

**Apollo Lunar Sample Photographs: Digitizing the Moon Rock Collection** G. E. Lofgren<sup>1</sup>, N. S. Todd<sup>2</sup>, S. K. Runco<sup>3</sup>, and W. L. Stefanov<sup>4</sup>, <sup>1</sup>NASA Johnson Space Center, Mail Code KT, Houston, TX 77058, [gary.e.lofgren@nasa.gov](mailto:gary.e.lofgren@nasa.gov), <sup>2</sup>Jacobs Technology/NASA Johnson Space Center, Mail Code KT, Houston, TX 77058, [nancy.s.todd@nasa.gov](mailto:nancy.s.todd@nasa.gov) <sup>3</sup>NASA Johnson Space Center, Mail Code KX, Houston, TX 77058, <sup>4</sup>Jacobs Technology/NASA Johnson Space Center, Mail Code KX, Houston, TX 77058.

**Introduction:** The Acquisition and Curation Office at JSC has undertaken a 4-year data restoration project effort for the lunar science community funded by the LASER program (Lunar Advanced Science and Exploration Research) to digitize photographs of the Apollo lunar rock samples and create high resolution digital images. These sample photographs are not easily accessible outside of JSC, and currently exist only on degradable film in the Curation Data Storage Facility.

**The Apollo Photograph Collection:** During the initial examination of the lunar samples as they were returned from the moon, each rock was fully documented with a standard set of photographs. The set included 6 orthogonal views (4 sides, top and bottom) and a series of 16 stereo pairs taken at 45 degree intervals of rotation, Figure 1.



Figure 1. Ortho picture of 15075.

Subsequent processing and splitting of the samples for allocation has been further documented photographically, Figure 2.



Figure 2. Processing picture of 15075 showing sub-samples.

Samples that were studied extensively have over a hundred photographs. A full inventory of these photo-

graphs is given in Table 1. This table also shows the number of photographs that have been digitized to date as part of this ongoing effort. These images of the lunar samples provide the only views of the rocks before they were subdivided to provide allocations for scientific studies. Every surface of every rock can be viewed via this collection.

Table 1. Inventory of Photographs and Processing.

Mission	Requested	Scanned	Pending	% Compl
Apollo 11	2602	2602	0	100%
Apollo 12	5247	2550	2697	49%
Apollo 14	5478	0	5478	0%
Apollo 15	9580	9024	556	94%
Apollo 16	5964	4071	1893	68%
Apollo 17	5834	5620	214	96%
Totals	34705	23867	10838	69%

**Digitization Process:** The original film negatives are preserved in cold storage. For this project they are removed from cold storage and warmed and scanned in the Film Archive clean room. The negatives are being scanned at 3200 ppi (approximately 100 pixels/mm) and 16-bit color depth. This resolution will capture 10 micrometer features and the full dynamic range of the original film negatives. The images are captured as full resolution TIFF files (150-200 MB each) and match very closely the resolution of the original negatives. Medium resolution and thumbnail JPEG files are created for online viewing. High resolution JPEGs are also generated for printing and publication. Full resolution TIFF files are available upon request. The images will be archived permanently in the NASA Planetary Data System, or PDS [1].

**Data Restoration and Storage in Databases:** When the samples were first photographed, the photo numbers were recorded on paper forms that were stored in sample data packs; therefore, there was no single source of information that correlated sample numbers with the photo numbers. The negatives stored in the JSC photograph facility, and the associated hardcopy pictures, only reference this photo number. They are not identified as pictures of lunar rocks or their generic sample numbers. In order to generate the lists of photograph numbers to be scanned, more than 1000 lunar samples data packs had to be inventoried and each picture had to be described and indexed.

These lists were correlated with early photo indexes that were included in some of the original Apollo Sample Catalogs [2].

