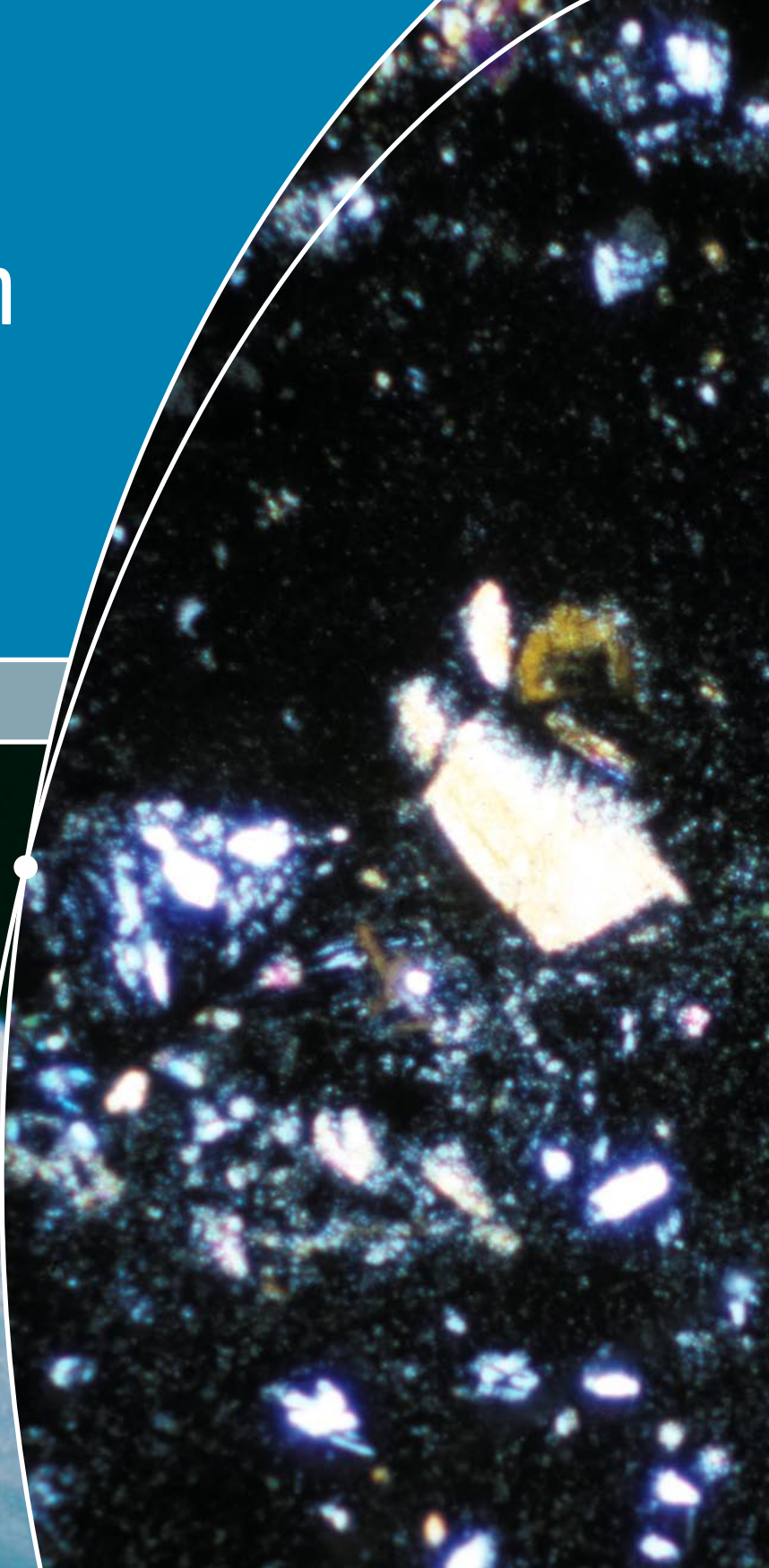


Accessing the Apollo Mission Images



“I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth. No single space project...will be more exciting, or more impressive to mankind, or more important...and none will be so difficult or expensive to accomplish....”

- John F. Kennedy

One Small Step for Man...

