

Restoration and PDS Archive of Apollo Lunar Rock Sample Data. P. A. Garcia¹, N. S. Todd², G. E. Lofgren³, W. L. Stefanov⁴, S. K. Runco⁵, D. LaBasse⁴, and L. R. Gaddis¹ ¹U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, Arizona 86001 (pgarcia@usgs.gov); ²Jacobs Technology/NASA Johnson Space Center, Mail Code KT, Houston, TX 77058; ³NASA Johnson Space Center, Mail Code KT, Houston, TX 77058; ⁴Jacobs Technology/NASA Johnson Space Center, Mail Code KX, Houston, TX 77058; ⁵NASA Johnson Space Center, Mail Code KX, Houston, TX 77058.

Introduction: In 2008, scientists at the Johnson Space Center (JSC) Lunar Sample Laboratory and Image Science & Analysis Laboratory (under the auspices of the Astromaterials Research and Exploration Science Directorate or ARES) began work on a 4-year project to digitize the original film negatives of Apollo Lunar Rock Sample photographs. These rock samples—together with lunar regolith and core samples—were collected as part of the lander missions for Apollo 11, 12, 14, 15, 16 and 17. The original film negatives are stored at JSC under cryogenic conditions.

This effort is data restoration in the truest sense. The images represent the only record available to scientists which allows them to view the rock samples when making a sample request. As the negatives are being scanned, they are also being formatted and documented for permanent archive in the NASA Planetary Data System (PDS) archive. The ARES group is working collaboratively with the Imaging Node of the PDS on the archiving.

Restoring Data in the PDS: The Discipline Nodes of the PDS periodically participate in restoration activities for some of the historic data acquired by past NASA space missions such as Apollo, Viking, and Voyager [e.g., 1-4]. These data are typically stored and archived on outdated media such as magnetic tapes, film negatives, hardcopy, and microfilm that are subject to degradation over time. The data are sometimes stored in mission-specific formats, with software tools no longer available to provide access. As time goes by, the data become more and more inaccessible to users.

The goal of a data restoration project within the PDS is to preserve the data and to allow broader access to them. During restoration, the data typically are transitioned to current data formats and migrated to more modern storage media.

Apollo Rock Sample Data: High-quality photographs of the lunar rock samples were taken as part of curation of the samples at JSC [5]. Photographs were also taken as the samples were subdivided for research. The initial photographic procedure included documenting the 4 sides, top and bottom of each sample, along with sixteen stereo pairs of each rock taken at 45 degree intervals. More photographs were taken at each step in the process of subdividing the individual rock samples. In addition, photographs were taken when

ever sample thin sections were made. The entire collection consists of around 35,000 photographs.

The digitized images. The JSC film archive project members are trained experts in the curation and handling of original film negatives. As part of this restoration project, film negatives for the rock samples are extracted from the cold storage vaults at JSC and handled within a formal film archive clean room to avoid contamination. The negatives are scanned at 3200 ppi (100 pixels/mm) and 16-bit depth, which captures 10-micron features and the full dynamic range of the original film. The equipment used for scanning includes a Hasselblad (Imacon) X5 scanner, a Kodak IQ Smart3 scanner and a Durst Sigma scanner. The scanned images are reviewed by image processors and quality control personnel and saved in lossless TIFF format. From this TIFF image, a set of lower resolution JPEG images is generated for printing and website use. The total combined data volume for these archives is anticipated to be about 15 terabytes [6].

Table 1. Size and resolution of digital files.

File Type	File Size Range	Image Resolution (ppi)	Size (pixels)
16-Bit TIFF	100-460 MB	3200	7256x7224
High Res JPEG	350-1.5MB	2040-3200	3000x2980
Low Res JPEG	50-70KB	72	640x630
Thumbnail	2-25KB	72	150x145

PDS Archive of Apollo Lunar Rock Sample Data: The PDS archive of Lunar Rock Sample Data is being generated mission by mission as the scanning progresses. A separate archive will be created for each Apollo mission. Labels for each image will contain extensive metadata to allow searching by sample number, mission, rock type, descriptive mineralogic and petrographic terms, and across mission searches by collection station or lunar landmark. Detailed scan parameter metadata for each image will also be included in the labels. Lunar Sample Catalogs [7] corre-

sponding to each archive's samples will be included as ancillary data and referenced within the data label.