**Project Database.** A database has been created to associate sample numbers with photo numbers and descriptions. This database serves as the source for images and for the sample-related metadata that is included in the image files. Additional metadata is generated during film scanning detailing Photoshop scanning parameters that are provided as text files. The metadata is also part of the documentation process for PDS archiving. One goal of this data restoration is to provide associated sample data and photo descriptions embedded within the digital files to further preserve the connection between the lunar samples and their photographs. The information contained in this database is used to generate the records for a searchable, public database of available photographs.

**Database Search Interface:** The most important goal of this project is to make the images readily available to the public and specifically the lunar science community. This database combines lunar sample data from the Apollo missions, photographic data from the photo database, and links to available catalogs and lunar compendium files. In the future, this database will be extended to include sample processing history and allocation availability to help scientists better select samples to request for scientific study.

The digitized photographic negatives are now available for viewing and downloading as high resolution JPEG images on the Curation website. We have developed a search interface that combines access to the newly generated images together with all the Apollo lunar sample catalogs and the Lunar Sample Compendium [3]. Print quality JPEG files can be downloaded as needed.

The quick search function of the database will allow the user to search for a single sample generic (5 digit root sample number). There is a versatile advanced search function that will allow searches by sample classification: e.g., basalt, (olivine, ilmenite, pyroxene, feldspar); plutonic (anorthosite, dunite, gabbro, norite, troctolite); breccia (regolith, fragmental, impact melt). The advanced search also allows queries by mission: each mission can be searched by station or landmark. One can also search within a range of sample weights or by pristinity level based on original sample weight. Searches can be further refined to view samples that have thin section photographs available. A search on an individual sample will bring up a gallery of all the available photos of that rock (currently 69% of the pictures have been scanned and are available in this database). The images of the subdivided rocks samples show what is currently available for

study. The ability to view and study the whole rock and all its surfaces has never been as accessible.

**Photo Availability:** Digitized photos are currently available through the Lunar Sample Catalog Search Interface on the Astromaterials Curation website at: <http://curator.jsc.nasa.gov/lunar/samplecatalog/index.cfm>. TIFF files are available by request from: Nancy S. Todd, Curation IT Data Systems, at 281-483-9243 or [JSC-ARES-LunarRequests@mail.nasa.gov](mailto:JSC-ARES-LunarRequests@mail.nasa.gov)

**Apollo Sample Data on Google Moon:** The images from this project will also be used in Google Moon as part of the Curation Office effort to provide Apollo data for the Google Moon project [4]. The main goal of this project is to augment existing Apollo mission data on Google Moon with data and multimedia related to the Moon rock samples collected and returned from the Apollo missions. Data layers for selected Lunar rocks from Apollo missions 15 and 16 have already been completed and are available as kmz files for use within the Google Earth/Moon application; the kmz files will be available for download from Google [5]. The kmz files are now available for download from the Curation website at <http://curator.jsc.nasa.gov/lunar/moon/index.cfm>.

The lunar samples are organized by collection site at Apollo EVA stations. At each collection site, an overlay map shows the location of collected samples as depicted in station maps in Apollo mission documentation. A multimedia gallery presents the user with information about the collection site, a link to an interactive station map, and a selection of lunar sample thumbnails that direct the user to details for a particular sample. Other sample-specific multimedia, such as video, surface photography and annotated 360 degree panoramas of the lunar surface depicting the lunar samples in their natural state are also included. The sample details link to additional information on the Curation website.

Work is in progress to create data layers for the Apollo 17 mission. In the future, as more photos become available, we will also be creating data layers for the remaining missions.

#### References:

- [1] Garcia, P. A. et al. (2011) *LPS XLII*, Abstract #2310. [2] *Apollo Lunar Sample Catalogs*, <http://curator.jsc.nasa.gov/lunar/catalogs/samplecatalogs.cfm> [3] Meyer, C., *Lunar Sample Compendium*, <http://curator.jsc.nasa.gov/lunar/compendium.cfm>. [4] Dawson, M. D. and Todd, N. S. (2011) *LPS XLII*, Abstract #1783. [5] Google Earth, <http://earth.google.com>.

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