Mn-Zn-olv) Smithsonian Institution MNH #C282	JMUSTARD	



*PDS Geosciences Node*  
Washington University in St. Louis

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---

**Sample ID: OLV003**

Sample Collection Locality: UNK

Sample Classification: Earth, Unconsolidated, Mineral, Nesosilicate, Forsterite

Sample Description: (see also entry for OLV003 size 45-90 microns [SC-EAC-002]) FOR 90.4% -- FAY 9.

Sample Particle Size Range: <= 0.09 mm

Sample Storage Location: University of Winnipeg

[Add to Cart](#) [Remove from Cart](#)

Sample 6 of 25

[< Previous](#) | [Search Results](#) | [Next >](#)

---

**Reflectance Spectrum**

Multiple reflectance measurements exist for this sample. Use the dropdown box below to view different measurements.

Product ID: CLPO50

Spectral Range: 0.3 to 2.75  $\mu\text{m}$

Provider ID: JMUSTARD

**Measurement Geometry**

Instrument: BDVNIR\_RELAB

Spectral Range: 0.3 to 2.6  $\mu\text{m}$

Geometry Type: BIDIRECTIONAL

Incidence Angle: 30 °

Emission Angle: 0 °

Phase Angle: 30 °

Azimuth: n/a



REFLECTANCE (DIMENSIONLESS)

WAVELENGTH (MICROMETERS)

■ c1po50\_bdvnr

Download Data File [c1po50\\_bdvnr.tib](#)

Download Graph [CLPO50.png](#)

**Publications**

Bishop, J.L., C.M. Pieters, R.G. Burns, J.O. Edwards, R.L. Mancinelli, and H. Froeschl, Reflectance spectroscopy of ferric sulfate-bearing montmorillonites as Mars soil analog materials, *Icarus*, Vol. 117, pp. 101-119, 1995.

36 IPDA | Geosciences Node Technology and Lessons Learned

# Geosciences Services: Orbital Data Explorer

- Web site: **<http://ode.rsl.wustl.edu>**
- Concept: Search, display, and download orbital data integrated across instruments and missions.
- Allows integrated search by data set, product ID, latitude-longitude, and time range, of both image and non-image data, located at Geosciences or other PDS nodes.
- Includes data sets from MESSENGER, MRO, Mars Express, Lunar Prospector, Clementine, and soon LRO.
- Identifies products from MRO coordinated observations.
- Allows browsing through archive directories.
- Displays results in a list, thumbnail images, on a map, or as details of individual products.
- Allows shopping-cart style download of “mini-archive”, data plus relevant metadata and documentation in an archive volume structure.

# Mars Orbital Data Explorer Snapshots

SEARCH for  
Products

MAP Products

Instrument	Type	Product ID
MRO HIRISE	RDR	<a href="#">AEB_000001_0000</a>
MRO HIRISE	RDR	<a href="#">AEB_000001_0050</a>
MRO HIRISE	RDR	<a href="#">AEB_000001_0100</a>
MRO HIRISE	RDR	<a href="#">AEB_000001_0150</a>
MRO HIRISE	RDR	<a href="#">AEB_000002_0000</a>
MRO HIRISE	RDR	<a href="#">AEB_000002_0050</a>
MRO HIRISE	RDR	<a href="#">AEB_000002_0100</a>
MRO HIRISE	RDR	<a href="#">AEB_000002_0150</a>
MRO HIRISE	RDR	<a href="#">PSP_001330_1395</a>
MRO HIRISE	RDR	<a href="#">PSP_001331_2260</a>
MRO HIRISE	RDR	<a href="#">PSP_001332_2620</a>
MRO HIRISE	RDR	<a href="#">PSP_001333_2485</a>
MRO HIRISE	RDR	<a href="#">PSP_001334_2215</a>
MRO HIRISE	RDR	<a href="#">PSP_001334_2645</a>
MRO HIRISE	RDR	<a href="#">PSP_001336_1560</a>
MRO HIRISE	RDR	<a href="#">PSP_001337_1675</a>
MRO HIRISE	RDR	<a href="#">PSP_001337_2480</a>
MRO HIRISE	RDR	<a href="#">PSP_001338_1765</a>
MRO HIRISE	RDR	<a href="#">PSP_001338_2480</a>
MRO HIRISE	RDR	<a href="#">PSP_001340_1945</a>
MRO HIRISE	RDR	<a href="#">PSP_001341_2010</a>
MRO HIRISE	RDR	<a href="#">PSP_001341_2485</a>
MRO HIRISE	RDR	<a href="#">PSP_001341_2650</a>
MRO HIRISE	RDR	<a href="#">PSP_001342_1910</a>
MRO HIRISE	RDR	<a href="#">PSP_001342_2680</a>

