FGDC GEOSPATIAL METADATA FOR THE PLANETARY DOMAIN. Trent M. Hare, James A. Skinner, Jr., Corey M. Fortezzo, and Mark S. Bailen, U. S. Geological Survey, Astrogeology Team, 2255 N. Gemini Drive, Flagstaff, AZ 86001, USA, thare@usgs.gov.

Introduction: Metadata is ancillary documentation that helps describe the rationale, authorship, attribute descriptions, spatial reference, and other pertinent information of geospatial data sets, as recommended by the Federal Geographic Data Committee (FGDC). It is commonly referred to as "data about data". Like most documentation, geospatial metadata has always been more of an afterthought when cartographic products are created and released. It is not unusual that researchers use data found on-line without a full understanding of accuracy or intent – simply because it is not made available – perhaps leading to a mis-application of data sets. Metadata becomes more relevant as the volume of digital data increases and the availability of easy-to-use remote sensing and Geographic Information Systems (GIS) mapping applications increase.

Due to their uniqueness and variety, planetary metadata standards have never been wholly synchronized with the widely available but more Earth-based FGDC standards. Herein, we describe the benefits of using FGDC standards for geospatial data within the planetary domain. This exclusively targets geospatial data, specifically data sets that can be registered to a solid body (exempting, for the time being, products that focus on atmospheres, plasma, and rings).

PDS Background: For more than two decades, the planetary community has been fortunate to have an official NASA archive initiative called the Planetary Data System (PDS, [1]). The PDS is a project and standard which requires the publication of "metadata" for planetary missions and their data products. For geospatial PDS collections, a data product is commonly a single image (e.g. MRO CTX [2] or LROC [3] frame), but it can also be a single database of all the data taken over the entire mission (e.g. MOLA topography shots [4]). The prime objective for the PDS is to archive the raw Engineering Data Records (EDRs). However, one of the most important changes in the PDS, particularly for the Imaging and Geosciences nodes, was the acceptance and distribution of map projected (GIS-ready) single frame images and/or derived mosaics.

Once planetary data is released in a map-projected form, there is no longer any reason to consider it a highly specialized product requiring specialized software. That means that the same formats and standards, and thus mapping applications, that support Earth-based data, can now be used for these planetary products [5]. This is best illustrated by the Mars HiRISE PDS release, which was the first mission to release their map-projected PDS archive using a hybrid method which combines the use of the GeoJPEG2000 image and a detached PDS label [6-8]. This hybrid approach has been emulated in subsequent missions such as Lunar Orbiter Laser Altimetry (LOLA) and (most likely) LRO Diviner and LROC [9]. This allows the instrument teams to support commonly used geospatial formats and the required PDS standards at the same time and provides wider and more consistent, knowledgeable use of mission data by the planetary community.

FGDC Background: The FGDC endorses the development, use, sharing, and dissemination of geospatial data on a national basis [10, 11]. This effort is known as the National Spatial Data Infrastructure. The U.S. Geological Survey (USGS) has supported the lead FGDC Secretariat position but it is truly a collaboration between many Federal, State, Tribal, and local governments and includes academic institutions, a broad array of private sector geographic business providers, and data users.

In 2004, the International Organization for Standardization approved ISO19115 - Metadata Standard based on of the FGDC standard. ISO approval underscores broad international support and, as a result, many tools and applications have been built around its use. When the standard is applied correctly, the user should have a significantly clearer understanding of the described data and ease in applying it to their research goals. The major sections required in a FGDC record include:

1. Identification
2. Data Quality
3. Spatial Data Organization
4. Spatial Reference
5. Entity and Attribute
6. Distribution
7. Metadata Reference

Existing Planetary Use Cases for FGDC: While not extensive, there are several planetary projects which currently use the FGDC standard. For example, NASA's Planetary Geology and Geophysics project now requires all USGS published planetary geologic maps to be in a GIS compatible format. Because these GIS files will be published through the USGS and the USGS requires all geospatial data to have FGDC metadata, all planetary geologic maps must also have an FGDC record. Another example includes the Lunar

Mapping and Modeling Project (LMMP). The LMMP team which has chosen the FGDC metadata standard to define the required documentation elements needed for each data set. LMMP data providers must create a metadata record prior to submission (see data portals) [12].

