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MIGRATION OF MAGELLAN MISSION FROM THE PDS3 TO THE PDS4 STANDARD.

E. A. Guinness, D. V. Politte, and S. Slavney, 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, guinness@wustl.edu.

Introduction: The Planetary Data System (PDS) is in the midst of a five year effort to migrate its legacy datasets from the older PDS3 standard to the current PDS4 standard [1]. As part of that effort, the PDS Geosciences Node led by Washington University is migrating its collection of Magellan Venus datasets in FY21 and FY22. The Geosciences Node archive of Magellan data consists of twelve datasets and comprises a data volume of about 750 Gbytes with over 700,000 files (Table 1). There are also a few Magellan datasets archived at the PDS Cartography and Imaging Sciences (CIS) Node, but these datasets are not part of this project. The CIS Node plans to migrate them at some time the future. Data returned by Magellan is one of the prime sources of data for Venus surface geology and geophysical studies. The migration of Magellan datasets will make these data more accessible and useful to science investigators and will support science from proposed future Venus missions such as VERITAS and the DAVINCI probe as possible NASA Discovery class missions or concepts for missions to Venus proposed in the next Planetary Science Decadal Survey.

Magellan Mission: The Magellan spacecraft was launched on May 4, 1989. It arrived at Venus on August 10, 1990 and began systematic mapping of the Venus surface on September 15, 1990. The main experiments for geologic mapping were Synthetic Aperture Radar (SAR) imaging, altimetry and radiometry measurements using the spacecraft's main antenna, along with radio science experiments [2, 3]. The mission phases were divided into 243 Earth day mapping cycles. The first three mapping cycles concentrated on collecting radar imaging and altimetry data. The fourth and fifth cycles were used to collect data on the planet's gravity field. The final cycle occurred after the spacecraft orbit was lowered to collect better gravity data near the poles. The mission was completed on October 13, 1994 after the spacecraft was commanded to drop into the Venus atmosphere.

Magellan Data Archiving: The Magellan Mission was one of the first missions to archive its data directly to the PDS during the mission lifetime. PDS standards were in the early stages of development at the time of Magellan operations and archiving. In some cases, the standards used by Magellan pre-date the PDS3 standard. In addition, some datasets were created on Digital Equipment Corporation VAX computers and used VAX storage formats for binary data, which are no longer in common use. Many of the raw datasets were written onto 9-track magnetic tape by the Magellan Project for delivery to PDS. A set of derived datasets (i.e., image mosaics and altimetry and radiometry data) were transferred to CD-ROMs with hundreds of copies made and widely distributed to the interested research community. The remaining datasets were written to a limited number of write-once CDs either by the original data producer or by the Geosciences Node for archiving at the PDS. For example, the Geosciences Node transferred its collection of several thousand F-BIDR (Full Resolution Basic Image Data Record) 9-track tapes to hundreds of write-once CDs. Eventually, the Geosciences Node copied all of its Magellan archives to online storage and makes the data accessible via its website and Orbital Data Explorer (ODE) search service.

Geosciences Node Archive of Magellan Datasets: Table 1 summarizes the twelve Magellan datasets in the PDS Geosciences Node archive and their size. There are several SAR imaging datasets. The F-BIDR and C-BIDR (Compressed Basic Image Data Record) data are along-orbit-track images that span nearly pole to pole with the F-BIDR being full resolution (75 m/pixel) and the C-BIDR with resolution reduced by a factor of 3x. The F-MIDR (Full Resolution Mosaicked Image Data Record) and Cx-MIDR data are mosaics derived from the F-BIDRs and C-BIDRs, respectively. The Cx-MIDRs have three different levels of resolution reduction. There are also several altimetry and radiometry datasets. The ALT-EDR (Altimetry Experiment Data Record) dataset contains the raw altimetry data organized by orbit track. Note that the raw radiometry data is stored with the F-BIDRs. The ARCDR (Altimetry and Radiometry Composite Data Record) data contain the reduced altimetry and radiometry data stored in along orbit track format. The GxDR dataset is a set of four global maps derived from altimetry and radiometry data, such as topography, slope, and microwave reflectivity and emissivity. The SCVDR (Surface Characteristics Vector Data Record) and GVDR (Global Vector Data Record) datasets contain a set of surface properties (e.g., RMS slopes and Fresnel reflectivity) derived from data in the other datasets. Finally, there are several datasets produced from the radio science observations, including the raw radio science tracking data, gravity datasets (LOSAPDR

