

IDENTIFYING COMMUNITY NEEDS FOR A MARS EXPLORATION ROVERS (MER) DATA CATALOG S.B. Cole¹, J.C. Aubele², B.A. Cohen³, S.M. Milkovich⁴, and S.R. Shields⁵, ¹shoshe@astro.cornell.edu, ²New Mexico Museum of Natural History & Science, Albuquerque, NM, ³NASA Goddard Space Flight Center, Greenbelt, MD, ⁴NASA Jet Propulsion Laboratory, Caltech, Pasadena, CA, ⁵New York Space Grant Consortium, Ithaca, NY.

Introduction: The Mars Exploration Rovers (MER) mission was the first long-duration surface mission on another planet: Spirit and Opportunity operated for 2210 and 5111 sols (martian days), respectively. The wealth of data returned by the rovers is archived in the Geosciences Node of NASA's Planetary Data System (PDS; <https://pds-geosciences.wustl.edu/missions/mer/index.htm>) and searchable through the MER Analyst's Notebook (<http://an.rsl.wustl.edu/mer/>); Pancam images, including mosaics, can be found on the Pancam website (<http://pancam.sese.asu.edu/images.html>).

The MER Analyst's Notebook is organized by Sol (day of mission) and instrument, and includes mission-generated documentation; using it is intuitive if one is intimately familiar with the mission. Without access to the team's corporate knowledge, however, it can be difficult for a researcher to navigate the Notebook in order to find desired data products.

Additionally, it can be challenging for new MER data users to assess the "data quality" of a data product before they download and analyze it, *i.e.*, whether an Alpha Particle X-ray Spectrometer (APXS) data product is a low signal-to-noise "touch and go" observation *vs.* a high signal-to-noise spectrum, integrated over many hours, that would yield higher-fidelity information. These factors decrease the productivity and increase the frustration levels of researchers who were not on the MER team but want to delve into MER data. For example, it is difficult to find Pancam images at Marathon Valley, Mössbauer observations of sulfate soils, or publication-quality APXS spectra of Watchtower Class rocks, without prior knowledge of the geographic location of Marathon Valley, the names of individual soil and rock targets or classes, APXS integration times, or the Sol (day of mission) or site (incremented rover location) of the observations (see Figure 1).

The MER Data Catalog Project: Enabling future generations of MER researchers: Scientific researchers who are casually familiar with the MER mission may not have sufficient background to make efficient use of the PDS or the Analyst's Notebook, and it is beneficial to the entire Mars community for them to be able to find data products necessary for their research. Furthermore, we wish to enable school teachers, museum informal science educators, and

summer research students to easily incorporate MER data into exhibits and short-term projects in which there is little time or facility for a deep dive into mission-generated documentation. We anticipate that workers whose studies require more depth and detailed analysis will continue their work by using the documentation and tools available on the PDS and the MER Analyst's Notebook.

The MER Data Catalog Project aims to remove these barriers of entry to the rich MER datasets by providing the capability to search archived data products using user-friendly, descriptive terms such as location, target, and rock or soil class. In addition, we will catalog geologic and atmospheric phenomena apparent in image data. Researchers will be able to search the catalog for images that exhibit objects such as clasts, outcrops, ripples, clouds, dust devil, craters, etc. (see Figure 1).



Figure 1. Pancam image 2P166850381RADA9DWP2279R1C1, acquired by the *Spirit* rover on Sol 456 (April 15th 2005) when the rover was at the Cumberland Ridge site on Husband Hill. This image shows the Watchtower Class outcrop "Larry's Lookout", the Mini-TES target "Astern", and rover tracks, and overlooks Tennessee Valley. Geologic phenomena apparent in this image include outcrop, float rocks, bright soil, bedforms, and a valley. A search in the MER Data Catalog for any of the terms mentioned in this caption would lead to this image.

We will supplement the catalog with documentation designed to introduce non-MER researchers to the

nuances of analyzing MER data, including “how-to” guides with tips from members of the MER team. For example, Chapter 2 of [1], “The Mars Exploration Rover and the Athena Science Payload”, written by a member of the MER team, describes the MER vehicle and its instruments, including calibration, data products, and onboard and ground-based data processing, at a level accessible to experienced researchers new to MER analysis.

Pilot Study: We are in the midst of a pilot study to determine the scope of the catalog, prioritize our cataloging efforts, identify a database system that meets our requirements, and estimate the time required to complete the catalog.

Surveying the community to determine catalog scope and priorities. We are conducting a survey of potential catalog users – including the Mars scientific community, the greater planetary science and geoscience communities, and the general public – to assess the demographics of people interested in using MER data; their research foci; and the geographic locations, types of data products and observations, and geologic and atmospheric phenomena they would most like to study. We will use the results of the survey to prioritize our cataloging efforts in order to meet the community’s most urgent needs as quickly as possible. The survey will be open through April 2020; interim results collected by February 29th 2020 will be presented and their implications for catalog effort prioritization will be discussed as part of this presentation. We invite all readers of this abstract to take the survey, which can be found at <http://www.merdatacatalog.com/survey>. No identifying information is collected, and all data will be presented in aggregate. Completing the survey should take approximately 5-10 minutes. This survey has received approval from the Cornell University Institutional Review Board (IRB) Office.

Database infrastructure. We have consulted with Cornell University’s Research Data Management Service Group (RDMSG) about existing database frameworks in the hopes of finding one that will work for our catalog. The RDMSG determined that no suitable database system currently exists. We will develop our own database architecture, which we plan to make publicly available.

Workforce development and engagement. We are partnering with the Learning Web [2], an Ithaca, NY, non-profit that connects local youth to mentors for hands-on experiential education in a mentor-apprentice model. We will train apprentices to catalog MER data, which will enable us to estimate the length of time necessary to train catalogers and catalog the data. Apprentices who show promise may be hired to work on the final catalog. Because cataloging the data involves

skills such as cross-referencing data products and identifying features in images rather than the analytical skills one develops by majoring in physical sciences, we plan to recruit catalogers of approximately undergraduate age who are interested in space science and exploration but chose not to major in a STEM field; our recruitment effort will actively focus on hiring women and underrepresented minorities. We hope to show these individuals that the traditional path of majoring in STEM and attaining a PhD is only one mode of entry into space exploration, and we will encourage them to develop a career in the field.

Summary: We are creating a user-centered catalog of MER data in order to reduce the barriers of entry for workers who were not on the MER team; the catalog is not intended to be a duplicate or replacement for the MER Analyst’s Notebook, but rather an entry point for those unfamiliar with the mission. We seek to design and develop a database architecture that will be flexible enough to expand the data catalog to additional rover missions, and we will make the architecture publicly available. We will expand the Mars workforce by hiring capable catalogers who would not follow the traditional academic path into planetary science. Cataloging 7321 sols’ worth of data will require an extended period of time; we will prioritize our cataloging efforts according to community need as determined by our survey of potential catalog users. We highly encourage the reader with an interest in using MER data to take our survey, available at <http://www.merdatacatalog/survey>.

Our goal is for everyone – senior research scientist, graduate student, undergraduate, museum visitor, space enthusiast, future astronaut standing on Husband Hill in Gusev Crater – to be able to easily find and use *Spirit* and *Opportunity* data of interest to them.

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References: [1] Cole S.B. (2015), “Petrology, Stratigraphy, and Geologic History of Husband Hill, Gusev Crater, Mars” PhD diss., Cornell Univ. [2] <https://www.learning-web.org>