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BULLETIN

Geospatial Data and Software Reviews

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On January 3, 2019, the China National Space Administration's (CNSA) Chang'e 4 spacecraft became the first to land on the far side of the Moon when it touched down in the Von Kármán carter. On February 15, 2019 the Working Group for Planetary System Nomenclature of the International Astronomical Union (IAU) officially named the landing site Statio Tianhe, after "the ancient Chinese name for the Milky Way, which was the sky river that separated Niulang and Zhinyu in the folk tale 'The Cowherd and the Weaver Girl.'"[1] This got me wondering: are there sources of GIS data for planetary bodies other than the Earth?

As it turns out, there is a comprehensive of source of free, open data on what tends to be called "planetary GIS": the USGS Astrogeology Science Centre[2]. Planetary GIS is related to this discipline known either as astrogeology or planetary geology (a word of warning: if you take a wrong turn at Google and search for "astrogeography," you'll instantly find yourself deep in a world of astrological woo). The Astrogeology Science Center, which supports not just the American but the international scientific community, counts as part of its mission the conduct of "innovative, fundamental research that advances the fields of planetary cartography, geoscience, and remote sensing."[3] Any search for planetary GIS information should start here. The website hosts a large collection of georeferenced imagery, maps, and datasets, as well as GIS tools, tutorials, and other information.

The Astrogeology Science Center was founded in 1968 to support the manned Apollo missions to the Moon and has continued to map "nearly every solid surfaced body in the solar system," according to USGS GIS specialist Marc Hunter[4]. Creating maps in the early years was a "complicated process of hand-cutting mosaics, and airbrushing relief maps," continues Hunter, "but over the last 30 years has become entirely digital as [the Astrogeology Science Center uses] mission data to create science and GIS ready products"[5]. Hunter notes that planetary data may pose challenges where things like custom coordinate systems and lack of standardization occur, but that

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[1] "IAU Names Landing Site of Chinese Chang'e-4 Probe on Far Side of the Moon," International Astronomical Union, https://www.iau.org/news/pressreleases/detail/iau1901/?lang - all URLs retrieved March 20, 2019.

[2] https://astrogeology.usgs.gov/.

[3] https://astrogeology.usgs.gov/about/mission.

[4] Private correspondence.
[5] Ibid.

more recent changes to applications such as QGIS and ArcMap have made these easier to handle. However, Hunter grants that "a lot more commonality with terrestrial geoscience data than people would think"[6] and that planetary GIS draws significantly on conventional GIS practices.

