

**PDS Archive Release of Apollo 11, Apollo 12, and Apollo 17 Lunar Rock Sample Images.** P. A. Garcia<sup>1</sup>, W. L. Stefanov<sup>2</sup>, G. E. Lofgren<sup>3</sup>, N. S. Todd<sup>2</sup>, and L. R. Gaddis<sup>1</sup> <sup>1</sup>U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, Arizona 86001 (pgarcia@usgs.gov); <sup>2</sup>Jacobs Technology/NASA Johnson Space Center, Mail Code KA, Houston, TX 77058; <sup>3</sup>NASA Johnson Space Center, Mail Code KT, Houston, TX 77058.

**Introduction:** Scientists at the Johnson Space Center (JSC) Lunar Sample Laboratory, Information Resources Directorate, and Image Science & Analysis Laboratory have been working to digitize (scan) the original film negatives of Apollo Lunar Rock Sample photographs [1, 2]. The rock samples, and associated regolith and lunar core samples, were obtained during the Apollo 11, 12, 14, 15, 16 and 17 missions.

The images allow scientists to view the individual rock samples in their original or subdivided state prior to requesting physical samples for their research. In cases where access to the actual physical samples is not practical, the images provide an alternate mechanism for study of the subject samples. As the negatives are being scanned, they have been formatted and documented for permanent archive in the NASA Planetary Data System (PDS). The Astromaterials Research and Exploration Science Directorate (which includes the Lunar Sample Laboratory and Image Science & Analysis Laboratory) at JSC is working collaboratively with the Imaging Node of the PDS on the archiving of these valuable data. The PDS Imaging Node is now pleased to announce the release of the image archives for Apollo missions 11, 12, and 17.

**PDS Data Restoration Projects:** The PDS periodically conducts restoration work on historic data acquired by past NASA space missions [3]. These data typically have been stored on what have become outdated media, such as magnetic tapes, film negatives, hardcopy (paper), and microfilm. These media are difficult or impossible to use and subject to degradation over time. The data are sometimes also stored in mission-specific formats requiring software tools which have not been kept current and are therefore no longer available to users to provide data access.

The goals of a PDS data restoration effort are to provide long-term preservation of the data and broader public access to them. During restoration, the data typically are transitioned to current data formats and migrated to more current archive storage media.

**The Apollo Rock Sample Data:** As part of the original curation process at Johnson Space Center, high-quality photographs were taken of the individual lunar rock samples [4]. During the initial photographic procedure, pictures were taken of the top, bottom, and sides, of each sample, along with sixteen stereo pairs of each rock taken at 45 degree intervals. In cases

where individual rock samples were cut up or subdivided, further photographs were taken at each step in that subdivision process. Photographs were also taken whenever sample thin sections were made. The entire collection (for all six missions) consists of roughly 36,000 photographs.

*The digitized images.* The original negatives have been scanned at 2040 ppi (80 pixels/mm) and 16-bit depth, allowing users to resolve 12.5-micron features, and retaining the full dynamic range of the original film. The scanned images were then reviewed and saved in a lossless TIFF format. From this TIFF image, a set of JPEG images in various sizes was generated for browsing, print, and web use. The total combined data volume for the Apollo 17 archive is 2.2 terabytes [2], while the archives for Apollo 11 and 12 are each roughly 1 TB in size.

**Table 1.** Size and resolution of digital files for Apollo mission sample images.

Mission	Number of Images	Average Image Size	Total Archive Size
Apollo 11	2,540	250 MB	1 TB
Apollo 12	4,700	200 MB	1 TB
Apollo 17	5,713	400 MB	2.2 TB

**The PDS Archive of Apollo 11, 12, and 17 Lunar Rock Sample Data:** The PDS archives of Lunar Rock Sample Images are being generated concurrently, mission by mission, as the scanning progresses. The individual archives for Apollo 11, 12, and 17 are the first of the archives to be completed. Archives for Apollo missions 14, 15, and 16 are underway. The data product label for each image contains extensive metadata to allow for database ingestion and subsequent searching by sample number, mission, rock type, descriptive mineralogic and petrographic terms, and cross-mission searches by collection station or lunar landmark. Information on the scan parameters for each image is also included in the labels. Lunar Sample Catalogs [5] corresponding to the samples in each archive will be included in the archives as ancillary data and referenced within the data product labels.