RETRIEVE and VIEW Products

# Mars ODE: MOLA Altimetry Query Tool

- Searches MOLA data base of ~700 million altimetry measurements by location, time, or altitude
- Results:
  - ASCII/CSV Table
  - Shapefiles (ArcGIS)
  - Binned Images
- Similar tool will be available for LRO and MESSENGER data

The screenshot shows the Mars Orbital Data Explorer (MOLA Altimetry Query Tool) interface. The page title is "Mars Orbital Data Explorer" and it is part of the "PDS Geosciences Node" at Washington University in St. Louis. The interface includes a navigation bar with links for Home, Data Product Search, Tools, Data Set Browser, Download, and Help & Resources. The main content area is titled "MOLA PEDR QUERY" and includes a "Reset Form" button. The text explains that the Mars Global Surveyor's Mars Orbital Laser Altimeter (MOLA) instrument provides a series of laser altimetry measurements across the surface of Mars. It offers two key altimetry products: PEDR and MEGDR. The MOLA PEDR Query provides a searchable database of approximately 595 million individual PEDR measurements.

**STEP 1. SELECT DATA POINT LATITUDE / LONGITUDE RANGE TO SEARCH (A SELECTION IS REQUIRED)**

ODE uses [areocentric](#) coordinates that are based on the product's center latitude and longitude.

The search area is defined by the following parameters:

- Max Latitude (-90 to 90)
- Western most Longitude (0 to 360)
- Eastern most Longitude (0 to 360)
- Min Latitude (-90 to 90)

A "Show Area On Map" button is provided. The map shows a color-coded altimetry map of Mars with a grid overlay. The map is titled "Selected Search Area" and shows a range of latitudes from -90° to 90° and longitudes from 180° to 180°.

**STEP 2. SET ADDITIONAL FILTERING PARAMETERS (OPTIONAL)**

<input checked="" type="checkbox"/> Select a Product ID or filter by a partial Product ID	(Show Options - 0 Parameters Set)
<input checked="" type="checkbox"/> Filter by Altitude	(Show Options - 0 Parameters Set)
<input checked="" type="checkbox"/> Filter by Orbit Number	(Show Options - 0 Parameters Set)
<input checked="" type="checkbox"/> Filter by UTC Time	(Show Options - 0 Parameters Set)

**STEP 3. PREVIEW RESULTS COUNT**

Click the button below to see how many Mola PEDR points match your selected criteria.

Query Count

# ODE map search tool

**Mars Orbital Data Explorer**  
PDS Geosciences Node  
Washington University in St. Louis

Home Data Product Search **Map Search** Tools Data Set Browser Download Help & Resources

Mars ODE Map Interface - North Polar

Zoom In Zoom Out Full Extent Prev Extent Next Extent Pan Select Products By Area Remove Area Selection Select Projection Map Help

**Map Display Controls**

Selected Layers Set Filters (Optional) View Selection Results

Instrument	Product ID	
MRO CRISM DDR	<a href="#">FRT0000A072_07_DE168L_DDR1</a>	<input type="checkbox"/>
MRO CRISM DDR	<a href="#">FRT0000A072_07_DE168S_DDR1</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000A072_07_IF168L_TR83</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000A072_07_IF168S_TR83</a>	<input type="checkbox"/>
MRO CRISM DDR	<a href="#">FRT0000BC42_07_DE168L_DDR1</a>	<input type="checkbox"/>
MRO CRISM DDR	<a href="#">FRT0000BC42_07_DE168S_DDR1</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000BC42_07_IF168L_TR83</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000BC42_07_IF168S_TR83</a>	<input type="checkbox"/>
MRO CRISM DDR	<a href="#">FRT0000D372_07_DE168L_DDR1</a>	<input type="checkbox"/>
MRO CRISM DDR	<a href="#">FRT0000D372_07_DE168S_DDR1</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000D372_07_IF168L_TR83</a>	<input type="checkbox"/>
MRO CRISM TRDR	<a href="#">FRT0000D372_07_IF168S_TR83</a>	<input type="checkbox"/>

