THE PDS ORBITAL DATA EXPLORER TOOLS AND DATA SERVICES. J. Wang, D. Scholes, F. Zhou, S. Slavney, E. A. Guinness, and R. E. Arvidson, Washington University in St. Louis, 1 Brookings Drive, Campus Box 1169, St. Louis, Missouri, 63130, wang@wunder.wustl.edu.

Introduction: The Orbital Data Explorer (ODE, http://ode.rsl.wustl.edu) is a web-based search tool developed and maintained at NASA's Planetary Data System's (PDS) Geosciences Node (http://pds-geosciences.wustl.edu). ODE provides search, display, and download functionality for PDS archives of orbital data products from planetary missions to Mars, the Earth's Moon, Mercury, and Venus [1,2,3,4,5]. ODE includes access to archives at the PDS Geosciences and other nodes. Currently, 989 terabytes of PDS data are accessible through the ODE.

ODE Key features: ODE supports searches and retrieval of PDS planetary data products across multiple missions and instruments. It offers form- and map-based searches for named features and user-defined regions. The form-based search can be filtered through coverage, location, time, observation angle, and product ID. The map-based search interface has been developed using the ESRI ArcGIS Server and Javascript API, which supports the display of footprint coverage for data products on a number of user selectable basemaps. A user can graphically specify a search area and have a list of returned data products that intersect the specified region [3]. Figure 1 presents an example of a cross-mission instrument search of Odyssey THEMIS, MRO (Mars Reconnaissance Orbiter) HiRISE, and MRO CTX data at Gusev Crater using the Mars ODE map interface. Data product footprints (color coded by product type) are overlain on an MGS (Mars Global Surveyor) MOLA shaded relief map. ODE also provides data product previews for visual confirmation of selected data prior to download.

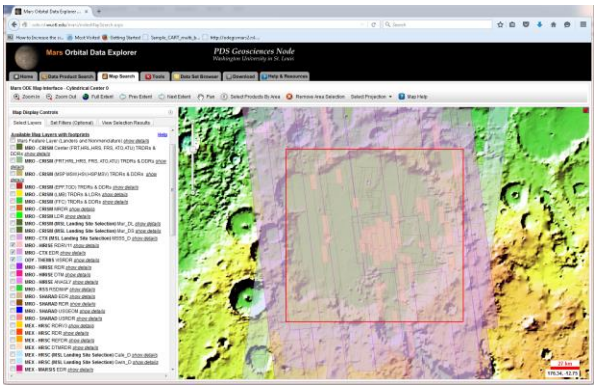

Figure 1. Example of cross-mission instrument search using the Mars ODE map interface.

ODE provides a shopping cart model for downloading many files at once. The cart ordering system retrieves data from host PDS nodes and data nodes, adds relevant documents, and provides download information to the user.

ODE supports granular-level search capabilities, together with specialized query tools for subsetting for a number of science datasets for specified regions [6]. The orbital laser altimetry and thermal emission spectrometer instruments, e.g., MGS MOLA and LRO (Lunar Reconnaissance Orbiter) LOLA and Diviner, produce along-track data products with limited cross-track coverage. The ODE granular search tool extracts from the along-track products the portion of data covering the user's desired search area and packages the data in a format appropriate for the user's needs.

ODE generates product type coverage KMZ (zipped file of Keyhole Markup Language, KML) files and shapefiles for use with Google Earth/Mars/Moon and other GIS tools. Additionally, a Representational State Transfer (REST) interface (http://oderest.rsl.wustl.edu/, [7]) allows external users to access the ODE metadata and data products without using ODE web interfaces. For example, the NASA Ames efforts to produce automated LRO Narrow Angle Camera Digital Terrain Maps use ODE REST to access PDS metadata [8].

ODE Data Inventory: ODE provides data access to many planetary missions, including the ongoing MRO, Odyssey, European Space Agency's MEX (Mars Express), LRO, GRAIL (Gravity Recovery and Interior Laboratory), and recent MESSENGER (Mercury Surface, Space Environment, Geochemistry and Ranging) missions, as well as a number of completed missions such as MGS, Viking Orbiter, Clementine, Lunar Prospector, Lunar Orbiter, Indian Space Research Organization's Chandrayaan-1, and Magellan. There are currently a total of 19 million PDS products cataloged in ODE metadata databases.

