

THE NASA PDS GEOSCIENCES NODE IN 2023 AND BEYOND. Jennifer G. Ward, Edward A. Guinness, Daniel M. Scholes, Thomas C. Stein, Daniel V. Politte, and Paul K. Byrne, Department of Earth and Planetary Sciences, McDonnell Center for the Space Sciences, Washington University in St. Louis, 1 Brookings Drive, Campus Box 1169, St. Louis, Missouri, 63130, jgward@wustl.edu.

Introduction: The Geosciences Node of NASA's Planetary Data System (PDS) archives and distributes science data related to the study of surfaces and interiors of terrestrial planets and their moons. These data, along with tools and expert advice on their use, are provided at no cost to scientists, educators, and the public.

PDS Geosciences Node Overview: The Geosciences Node archives include data from past NASA planetary missions as far back as the Viking and Mariner programs in the 1970s, current missions, and individual investigators. Our archives currently contain 358 terabytes of digital data and are expanding at a rate of about two terabytes per month. Prof. Paul Byrne replaced Prof. Ray Arvidson as Geosciences Node Director in June 2022.

The Geosciences Node works closely primarily with NASA planetary missions and individual researchers to help them design high-quality, well-documented, peer-reviewed archives. The Geosciences Node typically serves as the lead PDS Node for missions to Mercury, Venus, Mars, and the Moon in cases where the main objective is to study the surfaces and interiors of these bodies. As lead Node, we coordinate archiving among all PDS Nodes involved with a given mission, in addition to archiving data from relevant instruments. Table 1 lists the active and developing missions that deliver or will deliver data to the Geosciences Node.

The Geosciences Node's primary interface to the planetary science community is its website at pds-geosciences.wustl.edu, where all Node holdings are available for download. Other services include the Orbital Data Explorer (ode.rsl.wustl.edu) [1], the Analyst's Notebooks (an.rsl.wustl.edu) [2], the Spectral Library web interface (pds-speclib.rsl.wustl.edu), and the Community Forum (geoweb.rsl.wustl.edu/community). We also offer Digital Object Identifiers (DOIs) for our datasets (pds-geosciences.wustl.edu/dataserv/doi.htm). Questions about any of our data and services may be sent to geosci@wunder.wustl.edu.

Recent Activities:

Mars Sample Dossier. We provided guidance to the Mars 2020 science team on development of the Sample Dossier archive, including proper content and documentation. Initial reports for the first 10 collected samples are posted in the Node archive. In addition, related images and metadata are available in the Perseverance Analyst's Notebook.

Mars Sample Return. We began work with the Mars Sample Return (MSR) program to capture and archive operations data and contextual information related to depot creation and transfer of Mars 2020 collected samples. Efforts will continue in 2023 to help develop an archive plan for Phase E activities. We are extending the Analyst's Notebook to support the MSR Sample Record Inventory and interoperability with the Johnson Space Center curation facility system.

Table 1. Geosciences Node Archives of Active and Developing Missions

Active Missions	Science Experiments
Mars 2020*	PIXL, RIMFAX, SHERLOC, SuperCam, Returned Sample Science
InSight* (EOM 12/15/22)	HP3, RAD, RISE, SEIS, IDA
MSL*	APXS, ChemCam, CheMin, DAN, SAM
MRO*	CRISM, SHARAD, Radio Science
LRO*	Diviner, LEND, LOLA, Mini-RF, Radio Science
Mars Express	ASPERA, HRSC, MaRS, PFS, MARSIS, OMEGA, SPICAM, VMC
Mars Odyssey*	GRS, HEND, NS, Radio Science
Developing Missions	Science Experiments
VIPER*	MSolo, NIRVSS, NSS, TRIDENT, Rover Imaging
Europa Clipper	MISE, REASON, Radio Science/Gravity
Lunar Trailblazer*	HVM3, LTM
Dragonfly*	DraMS, DraGNS, DraGMet
VERITAS*	TBD
* Geosciences Serves as Lead PDS Node	

CLPS DASS. We helped establish a Commercial Lunar Payload Services Data Archive Support Service (CLPS DASS), which provides resources for and tracks the progress of those teams delivering data from the numerous CLPS payloads. These resources are continually updated based on feedback from CLPS project teams as they prepare their archives.