Click to view New Search Results [close]

40 km  
Lon: -90.256, Lat: 84.929

# ODE new data sets

- Chandrayaan-1 Mini-RF Forerunner
- Odyssey GRS
- Lunar Orbiter Camera
- Odyssey THEMIS
- Viking Orbiter Camera

# ODE Venus under development

The screenshot displays the Venus Orbital Data Explorer (ODE) interface. At the top, there is a header with the Venus Orbital Data Explorer logo and the PDS Geosciences Node logo (Washington University in St. Louis). Below the header is a navigation bar with buttons for Home, Data Product Search, Map Search, Tools, Data Set Browser, Download, and Help & Resources.

The main content area is divided into two sections. On the left, the "SEARCH RESULTS" section shows "Products Found: 1,255" and a table of search results. The table has columns for Instrument, Type, Product ID, and Obs Time. The right section displays the details for a selected product, "F-MIDR.25S101;1", including a product description, links to more information, and a large image of the Venus surface.

**SEARCH RESULTS**

Products Found: 1,255  
 Display Product Thumbnails Update Cart

1 2 3 4 5 6 7 8 9 10 ... >>

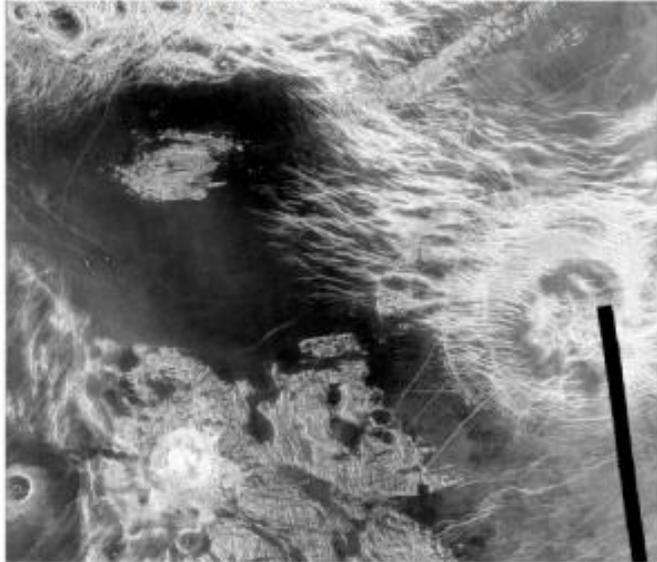
Instrument	Type	Product ID	Obs Time	
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N333;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N333;201</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N345;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N345;301</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N351;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N351;201</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N357;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25N357;301</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S003;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S009;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S034;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S082;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S082;301</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S095;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S101;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S131;1</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S131;201</a>		<input type="checkbox"/>
MGN RDRS	FMIDR	<a href="#">F-MIDR.25S137;1</a>		<input type="checkbox"/>

**F-MIDR.25S101;1**

Product Description: Magellan F-MIDR (Full-Resoluti [\[more...\]](#)  
[More About this Product Type \(help page\)](#)  
[PDS Volume](#) [AAREADME.TXT](#) [ERRATA.TXT](#)

