POW: UPDATE FOR THE PDS MAP PROJECTION WEB SERVICE. Trent M. Hare, S.W. Akins, R.M. Sucharski, M.S. Bailen, J. Shute, J.A. Anderson, and L.R. Gaddis. U. S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ, 86001 (thare@usgs.gov).

Introduction: In July of 2013, the USGS Astrogeology Science Center publicly released a tool called the Map Projection (on the) Web Service (POW). This free online service transforms raw Planetary Data System (PDS) images to science-ready, map-projected images [1]. POW uses PDS Imaging Node tools (PILOT and UPC [2, 3]) to locate images and then allows the user to select and submit individual images to be map-projected. This process uses Astrogeology's image processing package called the Integrated Software for Imagers and Spectrometers (ISIS, currently in version 3) [4]. In the last six months, we have had over a hundred users register and the system has processed thousands of images.

Relevance: PDS archives are typically stored in their "raw" or Engineering Data Record (EDR) format. Before they are truly useful for analysis, these images, at a minimum, should be radiometrically calibrated and then map-projected [5]. While some instrument teams provide map-projected versions of their data, many other archives must first be processed by the individual researcher. POW provides users with calibrated cartographic images that can be used readily for geologic mapping, change detection, merging of dissimilar instrument images, analysis in a Geographic Image System (GIS) and use in a host of other scientific applications (e.g., ArcMAP, ENVI, Matlab, JMARS, QGIS, Opticks, etc.).

POW is dependent on ISIS and the instruments it supports [4]. As new instruments are added to ISIS, POW will also increase the number of instruments it supports. Currently, instruments supported in POW include:

- Cassini Imaging Science Subsystem (ISS) and Visible and Infrared Mapping Spectrometer (VIMS)
- Clementine Near Infrared (NIR), Ultraviolet and Visible (UVVIS), High Resolution (HIRES),
- Galileo Solid State Imaging (SSI)
- Lunar Reconnaissance Orbiter Wide Angle Camera (WAC), Narrow Angle Camera (LROC-NACL, LROC-NACR)
- Mariner 10 vidicon cameras (VID A, VID B)
- Mars Express High Resolution Stereo Camera (HRSC)
- Mars Global Surveyor Mars Orbiter Wide Angle Camera (MOC-WAC), Narrow Angle Camera (MOC-NAC)
- Mars Reconnaissance Orbiter Context Camera (CTX)
- Messenger Mercury Dual Imaging System (MDIS-WAC, MDIS-NAC)
- Mars Odyssey Thermal Emission Imaging System (THEMIS-IR, THEMIS-VIS)
- Viking Orbiter 1 & 2 vidicon cameras (VIS-1B, VIS-2A, VIS-2B)
- Voyager I & II Imaging Science Subsystem (ISS) vidicon cameras **(**NAC-1, NAC-2, WAC-1, WAC-2)

Learning Tool: While ISIS is free to the community, it can be a difficult package to learn. Currently, ISIS must be installed on a UNIX platform (e.g., Linux or Mac OSX) and requires the user to be familiar with UNIX operating system commands. POW allows researchers to make use of a wealth of PDS science data without having to install or learn how to run ISIS and to benefit from a recommended processing pipeline as defined by USGS and the instrument teams. This service can also be used as a learning tool or an introduction to ISIS for those who would like to run it locally because the ISIS commands will be logged and delivered to the user.

Using the POW front-end, a user is allowed to 1) select and submit a list of up to 50 PDS EDR images, 2) define an output map projection and its parameters (e.g., Polar Stereographic, Sinusoidal), 3) define the output bit type (8, 16, or 32 bit), and 4) select an ISIS or PDS output format or a more standardized geospatial format such as GeoTiff, GeoJPEG2000, PNG, or JPEG. Conversion to the various supported image formats will be completed using the Geospatial Data Abstraction Library (GDAL), which passes all cartographic information into the output format [5].

The Future of POW: Since the release of POW, we have had many ideas for a variety of future uses from in-house and external users. Below are some of these potential improvements.