The rock sample images are not typical of the images usually archived in the holdings of the PDS Imaging Node. The images contain scales, size cubes, identification markers and other pertinent pieces of information directly in the image (Figure 1). These aspects of the images caused us to archive the images in the form of PDS document files to reside within the data directories of the archives.

Archive Physical File Structure. Apollo lunar rock data will be organized according to 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 will contain reduced-resolution JPEGs generated from each TIFF file, and the document subdirectory will contain the sample catalogs for samples referenced in each photo archived as PDF files.

Web Services for the Apollo Rock Sample Data:

A database containing information for each photograph has been created to correlate the photo with its corresponding sample from the Apollo collection. 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 will be provided to allow users to search for photographs based on multiple criteria. These criteria range from sample-specific data (such as mission, EVA station or landmark, rock classification, sample mineral composition, available pristine sample mass ranges and availability of thin sections) to photographic image-related data, such as photo type and photo description. This searchable database is available on the Curation website at: <http://curator.jsc.nasa.gov/lunar/samplecatalog/index.cfm>.

Data Set Availability: Photographs for three Apollo missions have over 95% of photos digitized: Apollo 11, 15, and 17 [6]. The Apollo 17 Lunar Sample Data Archive is currently being compiled for PDS peer review. Additional archives will be available soon after the digitization and documentation processes are completed.



Figure 1. Photo Number S73-24016, Sample 76235.

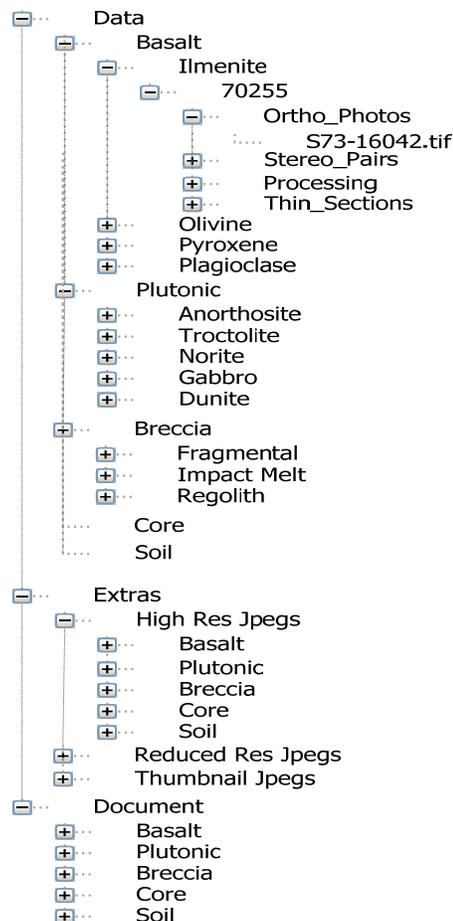


Figure 2. Sample partial file directory structure.

References: [1] Williams D. R. et al. (2009) *LPS XL*, Abstract #1991; [2] Akins S. W. et al. (2009) *LPS XL*, Abstract #2002; [3] Guinness, E., et al., 1990, An Archive of Digital Images from NASA's Viking Orbiter 1 and 2 Missions, Mission to Mars: PDS Volumes USA_NASA_PDS_VO_1001 through VO_1064. (CD-ROM); [4] Eliason, et al., 1990, Archive of Digital Images from NASA's Voyager 1 and Voyager 2 Missions, PDS Volumes VG_0001 through VG_0038 (CD-ROM); [5] Lunar Curation Laboratory (1981) *Laboratory Operating Procedure 20*, NASA JSC; [6] Lofgren G. E. et al. (2010) *LPS XLII*, this volume; [7] Lunar Sample Catalogs, <http://curator.jsc.nasa.gov/lunar/catalogs/samplecatalogs.cfm>

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