PLANETARY DATA SEARCH WITH PDS GEOSCIENCES NODE'S ORBITAL DATA EXPLORER. J. Wang[1], D. Scholes[2], R. E. Arvidson[3], E. A. Guinness[4], and F. Zhou[5], McDonnell Center for the Space Sciences, Department of Earth and Planetary Sciences, Washington University in Saint Louis, 1 Brookings Drive, Campus Box 1169, Saint Louis, Mo, 63130, [1]wang@wunder.wustl.edu; [2]scholes@wunder.wustl.edu; [3]arvidson@wunder.wustl.edu; [4]guinness@wunder.wustl.edu; [5]chow@wunder.wustl.edu.

Introduction: The Orbital Data Explorer (ODE, https://ode.rsl.wustl.edu) is a web-based search tool developed and maintained at NASA's Planetary Data System (PDS) Geosciences Node (https://pds-geosciences.wustl.edu). ODE provides search, display, and download functionality for PDS3 and PDS4 archives of orbital data products from planetary missions to Mars, the Earth's Moon, Mercury, and Venus [1,2,3].

Overview: As shown in figure 1, the basic components of ODE consist of a background processor, a number of metadata databases and granular databases [4] for specific instrument data, map servers, an interactive website, specialized query tools, and REST (Representational State Transfer) API (Application Programming Interface) web services. Planetary data from multiple missions and instruments are processed by the background processor to standardize the product metadata, which are then organized into the corresponding databases. The processing ensures that all footprint data use the same unified coordinate system, and all the field values in the label are standardized. Product footprints are then used to build coverage maps and to publish web services using ESRI® ArcGIS Server 10.4.1. Users can query PDS products through the map interface, the specialized query tools, or the ODE REST API, in addition to the website's standard search functions.

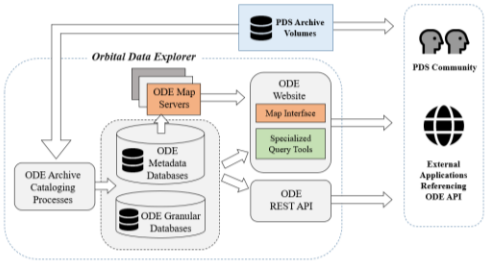

Figure 1. Components of Orbital Data Explorer

ODE Data Inventory: ODE provides access of metadata to 29 million PDS products with a volume of 1.74 petabytes of files from more than 14 planetary missions and over 53 individual instruments. Available active missions include MRO (Mars Reconnaissance Orbiter), Odyssey, LRO (Lunar Reconnaissance Orbiter), and ESA's (European Space Agency) MEX (Mars Express) and TGO (Trace Gas Orbiter); completed available missions include MGS (Mars Global Surveyor), Viking Orbiter, Clementine, Lunar Prospector, Lunar Orbiter, Chandrayaan-1, Magellan, GRAIL (Gravity Recovery and Interior Laboratory), and MESSENGER. Also, derived data from individual data providers have been added. Most PDS4 holdings available in ODE include ESA's TGO data and PDS4 migrated lunar prospector and MESSENGER data archived at the PDS Geosciences Node. A detailed list of the current ODE holdings are available at https://ode.rsl.wustl.edu/odeholdings/.

ODE is continually updated for active missions as new and accumulating datasets are released by PDS. PDS4 migrated data and derived data from individual data providers will also be added to ODE once they become available.

ODE Key Features: Key features of ODE are summarized in the following sections.

Data Searching and Retrieval. ODE offers form-based and map-based searches across multiple missions and instruments. A form-based query let users set parameters of mission, instrument, processing level of the data, observation type, location, time, observation angle, and PDS product identifier in the regular form-based Data Product Search interface. An interactive Map Search interface provides a map-based query, together with a Map Display Controls panel to set filters. Individual point, rectangle, or custom polygon location searches are supported by ODE. Figure 2 is an example of point search near China Chang'e-5 landing site, displaying search results from LRO and Clementine mission with multiple instruments. Search results are displayed in a table with links to view product detail pages. The detal pages include information such as browse, metadata, PDS label, and map context, if the product is map projected. The map context displays the product footprint plotted on a base map. Links are provided to allow the product detail page to be shared with colleagues via URL and email, or saved for later review. The DOI (Digital Object Identifier) of the product's PDS3 dataset or PDS4 bundle has been added to the detail page for reference and citation, as well. Product files can be downloaded directly from the detail page, and ODE provides a convenient cart system with a high-speed download option of using Aspera Connect [5].