In 1961, then U.S. President John F. Kennedy surprised the world by announcing plans to do the seemingly impossible — send a man to the Moon. Shortly after, NASA developed the Apollo program, launching a series of rockets into space to gather data, ultimately landing on the Moon before the end of the decade.

Making Kennedy’s claims a reality, Neil Armstrong stepped off the Apollo 11 Lunar Module on July 20, 1969, taking the first human steps on the Moon’s surface. After this historic occurrence, five more Apollo missions carried astronauts to the Moon, with the final journey completed in 1972. Since then, no new manned missions have been made, making the data and images collected during the Apollo journeys extremely valuable to our understanding of the Moon.

Irreplaceable Photographs

Following the missions, the original Moon photograph negatives were copied to duplicate film, which were then used to create prints. Most of the prints of these images in circulation today are third copies or fourth generation photographs. For almost 40 years, the original negatives captured during these remarkable missions have been carefully preserved in long rolls of film, in a freezer (0° F) in the Film Archive of Johnson Space Flight Center in Houston, Texas.

In March of 2004, scientists began discussing the possibility of digitally scanning these original flight film negatives. With high resolution digital scans, these scientists hoped to increase research efforts and public access, believing that technological advancements in high-resolution scanning would allow them to carefully record the information contained in the flight films. Collaborating with NASA, the scan team quickly identified the DSW700 Photogrammetric Scanner from ERDAS as the most appropriate scanning solution. Fulfilling all the requirements, the DSW700 provides high geometric and radiometric fidelity in an automated fashion, safely handling the high rolls of this irreplaceable film. Prior to this project, Johnson Space Flight Center did not have the capability to scan these images.



An ASU graduate student conducts research and analysis on a moon image.

Scanning the Images

Following the initial discussions for this project, scanning began at Johnson Space Flight Center in June 2007, and is expected to take three years to complete. Working alongside NASA is Arizona State University (ASU), with ERDAS providing specialized processing software and enhancements to the DSW700.

This included increasing the normal 12-bit scan of the DSW700 to 14-bit, empowering the scanner to record digital images in 16,384 shades of grey. This was necessary because of the Moon's vast contrast, enhanced by the original film that captured the wide range of grey scale variation. With this improvement, this DSW700 is the world's only photogrammetric scanner containing a 14-bit sensor. Already capturing the film's finest details with 200 pix/mm (5-micron pixels), the 14-bit grey scale capability ensures the most comprehensive scanning possible.

The scanning is being done in stages, beginning with 35-mm photographs (about 620 frames), followed by 10,153 frames (BW) from the Metric camera and finishing with the 4,612 frames from the Panoramic camera (BW).

Before scanning begins, the Johnson Space Flight Center staff follows careful procedures for each roll of film. First, the sealed film canister is identified and transferred from the freezer to the refrigerator to equilibrate for 24 hours. During the next 24 hour period, the sealed canister is placed in room temperature to further equilibrate. After two days of temperature control, the film is then removed from the canister, ready to be scanned.

Normally, the maximum scan size limit for a photogrammetric scanner is 12 inches square, but the panoramic images measure 45.2" by 4.5". Because of the large number of photographs to scan, it was not feasible for an operator to advance the film, scan in sections, and then manually re-stitch the imagery together. To solve this problem, ERDAS customized software specific to this DSW700. This software enables scanning the 45.2" long frames in several pieces, completely unattended, and then automatically re-stitches each piece into a digital form of the original image. To do this, the DSW700 assigns fiducials to the images during the preliminary scans. Once an image is completely scanned, the automated process restarts for the next photograph on the roll of film. Providing the utmost accuracy, the grain of the original film can be seen when the scans are fully enlarged. With scanning completed, the roll of film is returned to the canister, sealed and placed back into the temperature-controlled vault.



ASU graduate students collectively examine moon craters.

