THE ANNEX OF THE PDS CARTOGRAPHY AND IMAGING SCIENCES NODE: A 2019 UPDATE. T.M. Hare, L.R. Gaddis, M. Hartke, A. Sunda, D.P. Mayer, M. Bailen. USGS Astrogeology Science Center, Flagstaff, AZ 86001 (thare@usgs.gov)

Introduction: The Cartography and Imaging Sciences Node ("Imaging" or IMG) of the NASA Planetary Data System (PDS) archives and delivers large digital image collections from planetary missions (see https://pds-imaging.jpl.nasa.gov/). Included among these collections are nearly 1200 TB of digital image archives, ancillary data (calibration files and software, geometric data, etc.), software, tutorials and tools.

While the great majority of archived products are delivered to IMG by data providers on planetary mission instrument teams, smaller research products from individual NASA-funded investigators are now required to be archived at PDS or PDS-equivalent sites. This effort represents a significant increase in the variety and complexity of data holdings for IMG. The *Annex* (https://astrogeology.usgs.gov/pds/annex) is a facility hosted at the U.S. Geological Survey's Astrogeology Science Center and developed by IMG to support scientists who use PDS data to create derived geospatial products that can be registered to a solid planetary body [1-3]. Examples of geospatial derived products are cartographic and thematic maps of the planets and their moons, local and regional geologic maps and feature databases, derived topography, etc. Many such products are developed through data analysis programs, often many years after active missions (and their accumulating archives) have ended. Since 2016, the Annex has been considered a PDS-equivalent site for hosting such data products.

Architecture: The *Annex* service is currently built on an online data catalog at USGS Astrogeology Science Center called Astropedia [4]. Astropedia was created to provide a method to catalog and serve the decades of images, mosaics and other derived data products created by Astrogeology scientists and cartographers. Detailed metadata, including documentation, links to source data, and publications are included for each product served. Many of these products were derived from data in PDS archives and are in the form of global digital image mosaics, cartographic maps, landing site elevation maps [5, 6], feature data products (i.e.,

craters [7]) and various Geographic Information System (GIS) projects and layers.

The metadata standard used for Astropedia was created by the U.S. Federal Geographic Data Committee (FGDC) with small modifications to better support planetary data [8, 9]. These same standards, along with existing PDS3 standards, are being used to help develop updated image and file labels for PDS4 products, the next generation information model now required by NASA for new products [10, 11]. FGDC geospatial metadata, sometimes called "data about data," is documentation that describes the rationale, authorship, attribute descriptions, spatial reference, errors and other relevant information about a given set of data. Every data product served by the Annex is required to have associated metadata that follows the FGDC metadata standard. Use of these metadata standards supports search and retrieval of data and allows us to expand both the holdings and accessibility of planetary derived data products.

Approach: Astropedia is built entirely on an open-source infrastructure that includes the PostgreSQL database with the PostGIS add-ons [12] to support geographic objects, Alfresco Document Management System (DMS) as a data repository [13], Openlayers for web-based interactive mapping [14], and Mapserver as a Open Geospatial Consortium Web Map Service (WMS) to serve planetary geospatial data.

To locate data products in the *Annex*, a web interface (***Figure 1***) provides a keyword-based search and an interactive mapping tool that allows selection of planetary targets upon which the user can restrict searches based on mission, data type (e.g., image mosaic, topography, geology), GIS-ready formats (e.g. GeoTiff including PDS label) and more (https://astrogeology.usgs.gov/search). Geospatial searching is currently limited to quadrangle regions (e.g. Lunar 1:2.5M or Mars 1:2M quadrangle names) or planetary named features, but we are actively moving to support more robust geospatial search capabilities. We are

also now adding product tags and filters for PDS-only products (both PDS3 and PDS4).

Annex Submission Requirements: The *Annex* accepts submission of NASA-funded geospatial products that have a PDS data heritage. As stated above, submitted products will be required to have extensive metadata that meets PDS standards and benefits from FGDC requirements. IMG personnel will help guide users through the process and help define which metadata fields are required for each product. Once reviewed and accepted, the product and metadata will then be ingested into the Astropedia content catalog.

Geospatial products submitted to the *Annex* must be validated and reviewed prior to publication. Products that have already been published in professional science journals will be considered reviewed. Other products will require a separate peer review; IMG staff will assist with these reviews and submission to the PDS data registry.

Summary: The implementation of the *Annex* as a PDS-equivalent archive is still evolving. We are attempting to meet the immediate need for public release of NASA-funded data products in highly usable formats and simultaneously support the long-term archiving requirements of PDS. While full accomplishment of these goals may take some time, we firmly recognize that as *Annex* products

are derived from data from one or more PDS archives, these "child" products must properly relate back to their source archive through product metadata and the PDS4 archive structure that facilitates such connections.

References: [1] Gaddis et al. (2012) USGS Open File Report 2014-1056, 199 pages, https://dx.doi.org/10.3133/ofr20141056; [2] Hare et al. (2013) 44th Lunar and Planetary Science Conference, abs. #2044. [3] Hare, et al. (2015) 2nd Planetary Data Workshop, abs. #7060. [4] Bailen et al. (2012) 43rd LPSC, #2478. [5] Becker et al. (2009) Eos, 90-52, Fall Meet. Suppl., Abstract P21A-1189. [6] Fergason et al. (2017) 48th LPSC, abs. #2163. [7] Robbins (2018) JGR-P 123, http://dx.doi.org/10.1029/2018JE005592. [8] Federal Geographic Data Committee, 2011, Preparing for International Metadata, Federal Geographic Data Committee, Washington, D.C., also see http://www.fgdc.gov/. [9] Hare et al. (2011) LPSC 42, #2154. [10] Planetary Data System Standards Reference, v. 3.8, JPL D-7669, Part 2, see also http://pds.nasa.gov/tools/standards-reference.shtml. [11] Crichton et al. (2011) 6th European Planetary Science Congress, abs. #1733. [12] PostGIS, see http://postgis.refractions.net/. [13] Alfresco, see http://www.alfresco.com/. [14] OpenLayers, see http://openlayers.org/.

Figure 1. An example of the primary search interface for Annex products. Users can search for products in the Annex by product type, spacecraft, region, etc. A search filter for GIS-ready products is in place and we are currently adding selections for instruments and PDS products (both PDS3 and PDS4 formats at a several review levels).