PDS GEOSCIENCES NODE DATA AND SERVICES. S. Slavney, J. G. Ward, L. E. Arvidson, and R. E. Arvidson, Dept. 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, Susan.Slavney@wustl.edu.

Introduction: The Geosciences Node of the NASA Planetary Data System (PDS, pds-geosciences.wustl.edu) archives planetary science data from missions to Mercury, Venus, Mars, and the Earth's Moon, and from individual investigators funded by NASA data analysis programs. We make the data available to the public free of charge, and we provide tools and expert advice for searching and using the data.

Mission Archives: The Geosciences Node works closely with developing missions to help them design quality, well-documented, peer-reviewed archives. We archive regular deliveries from six active missions, and we maintain archives from past missions as far back as the Viking and Mariner programs in the 1970s. Table 1 lists our active and developing missions. Not only do we archive the data from these missions, but for most of them we are also the designated Lead PDS Node, responsible for coordinating the archive plans and development mission-wide.

Table 1. Geosciences Node Archives of Active and Developing Missions

Active Missions	Science Experiments
Mars 2020*	PIXL, RIMFAX, SHERLOC, SuperCam, Returned Sample Science
InSight*	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, SPICE
Mars Odyssey*	GRS, HEND, NS, Radio Science
Developing Missions	**Science Experiments**
VIPER*	MSolo, NIRVSS, NSS, TRIDENT, Rover Imaging
Europa Clipper	MISE, REASON
Lunar Trailblazer*	HVM3, LTM
Dragonfly*	DraMS, DraGNS, DraGMet
*** Lead PDS Node**	

Data from the Mars InSight Lander and the Mars 2020 Perseverance Rover are archived under the PDS4 standard, which uses XML (Extensible Markup Language) to capture metadata in a rigorously controlled system that provides better access to tools for searching and reading the data products [1]. Developing missions will also archive under the PDS4 standard, while the remaining active missions will continue to use PDS3.

The first release of data from the Mars 2020 mission to PDS is scheduled for August 20, 2021.

Individual Investigators: We continue to work with individuals to archive their data generated by data analysis programs. Currently we have 49 pending archives in the queue, with data submitted from the CDAP, MDAP, LDAP, PDART, PSTAR, SSW, Exobiology, and other programs. Examples of recently archived datasets from individual investigators include: Mars Science Laboratory ChemCam passive surface spectra, a Mars target database, an Apollo seismic event catalog, a Magellan stereo-derived topography dataset, and lunar space weathering maps.

User Services: The Geosciences Node's primary interface to the planetary science community is its web site at pds-geosciences.wustl.edu. All Node data holdings are online and available for download through the web site. The archives are organized by planet, mission, instrument, and dataset. Other services include the Orbital Data Explorer (ode.rsl.wustl.edu) [2], the Analyst's Notebooks (an.rsl.wustl.edu) [3], the Spectral Library web interface (speclib.rsl.wustl.edu) [4], and the community forum (geoweb.rsl.wustl.edu/community). A notable new addition to our offerings includes a listing of Digital Object Identifiers (DOIs) for all of our datasets (pds-geosciences.wustl.edu/data-serv/doi.htm) to improve the search and access to our data. Together these web sites receive on average more than 2600 visitors per day who download more than 400 GB of data daily. Questions about any of our services can be sent to geosci@wunder.wustl.edu.

Guidelines for Archiving Data in Publications: Authors of journal articles who are required to archive their data in a public repository may not wish to undertake the steps involved in submitting their data to the PDS, steps that include labeling, documenting, and possibly reformatting the data products. The effort involved may not be justified for small, simple data sets. In this case we recommend that the authors submit the data to one of the many available online data

repositories, such as figshare (figshare.com) or Dataverse (dataverse.org). On the other hand, if the authors believe their data belong specifically in PDS and they are willing to put in the work, and to submit the data to a peer review, then we will work with them to create a PDS archive.

PDS3 to PDS4 Migration: NASA has requested that PDS nodes migrate their data archived under the previous PDS standard, PDS3, to the current PDS4 standard wherever possible. The Geosciences Node is implementing a long-term plan to convert almost all our holdings to PDS4. Table 2 shows our progress and plans for this effort. The schedule for future migrations is subject to change. Missions that began archiving with the PDS3 standard may continue to do so, in which case the data will be migrated to PDS4 at the end of mission. Note that LRO has chosen to begin PDS4 migration while still an active mission.

Table 2. PDS3 to PDS4 Migration Status

PDS3 Mission Archives at the Geosciences Node	**PDS4 Migration Status and Schedule**
MER	Complete
MESSENGER	Complete
Chandrayaan-1	Complete
Lunar Prospector	Complete
LCROSS	Complete
LRO	In progress FY21-22
Magellan	In progress FY21-22
Apollo	FY22
Mars Phoenix Lander	FY22-23
GRAIL	FY22-23
MGS	FY22-25
Mars Viking Lander	FY23
Mars Viking Orbiter	FY24
Mars Odyssey	FY26-27
Mars Pathfinder	FY27

Cloud Capabilities: The PDS Geosciences Node stores and distributes 263 terabytes of planetary archive data. Managing the large IT system required to support archiving efforts is challenging. The node identified several critical IT processes that would ease the burden on IT staff if they were migrated to the cloud.

A tertiary, offline copy of PDS archive data has historically been stored on tape and housed at an offsite facility. The node observed ~50% reduction in operating costs by migrating this workload to AWS Glacier Deep Archive cloud storage. The secondary copy of the PDS archive was migrated from onsite storage to the Azure Blob cloud storage tier. Azure Blob is designed to be an expandable, inexpensive, online cloud storage platform. Contracts are in place between Washington University and Azure to provide discounted storage and egress fees.

With a copy of the PDS archive data in Azure's online cloud, the node is now beginning to investigate methods by which end-users can use advanced cloud processing techniques to analyze the data.

References: [1] PDS Concepts, pds.nasa.gov/data-standards/documents/concepts. [2] Wang J. et al. (2021), this volume. [3] Stein T. C. et al. (2021), this volume. [4] Scholes D. et al. (2021), this volume.