Perhaps the best starting point for data discovery is Astropedia[7], the "[l]unar and planetary cartographic catalog" for browsing imagery and data holdings, listed under the site's Maps/Products tab as Product Search. Start browsing holdings by selecting the planetary body from the iconographic menu to the left of the screen; moons are listed as "sub-targets" of their parent planets and other entities have their own entries under "Small Bodies" (Plutophiles may rejoice to see that Pluto is implicitly recognized as a planet in this navigational scheme). Selecting an entity invokes a small info box with cartographic stats and quick links, an expandable web map of the body with overlays and an export feature, and a list of available data products for that body. There are several filters for locating data: for GIS-ready datasets, product type (potentially including DEMs, topographic maps, nomenclature, imagery mosaics, and others such as may be available for a give body), spacecraft (the source of the data), region (if applicable to the body), and a feature finder for named geographic features on the subject body. This last filter will select and zoom to the selected feature in the web map (see above) and filter the dataset results for products which include that feature. Astropedia isn't searchable, strictly speaking. There is only a site search feature available, although this does separate results found in data products from those found on the site's regular pages. The portal's idiosyncratic layout and navigation may pose accessibility issues for some users.
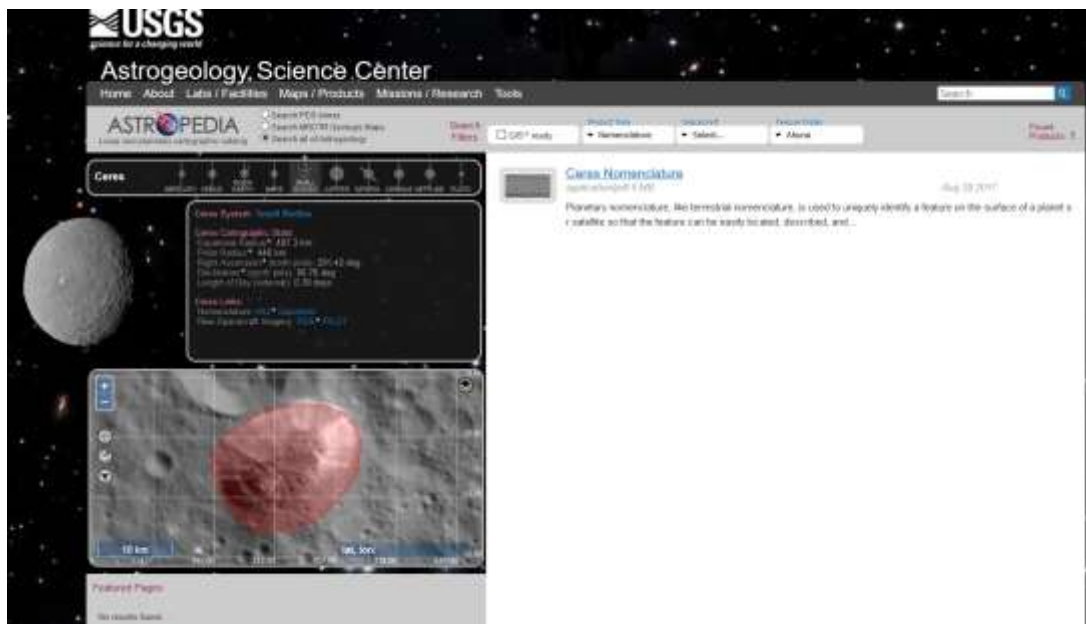

Figure 1 Screenshot of the Astropedia results page using the Feature Finder filter to locate a dataset showing Ahuna Mons on Ceres. Note that the feature is highlighted in the map box.

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[6] Ibid.

[7] https://astrogeology.usgs.gov/search.

Each data product has a detailed record page. The Astrogeology Science Center creates metadata based on the FGDC standard[8], extended by NASA's PDS4 (Planetary Data System 4)[9], and including a helpful prose description/abstract of the product. The record page also provides direct download links as well as record links to products from which the current product was derived, to ancillary products, and to related products. Additionally, the record page allows the user to "[p]roject, clip, convert format… and download" the product with a tool called Map a Planet.

Map a Planet (actually, Map a Planet 2, also stylized Map-a-Planet 2 or MAP2) is a service that "allows users to select global image mosaics for download, or with an account, one can also request the mosaic be map projected, clipped to extents, run pre-defined algebra functions against multi-band mosaics, and/or then convert it to the user's desired file format"[10]. Users must request a free account to use Map a Planet; the request requires the user to justify the request but there are no eligibility requirements posted and I was able to quickly obtain an account for the purpose of writing this review. Data requests through Map a Planet are not instantaneous; users submit work orders through the tool and are notified by email when the USGS servers complete the job.

The Astrogeology Science Center also hosts ArcGIS Server and WMS services to provide basemaps through its Planetary GIS group in ArcGIS Online[11]. These basemaps can be pulled directly into ArcMap, ArcGIS Pro, or the ArcGIS Online map viewer. The basemaps do not work well in ArcGIS Online, however, as the platform wants to superimpose them onto the default Earth basemap and project them onto the Earth's coordinate system.

The USGS also hosts the IAU's Gazetteer of Planetary Nomenclature[12], which is highly integrated with the Astrogeology Science Center's site. As well as providing a navigable, web-based gazetteer of features, the site also provides shapefile and KML downloads for named features of 41 planetary bodies using IAU-approved coordinate systems. The more Humanities-minded users may appreciate that the gazetteer includes information on the origins of the named features and the languages from which their names are derived.

Users can also download static map images from the Maps portal[13]. In general, this portal is less well organized and navigable than Astropedia and some product links in fact go to Astropedia

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[8] https://www.fgdc.gov/metadata/geospatial-metadata-standards.