PDS3 to PDS4 Migration. The Geosciences Node continues to work towards converting all our legacy PDS3 holdings to PDS4. Table 2 shows our migration status. Our current focus is on migrating our existing holdings from the Magellan and Clementine missions, along with assisting several Lunar Reconnaissance Orbiter (LRO) instrument teams on migrating their existing datasets. The LRO instrument teams are scheduled to begin delivering all new data in PDS4 starting with the March 15, 2023, data release; we are actively working with the teams on these efforts.

We are also assisting the Mars Science Laboratory (MSL), Mars Reconnaissance Orbiter (MRO), and Mars Odyssey missions in the conversions of their data processing pipelines to PDS4. All MSL teams plan to begin delivering new data in PDS4 by the end of FY23, MRO teams will do the same by the end of FY24, and Odyssey by the end of FY25. Migration of older MSL, MRO, and Odyssey data will follow the schedules listed in Table 2.

Table 2. PDS3 to PDS4 Migration Status

PDS3 Completed Mission Archives at the Geosciences Node	PDS4 Migration Status and Schedule
MER	Complete
MESSENGER	Complete
Chandrayaan-1	Complete
Lunar Prospector	Complete
LCROSS	Complete
GRAIL	Complete
Magellan	In progress FY21–23
Clementine	FY23
Apollo	FY23
Mars Phoenix Lander	FY23
Mars Global Surveyor	FY23–25
Mars Viking Lander	FY25
Mars Viking Orbiter	FY25–26
Mars Pathfinder	FY26
PDS3 Active Mission Archives at the Geosciences Node	PDS4 Migration Status and Schedule
LRO	In progress FY23
MRO	In progress FY23–25
MSL	FY24
Mars Odyssey	Best effort

Individual Investigators. The Geosciences Node continues to work with individual data providers to archive their data, generated primarily through NASA data analysis programs. Currently there are 45 pending archives in the queue, with data submitted from multiple ROSES programs including CDAP, MDAP, LDAP, PDART, and SSW. Examples of recently archived datasets from individual investigators include MSL Mastcam Photometry cubes (Jeff Johnson), Apollo passive seismic data (Mark Panning), XAS spectra of synthesized glasses (Molly McCanta), and improved Odyssey neutron spectrometer data (Katherine Mesick).

Application Program Interface (API). To support data accessibility, open science, and modern programming techniques, the PDS is developing an application programming interface (API) for accessing the PDS archives. The API will allow PDS data holdings to be queried and explored by metadata attributes. Through this service, software developers, researchers, and automated processes can traverse archives, pull metadata, and download associated PDS archive documents and observation data. The

Geosciences Node is participating in the planning and testing of the PDS API, which is being led by the PDS Engineering Node.

What to look for in 2023–2024: The Geosciences Node will continue to migrate most of its legacy PDS3 archives to PDS4 over the next several years, notably data from the Magellan, Clementine, and Apollo missions in FY23. Further, in parallel with our work supporting continuing missions, the Geosciences Node will continue to advise instrument teams from the Europa Clipper, Dragonfly, and Lunar Trailblazer missions, as well as CubeSat missions and CLPS providers, to design, plan, and implement their archives.

Notable data sets in the pipeline from individual investigators include 3D radar images from the MRO SHARAD instrument, MSL Mastcam calibrated data, and optimally processed Mars Express MARSIS radar data.

The Orbital Data Explorer's (ODE) product search will be updated with new faceted search features to help website users more efficiently search ODE's data catalog. The data holdings of ODE will continue to be updated with active mission data releases, as well as with data converted from PDS3 to PDS4. The expected PDS4 additions to the ODE in 2023 include newly released PDS4 LRO data from the LOLA, Diviner, LAMP, LROC, and MINI-RF instruments, as well as PDS4-migrated Magellan data. Venus ODE will be expanded with the addition of ESA's Venus Express data.

The Analyst's Notebook (AN) traverse maps for MER and MSL will be updated to include science targets. Curiosity and Perseverance rover archive data and daily reports will be added when released. PDS4 labels for MER, MSL, and Phoenix will be added as data sets are migrated, and Mars Target Encyclopedia archive data for MER will be incorporated. In addition, we will begin development of ANs for the VIPER and Dragonfly missions.

References: [1] Scholes D. M. et al. (2023) LPS LIV, this volume. [2] Stein T. C. et al. (2023) LPS LIV, this volume.