Geometric Backplanes: While most POW users are content with a simple, processed image and ancillary data for geomorphic studies or

mapping, to support more detailed scientific analyses we intend to add the capability for users to select "backplanes" or additional bands of information for each pixel in an image. ISIS currently supports more than a dozen geometric backplanes (e.g., Longitude, Latitude, radius, phase and emission angles, north and sun azimuths, etc.) which could be offered as backplanes by POW.

Custom Calibrations and CDR support: Currently, the recommended instrument-specific suite of noise removal and radiometric calibration algorithms applied in POW will be automatically selected for the user (typically these represent the same processing pipeline used by the originating instrument team). For user-specific calibrations or if the instrument team provides multiple processing methods, those options could be provided by POW.

As noted above, PDS supports the download of EDR (raw) images, and many instrument teams also provide Calibrated Data Records (CDRs). CDRs are often not map-projected, but they can be easily double or triple the EDR file size because they are generally a higher bit-type than EDRs. For some missions, the CDR archive volume can be prohibitive to store. To help with the rapidly increasing archive volumes, POW can deliver on-demand CDR products using the original mission pipeline in lieu of storing the CDR data. When fully integrated with PDS services, POW can offer support for multiple or versioned calibration methods as the instrument teams refine their procedures.

Control, Tonal Matches, and Mosaics: POW supplies users with individual images that are geometrically referenced only as well as the spacecraft pointing allows. Depending on the instrument and spacecraft, each image could have meter to kilometer spatial offsets between adjacent images. ISIS continues to add more robust methods for automatically controlling images to each other and to controlled base maps. POW will be able to take advantage of these ISIS methods along with any improvements to SPICE to enhance the registration of delivered images.

ISIS also supports the capability to tonally match multiple images to each other. This is accomplished using photometric corrections and/or pure statistical equalization methods. Both methods are especially useful for minimizing internal image seams in a mosaic. This equalization functionality could be added to POW for creating groups of images that have been tonally matched and properly blended into a seamless image mosaic.

Job Submissions: When POW was originally released, the only method to submit a list of images for processing was through the PILOT image locator interface [3]. Because each job is tied to a single user, we currently have a requirement that a user is logged into our website prior to submitting. This immediately became problematic even from our default interface because PILOT does not require a user to be logged in to find images. To overcome this, we have implemented a delayed log in method where a job can be submitted and added to a short-term queue to then give the user and opportunity to log in. This not only helps PILOT users but also has allowed us to test other methods for submission. For example, we have created a selection and submission tool within the GIS application ArcMap. Using this simple example, written in Python, many other desktop or web applications could be built to utilize POW.

Lastly, we are also considering methods such that logins will not be required for trusted users. This would potentially allow outside facilities to use POW as part of their processing pipelines.

Acknowledgments: This project was supported by NASA's PG&G Cartography Program. To use POW, please create a login on this website: http://astrocloud.wr.usgs.gov/

References: [1] Hare, T.M., et at., (2013), LPSC 44, abstract #2068. [2] Akins, S. W., et al, (2009), LPSC 40, abstract #2002. [3] Bailen, M.S., et al, (2013), LPSC 45, abstract #2246. [4] Keszthelyi, L., et al., this volume. [5] Hare, T.M., et al., (2007), LPSC 38, abs #2364.

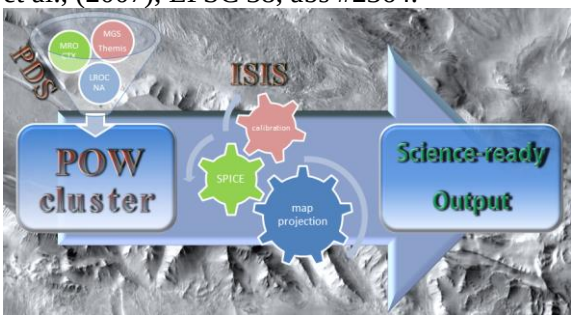

Figure 1. Simple graphical workflow for POW.