ODE has added a number of new datasets to its metadata databases in 2015 (Table 1), including SLDEM (a new DEM derived from both LRO LOLA and SELENE data) and RADR (Radiometric Data Record) datasets from the LRO LOLA instrument, the MRO Mars Climate Sounder (MCS) DDR (Derived Data Record) dataset, the MEX HRSC (High/Super Resolution Stereo Colour Imager) radiometrically calibrated RDR (Reduced Data Record) Version 3 dataset, as well as a number of MESSENGER MDIS (Mercury

Dual Imaging System) advanced map-projected datasets. Also, MRO CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) TER (Targeted Empirical Record) and MTRDR (Map-Projected Targeted Reduced Data Record) datasets will be added to ODE in 2016. A detailed list of current ODE holdings can be found at

http://wufs.wustl.edu/ode/odeholdings/index.html.

Table 1. New Datasets Added to ODE in 2015

Mission	Instrument	Product Type
LRO	LOLA	SLDEM RADR
MRO	MCS	DDR
MEX	HRSC	RDR V3
MESSENGER	MDIS	RDRBDR RDRMDR MAPHIE MAPHIW RTMNAC RTMWAC MDRWAC

ODE is updated for active missions as new and accumulating datasets are released by PDS, usually once every three months for a given mission, such as the MRO, Odyssey, and LRO missions. The MRO HiRISE data has been loaded each month due to the monthly release schedule from the HiRISE team. From 2015 to January 2016 ODE has loaded 16 releases of data from the Odyssey (Releases 50-54), MESSENGER (Releases 13-14), MRO (Releases 32-35), LRO (Releases 21-24), and GRAIL (Release 6) missions, 3 releases of MRO SHARAD Radargram data (Releases 3-5), and 18 deliveries of data from the MARSIS, OMEGA, and HRSC instruments on the ESA MEX mission.

ODE Structure: As shown in Figure 2, ODE consists of a back-end processor, a metadata database, a granular database, a front-end web interface, and a web-based REST interface.

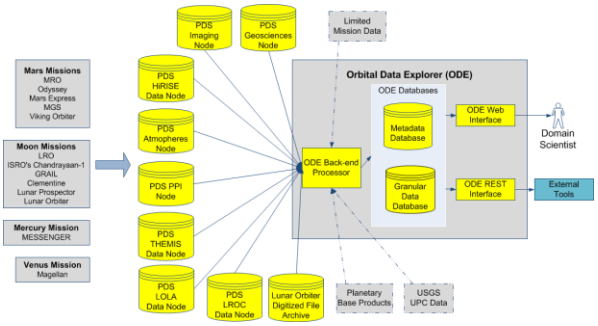

Figure 2. ODE Structure with REST Interface

The back-end processor ingests the metadata in the PDS data product labels into the ODE metadata databases. The data products themselves are often processed to create browse versions (images and plots) for display to users if there are no browse items in the PDS archives.

The granular data database hosts individual granular-level data records extracted from MGS MOLA PEDR (Precision Experiment Data Record) and LRO LOLA RDR and Diviner RDR data products. Currently, there are 595 million MOLA PEDR points, 10.5 billion LOLA RDR points, and 258 billion Diviner RDR points in the ODE granular database.

The website interface and REST are the public interfaces to the ODE metadata. The same functionality for PDS product search and retrieval exist for these two options. Both interfaces also support MOLA PEDR, LOLA RDR, and DIVINER RDR granular-level queries in the ODE granular databases.

Future Development: ODE will continue to add data from the MRO, MEX, MESSENGER, LRO, GRAIL, and Odyssey missions. ODE is being updated to support multiple browse images for select instrument data, such as MRO CRISM data products. We are planning an upgrade to the ODE website interface with options to simplify the product search to assist users who are not experts on missions and instruments.

Contact Information: The Geosciences Node welcomes questions and comments for additional functions from the user community. Please send email to geosci@wunder.wustl.edu. Comments and questions specific to ODE and REST access can be sent to ode@wunder.wustl.edu.

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References: [1] Bennett, K. et al. (2008), LPS XXXIX, Abstract #1379. [2] Wang, J. et al. (2009), LPS XL, Abstract #1193. [3] Wang, J. et al. (2010), LPS XLI, Abstract #2251. [4] Bennett, K. et al. (2013), 44th LPS, Abstract #1310. [5] Stein, T.C. et al. (2015), 2nd Planetary Data Workshop, Abstract #7019. [6] Wang, J. et al. (2011), 42nd LPS, Abstract #1896. [7] Bennett, K. et al. (2014), 45th LPS, Abstract #1026. [8] McMichael et al. (2015), 46th LPS, Abstract #2491.