[9] L. Gaddis et al, "Astropedia Annex: A repository for planetary research products," June 2012, https://astropedia.astrogeology.usgs.gov/download/Docs/PDS/AstropediaAnnex_PlanetaryDataWorkshop2012.pdf. See also M.S. Bailen et al, "Astropedia - a data portal for planetary science," 43rd Lunar and Planetary Science Conference, 2012, https://www.lpi.usra.edu/meetings/lpsc2012/pdf/2478.pdf. For more about the Planetary Data System and its Data Standards, see https://pds.nasa.gov/datastandards/about/.

[10] https://astrogeology.usgs.gov/tools/map-a-planet-2.

[11] https://www.arcgis.com/home/group.html?id=e71b1a3d3d704e0fb135bd02cb2ff80d

[12] https://planetarynames.wr.usgs.gov/.

[13] https://astrogeology.usgs.gov/maps.

records. However, the maps portal does host colour, high resolution images of some planets for turning into globes[14].
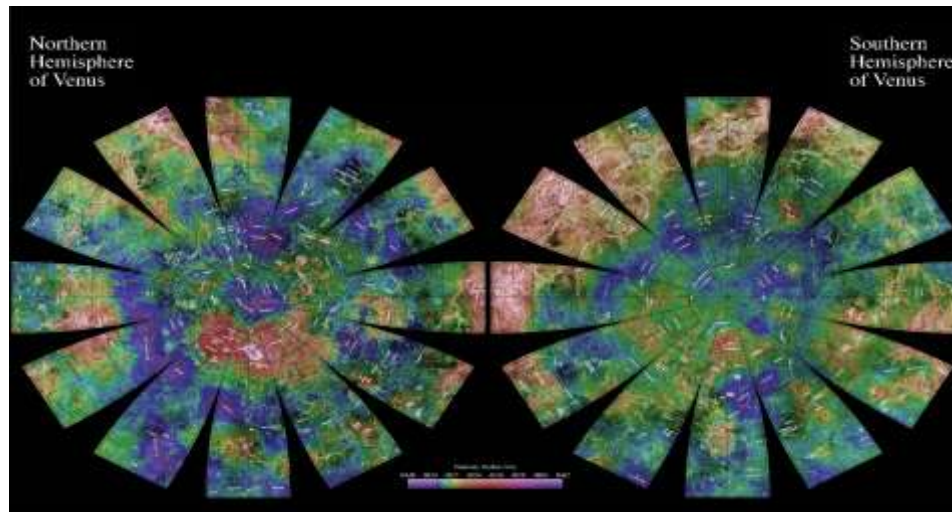

Figure 2 The Venus Magellan Globe, available through the map portal.

Several tools and tutorials are available through the Mapping, Remote-sensing, Cartography, Technology, and Research (MRCTR, pronounced "Mercator") GIS Lab at the Astrogeology Science Center[15]. These range from introductory videos for new ArcGIS users to more specialized, self-guided tutorials to the Planetary Geologic Mapping Python Toolbox[16] and other tools for ArcMap 10.x[17]. According to Hunter, much of his work through MRCTR is to "remove the hurdles and 'buttonology' of accessing and using GIS data for scientists and mappers"[18]. MRCTR's in-house services include "data management, custom tools, tutorials, help desk support and standards development"[19].

Finally, the Astrogeology Science Center partners with NASA on the Planetary Geologic Mapping Program[20]. While much of this site's information refers back to the pages on the Astrogeology Science Center's site, it does provide access to a larger version of the web map embedded in the Astropedia portal[21] and protocols, guidelines, and symbology for generating planetary maps according to USGS standards.

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[14] https://astrogeology.usgs.gov/maps/planetary-maps-and-globes.

[15] https://astrogeology.usgs.gov/facilities/mrctr-gis-lab.

[16] All of these at https://astrogeology.usgs.gov/facilities/mrctr/gis-tutorials.

[17] https://astrogeology.usgs.gov/facilities/mrctr/gis-tools.

[18] Private correspondence.
[19] Ibid.
[20] https://planetarymapping.wr.usgs.gov/.

[21] https://planetarymapping.wr.usgs.gov/Review.