Browse Meta Data Label Map Context

Browse Image - the image below is not the actual data product

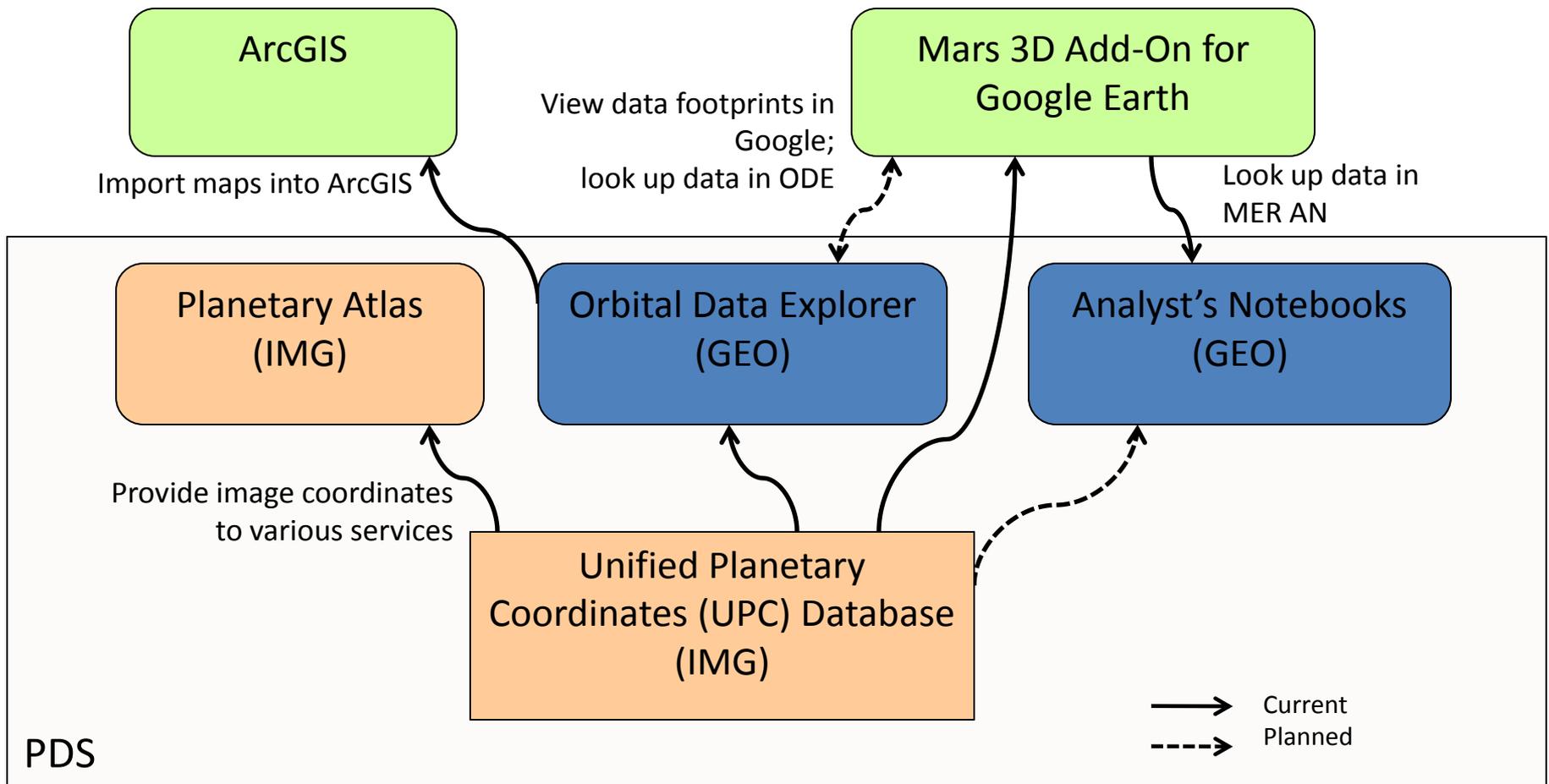


Add Product to Cart Remove Product from Cart [Cart & Download Help](#)

**PDS Product Files** **Derived Files**

Product Files & Labels	KB
<a href="#">f01.img</a>	1,051
Product Data File	

# Relationships among PDS services



# Lessons learned from interfaces

- Interface developers should do the heavy lifting.
  - Make it easy and intuitive for the end user.
- Leverage existing tools and common interface paradigms.
  - Don't reinvent the wheel.
- Engage your user community.
  - LPSC, AGU, DPS, and similar conferences are great place to acquire user requests and feedback.
  - Use an advisory group to get outside suggestions on priority.
  - Have a forum for making announcements and interacting with user community.
- Keep lines of communication open between engineers and scientists, so the archives and subsequent tools are useful to the scientific community.
  - Both groups think differently.
- Track web site / tool usage to see trends and what is popular with the user community.

# Conclusion

Challenges facing PDS now and in the next few years center upon:

- Increased number, size, and complexity of data sets to be archived, and...
- High user expectations for capabilities to navigate and access these data sets.

The Geosciences Node is meeting these challenges within funding guidelines with its unique combination of experience and expertise.