PDS to FGDC: At a minimum, proper metadata improves search, discovery, and data reuse. Both FGDC and PDS standards, while fairly different, strive to support this. The PDS working group is currently defining version 4 of their standard. The main change for version 4 will be a switch to the eXtensible Markup Language (XML). XML is a text-based encoding system which is ideal for machine-readable parsing applications but still can be understood when viewing in a simple text editor.

One of the best benefits of using XML is the ability to build transforms (known as XSLTs) for the conversion from one XML document to another XML or other format type. This means it should be a simple task to write a XSLT to map a PDS (version 4) document into a FGDC document for use in existing applications that already support the FGDC standard.

FGDC Based Data Portals: One of the latest trends in the geospatial community, including the planetary community, is to provide data portals. These portals help assemble data holdings for on-line browsing and download. Many of these data portals, open source and commercial, are built around the use of FGDC metadata to import, describe, and catalog the data for external users.

A prime example of an FGDC based portal is the United States' national initiative called the Geospatial One-Stop (GOS; also known as GeoData.gov). Eventually all government funded Earth-based geospatial collections will be available through this portal. To be able to host the diverse array of data currently found on the site, they mandate all submitted records must be defined using the FGDC standard. This allows the site to then automatically host the data for searching and download. GOS lists these goals for the portal:

- gain quick access to featured relevant data in the data categories and current events,
- use search tools to access a wide variety of geographic information,
- save your search criteria and maps,
- apply a subscription service to selected areas,
- view metadata,
- interact with map services,
- publish data and search for partners for data collections and acquisitions.

Lastly, this site has also embraced support for the Open Geospatial Consortium (OGC) web services including WMS, WFS, KML, etc. [13]. In short, services built using OGC technologies, allow one to stream geospatial raster and vector data sets across the Internet to mapping applications or simple web browsers.

The reason we have highlighted GeoData.gov is because many of these same data portal goals are currently being worked on by the planetary community. This includes projects by the PDS imaging and geosciences nodes, the Lunar Mapping and Modeling Project (LMMP), a project by the USGS called Astropedia, and various international data portals. An international group has even been created, called the International Planetary Data Alliance (IPDA), to help discuss and provide solutions to resolve some of these issues [14].

Conclusion: Data dissemination continues to be a challenge for the planetary community. By supporting FGDC metadata or PDS-to-FGDC conversion methods for planetary geospatial holdings, the community can help create an environment where planetary data is readily usable by existing data portals and more easily discoverable by researchers and the public.

References: [1] PDS, http://pds.jpl.nasa.gov/. [2] Malin, M.C., et al., (2007), Context Camera Investigation on board the Mars Reconnaissance Orbiter, J. Geophys. Res., 112, E05S04, doi: 10.1029/2006JE002808. [3] Robinson, M.S., et al., (2005), LROC - Lunar Reconnaissance Orbiter Camera, Lunar Planet Science Conference XXXVI, Lunar and Planetary Institute, Houston, TX, abstract # 1576. [4] Smith, D.E., et al., (2001), Journal of Geophysical Research, v. 106, no. E10, p. 23,689–23,722. [5] Hare, T.M, et al., (2009), Extraterrestrial GIS chapter, Manual of GIS, ASPRS, ISBN: 1-57083-086-X. [6] Hare, T.M., (2010), LPS XXXX, abs. 2728. [7] McEwen, A. S., et al., (2007), J. Geophys. Res., 112, E05S02, doi:10.1029/2005JE002605. [8] Castalia, B., (2008), LPS XXXIX, abs. 2484. [9] Chin, G., et al., Space Science Reviews Volume 129, Number 4, 391-419, DOI: 10.1007/s11214-007-9153-y. [10] URL: http://www.fgdc.gov [11] Federal Geographic Data Committee (2002), FGDC-STD-012-2002, [12] Cohen, B.A., et al. (2008), LPS XXXIX, abs. 1640. [13] OGC, http://www.opengeospatial.org/. [14] IPDA, http://planetarydata.org/