and spherical harmonic models), and Bi-Static Radar (BSR) raw and reduced data.

Expected Data Improvements due to PDS4 Migration: Some of the advantages of the PDS4 standard over the older standard include simpler and fewer data storage formats, more uniform and robust metadata requirements, and use of XML for metadata in labels, which enables a variety of standard software tools to access the metadata. As such, several of the Magellan data product types will have to be reformatted to meet PDS4 data storage standards. For example, the F-BIDR and C-BIDR image products need to be reformatted because they contain line prefix bytes that are not allowed in PDS4. In addition, any binary data that was originally stored using VAX floating-point format will be converted to IEEE formats. For the F- and Cx-MIDR mosaic products, the original 56 1k by 1k tiles of each mosaic will be merged into a single 8k by 7k mosaic. Browse products will be generated, where appropriate, and stored in a commonly used format such as JPEG or PNG. The newly migrated datasets will undergo PDS peer reviews because many of the data products will be reformatted.

Dataset Migration Priorities and Project Status: We are starting with the imaging datasets as the first priority for migration (BIDRs, MIDRs, and GxDR), along with the ARCDR and spherical harmonic gravity datasets. These are likely the datasets that are of most interest to the science community based on input from our Node advisory group. The more highly derived datasets would be migrated next, and finally the raw datasets, such as the ALT-EDR dataset. We have currently assembled the relevant mission documentation for data formats and have designed PDS4 bundles and collections structures for each dataset, along with bundle and collection logical identifiers (LIDs; the unique identifiers used in PDS4). We have also started PDS4 label design and software development for data conversion. When the migration and peer review are complete these new datasets will be ingested into the Geosciences Node ODE service for Venus, so that users can search, browse, and download the PDS4 versions of the data.

References: [1] Planetary Data System Standards Reference, Version 1.15.0.0, Oct. 2, 2020. [2] Saunders et al. (1992) *JGR, 97*, 13,067-13,090. [3] Johnson, W. T. K. (1991) *Proc. IEEE, 79*, 777-790.

Table 1: Geosciences Node Magellan Datasets			
Data Type	PDS3 ID	Volume, GBytes	Files; PDS3 Volumes
F-BIDR	mgn-v-rdrs-5-bidr-full-res-v1	480.698	229,632; 594
C-BIDR	mgn-v-rdrs-5-c-bidr-v1	77.252	134,231; 124
F-; Cx-MIDR	mgn-v-rdrs-5-midr-full-res-v1	75.453	153,449; 126
ALT-EDR	mgn-v-rdrs-2-alt-edr-v1	43.319	90,880; 71
ARCDR	mgn-v-rdrs-5-cdr-alt-rad-v1	8.342	39,794; 19
GxDR	mgn-v-gxdr-v1	0.507	802; 2
SCVDR	mgn-v-rdrs-5-scvdr-v1	29.664	51,786; 49
GVDR	mgn-v-rdrs-5-gvdr-v1	0.567	412; 1
BSR	mgn-v-rss-1-bsr-v1	7.018	1,871; 3 and 13^
LOSAPDR	mgn-v-rss-5-losapdr-l2-v113	1.057	2,699; 2
Spherical Harmonics	mgn-v-rss-5-gravity-l2-v1	0.884	54; 1
Radio Tracking	mgn-v-rss-1-tracking-v1	9.293	765; 1
Totals		747.288	703,574; 1003
^ 3 calibrated data and 13 raw data volumes			