The rock sample images are not typical of the images usually archived in the holdings of the PDS Imaging Node. The images contain scale rules, scale and orientation cubes, identification markers and other pertinent pieces of information directly within the image (Figure 1). Due to the special nature of these images, they have been archived in the form of PDS document files to reside within the data directories of the archives.

*Archive Physical File Structure.* Within the archives, Apollo lunar rock data are organized according to the geologic classification and sub-classification of the rocks, as well as by photo type (orthographic, stereo pair, sample processing or thin section; Figure 2). The “Extras” subdirectory of each archive contains the JPEG images generated from each TIFF file, while the “Document” subdirectory contains the sample catalogs and other reference material pertaining to the rock sample images.

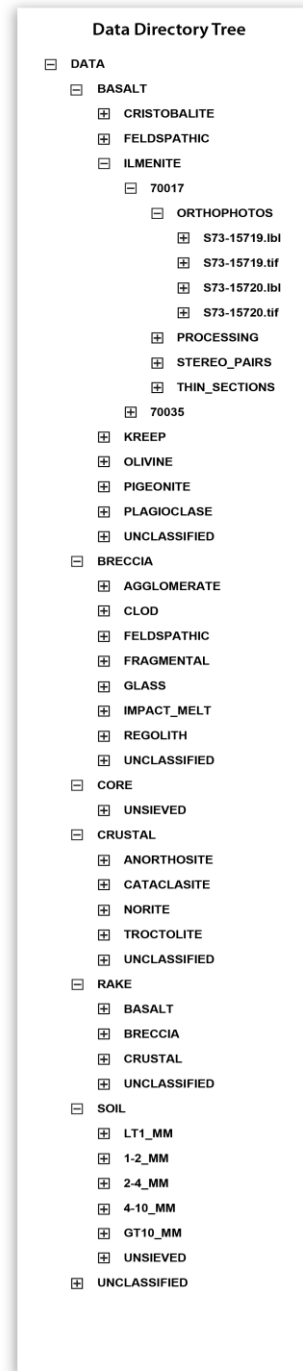
**Access to the Apollo Rock Sample Data:** The metadata for each photograph have been compiled in a database which will be used to complement the capabilities of the PDS archive and provide a more sophisticated mechanism for searching the Apollo rock sample data. An interactive web application allows users to search for images based on multiple criteria. These criteria include many parameters and range from mission, location, rock classification, and mineral type, to photo type and description. This searchable database of image data is available on the Curation website at: <http://curator.jsc.nasa.gov/lunar/samplecatalog>.

**Data Set Availability:** The PDS archives for Apollo 11, 12, and 17 [2] will be publicly released by March 2013. It is anticipated that the remaining archives (Apollo 14, 15, and 16) will be available within a few months after this initial archive release.



**Figure 1.** Photo Number S73-15319, Sample 79155

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**Figure 2.** Sample partial file directory

**References:** [1] Lofgren G.E. et al, LPSC XLII, 2011, Abstract #1867; [2] Todd, N. S., and Lofgren, G. E., LPSC XLIII, 2012, Abstract # 2860; [3] Garcia, P.A., et al, LPSC XLII, 2011, Abstract #2310; [4] Lunar Curation Laboratory (1981), *Laboratory Operating Procedure 20*, NASA JSC; [5] Lunar Sample Catalogs, <http://curator.jsc.nasa.gov/lunar/catalogs/samplecatalogs.cfm>.