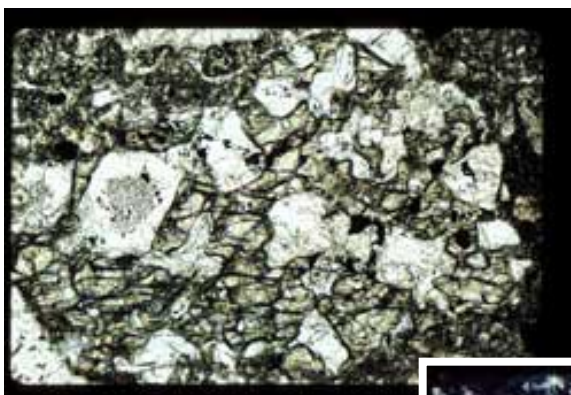
ASU Research Efforts

While ASU graduate students are primarily concentrating on archiving the images to make them accessible from a website, they are also conducting research and analysis. One example of these efforts is the counting of the Moon's craters appearing in these images. By doing this, the students aim to determine the ages of different units of the Moon and the impact rate of asteroids. Ultimately, they hope to re-photograph key areas found in the Apollo images to conduct more thorough change analysis, co-register the digital images and search for new craters that have formed since the 1970s. Proper analysis will help determine the number and size of small asteroids (50 cm to 5 meters) that have hit the Moon, altering existing craters or forming new ones. Because these small objects typically burn up when they hit the Earth's atmosphere, it is difficult to accurately measure their occurrences. Without an atmosphere to penetrate, the Moon provides an ideal environment to monitor these small asteroids. While typically safe from harming the Earth, these small asteroids pose a threat to individuals in space, spacecrafts and the International Space Station. Measuring their impact and rate of occurrence on the Moon will help scientists better understand their threat to man-made objects in space.

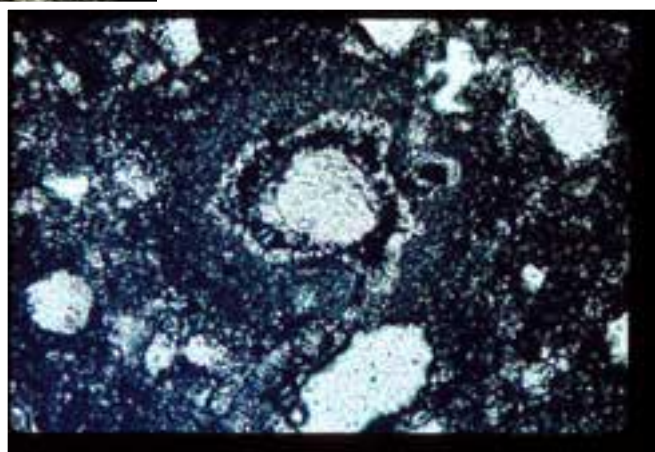
In addition, the ASU graduate students are also interested in conducting research on the Moon's soil, which is also called regolith. By identifying and measuring the layers of the small craters on the Moon, they hope to better understand the variations in the regolith's thickness. Also, by examining the images from Apollo 15 and Apollo 17, the graduate students can measure the relative changes in the regolith's brightness as compared to new pictures from future missions.

Making the Images Accessible

Because the DSW700 provides such acute precision and detail, the scanned images are often too large to be viewed utilizing a standard Internet connection and web browser. Each full resolution, 4.5-inch square frame scan is stored as a 16-bit tiff, resulting in a very large file (up to 1.3 gigabytes). To make these large files accessible, the archive's website (<http://apollo.sese.asu.edu/>) serves the images using Zoomify, a Flash-based application allowing users to zoom into an image, loading only the portion being examined.



Apollo moon images scanned using the DSW700 are available for download at apollo.sese.asu.edu/.



Alternatively, users can download various sizes and resolutions of the images, including the full raw scan. All processed frames have an algorithmic correction applied, simulating the natural contrast of conventional paper print. The processed files are reduced to 8-bit values, with the large PNG reduced in resolution by 1.4142x, with smaller versions also available.

Following a demonstration highlighting the first scanned images, ASU launched a full map of the Moon on the archive's website in September 2007. By clicking on individual points of the Moon, the corresponding images may be viewed or downloaded. Several hundred of these images will continue to be released on a monthly basis, until the completion of this project. This new digital photo collection provides a very inexpensive new mission to the moon. Readily accessible, these remarkable images promote greater understanding of our Moon, ultimately making former President Kennedy's dream an easily accessible reality to all.

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