A History of the NASA Planetary Data System (PDS) Imaging Node's Map-A-Planet Legacy Web Services.
P. A. Garcia[1], C. E. Isbell[2], and L. R. Gaddis[3], [1]U. S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, Arizona 86001, pgarcia@usgs.gov.

Introduction: The PDS Map-A-Planet web service [1-3] was originally developed in the late 1990s in response to the increased demand for access to planetary images and other data. This demand was facilitated by the rapid rise in popularity of then-new public access to the internet. At that time, the boom in internet technology had begun to enable easy access to the large amounts of data collected by NASA's Space Exploration Programs. These data had previously been unavailable in readily usable form to most people, including educators, citizens, and even scientific researchers.

Initially, Map-A-Planet only served data for Mars and the Earth's Moon, but as it grew in popularity, more data sets, as well as advanced processing capabilities, were added to the system. Today, the system serves scientifically accurate planetary global mosaics, allowing users to create image maps from forty-six different image-based data sets. Users can visually navigate any of the available data sets, select various image density stretches and map projections, customize a geographic area selection, define the spatial resolution, and add graticules (latitude and longitude grids) to their maps. In addition to real-time navigation, the order system allows users to order their maps in a variety of file formats. Twelve lunar elemental abundance tabular data sets are also available via Map-A-Planet.

Map-A-Planet users can be found in various parts of the world, and a number of college and university professors have incorporated Map-A-Planet into their class curricula. Map-A-Planet is freely available to the public and is used not only by educators, but also many lay persons and research scientists as well.

Planetary Bodies for which data are available: Map-A-Planet began by serving only a very limited number of data sets, but grew to provide access to a wide variety of scientifically important data. The system uses image processing software and tiled Mosaicked Digital Image Map (MDIM) data to create cartographic image maps of users' desired targets and regions [4-12]. Planetary bodies now supported by MAP are Mars, Venus, Mercury, the Earth's Moon, four Galilean satellites (Callisto, Europa, Ganymede, Io), and five moons of Saturn (Rhea, Dione, Tethys, Iapetus, Enceladus).

Generating the Maps: In the early days of Map-A-Planet, software called *MapMaker* was developed and utilized to generate the image maps. For data sets which were tiled, and at that time distributed on multiple CDs, MapMaker was able to locate and load the tiles required to produce a particular map, scale the tiles to the desired resolution, knit the tiles together, and then apply the appropriate image stretch and map projection to finalize the product requested.

Later, Map-A-Planet was updated to incorporate the use of the USGS Astrogeology Science Center's signature Integrated Software for Imagers and Spectrometers (ISIS) [13-16]. The transition to using the ISIS software provided users with even more speed and flexibility in generating their map products and also provided capability for creating larger maps through the order system.

Advanced Capabilities and Data Products: *Order Formats and Options.* Over the years, capabilities were added to the Map-A-Planet system, typically by user request. Now, in addition to JPEG, TIFF, and GIF image formats, Map-A-Planet gives users the ability to order maps in 8-bit, 16-bit LSB, or 32-bit LSW, for PDS, ISIS and RAW formats. Users can choose between Bilinear Interpolation and Nearest Neighbor methods for data resampling. They can generate products in Sinusoidal, Simple Cylindrical, and Mercator map projections and can obtain products in Polar Stereographic projection through the order system.

Derived and User-Defined Data Products. One of the last (but popular) features to be added to the Map-A-Planet system was the use of predefined and custom mathematical functions. Users can now apply six predefined functions, as well as virtually unlimited custom arithmetic operations, to their data. Selected elemental abundance (including three FeO wt% [18-20] derivations and TiO2 wt% [18]) and two optical maturity (OMAT [20,21]) functions are available for selection when ordering Clementine UVVIS multi-band products. The user-defined arithmetic operation function, available through the order system, allows users to enter custom mathematical expressions and operators to be applied to any available data set. Examples of such applications include single-band operations (additive and multiplicative corrections such as radiometric calibration) and multi-band operations such as differences, ratios, and advanced data manipulation such as spectral curvature, band depths, and band tilt maps [22].

Latest Data. Among the last data sets to be added to the Map-A-Planet system were the Clementine Near Infra-Red 6-Band Mosaic [24], Lunar Orbiter Mosaic (USGS) [17], Lunar Prospector Elemental Abundances

[23], Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) Albedo and Thermal Inertia maps [25], Mars Orbiter Camera (MOC) Wide Angle Mosaic [26], and Mars Orbiter Laser Altimeter (MOLA) maps [27], MESSENGER MDIS/Mariner 10 Global Image Mosaic of Mercury [28] and Kaguya Laser Altimeter Topographic Map [29].

The Next Generation: Map-A-Planet has inspired other web-based cartographic services. Most recently, a new development team has produced "Map-A-Planet 2" (MAP2) which is now in beta release [30-31]. The current version of Map-A-Planet is scheduled to be decommissioned within the next year, when comparable services are available through MAP2.

Summary: The popular Map-A-Planet Cartographic Web Service was designed for a wide variety of users and intended to be available to everyone. For more than fifteen years, the system has made access to large, complex digital image map data sets considerably easier. Map-A-Planet development was responsive to the needs of planetary researchers, educators, and the general public, filling a niche not addressed by other services. The Map-A-Planet service is planned to be decommissioned in the near future, but will be survived by other web services leveraged off of Map-A-Planet features and design.

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