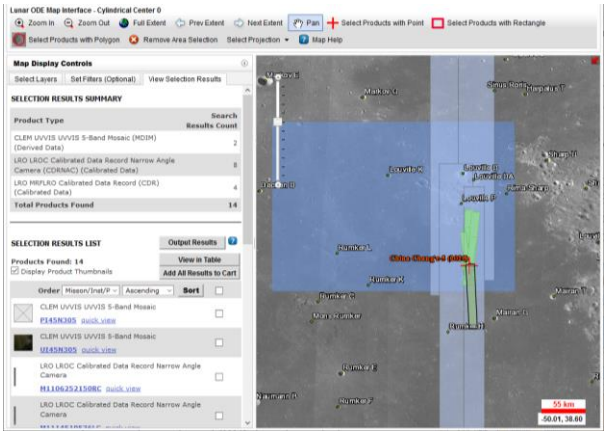

Figure 2. Point search near China Chang'e-5 landing site with cross-mission instrument of LRO LROC (Lunar Reconnaissance Orbiter Camera), LRO MINI-RF, and Clementine UVVIS (Ultraviolet/Visible Camera) data in Lunar ODE

Granular Data Search. For a few datasets derived from instruments that collect point data along an orbit track with limited cross-track coverage, ODE supports specialized granular query tools for subsetting science data at specified regions [4]. ODE granular data databases host data from individual records of data products from the orbital laser altimetry and thermal emission spectrometer instruments, e.g., MGS MOLA (Mars Orbiter Laser Altimeter) and LRO LOLA (Lunar Orbiter Laser Altimeter) and DLRE (DIVINER Lunar Radiometer Experiment). The ODE granular search tool extracts the portion of data covering the user's region of interest from the along-track products. It then packages the data in a user selected format and presents the formatted data for user download. Currently, ODE supports granular-level searches of the 595 million point MOLA PEDR (Precision Experiment Data Record) dataset and the 6.9 billion point LOLA RDR (Reduced Data Record) and 472 billion point DLRE RDR datasets.

MRO Coordinated Observation Search Tool. A coordinated observation is a planned observation involving multiple instruments at a given location and time. The Mars ODE website contains a search feature for filtering and locating PDS data products that were observed as part of an MRO coordinated observation. This search interface supports instrument, time, and location searches. The location search includes an interactive map for selecting search areas via individual points, rectangles, and custom drawn polygons. Search results can be viewed in a list format or through the map interface. Selections can be downloaded directly or through the ODE cart.

REST API. The REST interface (https://oderest.rsl.wustl.edu/, [6]) allows external users to develop domain-specific tools and interfaces 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 [7]. The ODE REST V2.1 interface also supports granular-level queries of MOLA PEDR, LOLA RDR, DIVINER RDR, and Mercury MESSENGER MLA (Mercury Laser Altimeter) RDR data. The query results are the same as the current ODE web-based granular query.

ODE Footprint Coverage Explorer. ODE generates product type coverage files in shapefile and KMZ formats for map projected PDS data products that are cataloged in ODE. The footprint coverage explorer page is organized by mission, instrument, processing level, and observation type, similar to the form-based product search. It provides access to coverage files, along with descriptive content information, file details, product type information, and general help for using the files.

Future Work: Newly released data from ongoing missions will continue to be added to ODE. ODE's catalog of PDS archives will be updated to reflect changes as archives are migrated from the PDS3 to PDS4 standard. Planetray orbital data from international missions will be added to ODE if available. The website interface will continue to be updated to improve data search and download capability. Feedback from the community is valued and always encouraged; comments from users can help identify useful future improvements and feature additions.

Contact Information: The PDS Geosciences Node welcomes questions and comments for additional ODE functions from the user community. Please send emails to ode@wunder.wustl.edu or post on the PDS Geosciences Node forum https://geoweb.rsl.wustl.edu/community/ if you have any comments or questions specific to ODE.

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References: [1] Wang, J. et al. (2009), LPS XL, Abstract #1193. [2] Bennett, K. et al. (2013), 44th LPS, Abstract #1310. [3] Wang, J. et al. (2021), 52nd LPS, Abstract #1394. [4] Wang, J. et al. (2011), 42nd LPS, Abstract #1896. [5] Scholes D. et al. (2018), 49th LPS, Abstract #1235. [6] Bennett, K. et al. (2014), 45th LPS, Abstract #1026. [7] McMichael et al. (2015), 46th LPS, Abstract #2491.