Apollo Lunar Sample Integration into Google Moon: A New Approach to Digitization. Melissa D. Dawson[1] , Nancy S. Todd[2], Gary E. Lofgren[3], [1]University of Oklahoma Norman, Oklahoma 72019 (melissadawson@ou.edu), [2]Jacobs Technology/NASA Johnson Space Center, Mail Code KT, Houston, Texas 77058 (nancy.s.todd@nasa.gov), [3]NASA Johnson Space Center, Mail Code KT, Houston, Texas 77058 (gary.e.lofgren@nasa.gov).

Introduction: The Google Moon Apollo Lunar Sample Data Integration project is part of a larger, LASER-funded 4-year lunar rock photo restoration project by NASA's Acquisition and Curation Office [1]. The objective of this project is to enhance the Apollo mission data already available on Google Moon with information about the lunar samples collected during the Apollo missions. To this end, we have combined rock sample data from various sources, including Curation databases, mission documentation and lunar sample catalogs, with newly available digital photography of rock samples to create a user-friendly, interactive tool for learning about the Apollo Moon samples.

Background: The growing popularity of spatial data visualization software for Earth and Planetary research, along with the restoration of high-resolution images of the Moon's surface from various NASA missions were the inspiration for undertaking this project [2]. This project was originally conceived as an extension of the WorldWind software program, a Java-based, open source program developed jointly by NASA and Google [3]. The project's focus changed when the NASA Ames Research Center Intelligent Robotic Group (IRG) created an Apollo 15 mission area layer superimposed onto the surface of Google Earth for one of their projects [4-5]. The files they provided us allowed us to focus our efforts exclusively on the creation of Apollo lunar sample content and shortened our development time dramatically. Using their data, we were able to develop an add-on for Google Earth showcasing Apollo 15 Moon Rocks [6]. The eventual release of Google Moon with Apollo mission data developed by NASA IRG allowed us to extend this effort to include the rest of the Apollo sample return missions.

Features of Apollo Lunar Sample Data Layer: Data layers for Apollo 15 and 16 samples have been completed and are ready to be used with Google Moon. We are currently working on the Apollo 17 data layer. Several user interface features were created for each data layer to make the experience more interactive for users and put together into a format suitable for use by the Google Earth/Moon application, which is freely available for download from Google [7]. Features include map overlays of sample collection sites, interactive station maps, multimedia and photo galleries, annotated 360° panoramas showing samples in their original locations, and sample detail views.

Interactive Station Maps. In order to create a more interactive lunar experience for the user, Adobe Creative Suite CS5 was used to create interactive station maps. Adobe Flash was used to create SWF movie files for the interative maps.

During the J-class missions (Apollo 15, 16, and 17), the lunar rover was introduced as a time-saving tool on the lunar surface. Therefore, there ranged between 10 and 11 station sites for each mission where lunar samples were found. Each of these station sites have a corresponding interactive station map, recreated from the original planimetric station maps drawn in the 1970s. These maps were redrawn using Adobe Fireworks from the Adobe Creative Suite CS5. The interactive portion of these maps is the clickable lunar sample buttons. These buttons, once clicked upon, release an expandable menu for the lunar sample queried (Figure 1) with links to related multimedia, astronaut commentaries, and sample information. The user can use these links to learn more information about the particular sample.

Annotated 360° Panoramas. One of the many tasks required of the Apollo astronauts while on the Moon was to take panoramic photographs of their surroundings. This was completed at almost every lunar station site. These panoramas show many of the samples returned to Earth in their native environment. These panoramas, which are comprised of an average of eighteen photographs, were stitched together using PanoramaStudio software into circular, 360-degree views. Therefore, the user can click and drag to view the entire area surrounding the astronaut at that particular station.

One feature of the 360° panoramas is embedded hotspots of the lunar samples. Small arrows were embedded into the panoramas, which can be turned on and off, to show the user the location of the lunar samples in relation to surface features and other samples. If clicked upon, the user is taken to the sample catalog page for the rock.

Lunar Sample Data. Inside of the expandable menus for each of the lunar samples, there are four clickable buttons found. These buttons are Sample Data, Surface Photograph, Movie, and Astronaut Commentary. The Sample Data button takes the user to the Sample Catalog page for the lunar sample, which gives a breakdown of the geological features of the rock, as well as information about its chemistry and location found. The Surface Photograph button shows a photo-

graph of the lunar sample pre-sampling, and the rock itself is distinguished from its surroundings, edited using Adobe Fireworks. The Movie button is currently a work-in-progress. Upon completion, it will show raw video footage of the astronauts on the Moon, with intermittent geological explanations from a collaboration with the University of Texas at El Paso (UTEP) Geology department[8]. The Astronaut Commentary button takes the user to a webpage with written dialogue between the astronauts about the lunar sample.

Google Moon KML Files: In order to integrate this data into Google Moon, each mission's data was coded into a KML (Keyhole Markup Language) file, which is compatible with Google Earth. A KML was created for each mission, and includes all previously mentioned mission data associated with it. Google has provided a sample gallery template that was used for uniformity, and is shown in Figure 2 below. This informational pop-up displays every feature for the station site queried, including thumbnails for each of the samples, a link to the interactive station map, video footage, and a 360-degree panorama (all of which are clickable thumbnails). The user has the option of scrolling through these features inside of the sample gallery pop-up, or exiting and clicking on the embedded interactive station map found on the surface of Google Moon. The station maps were carefully placed on the surface with an invisible background by matching the surface features with those on the maps.

Conclusion: The interactive station maps provide condensed and organized information of each of the sample sites to the user, containing links to sample catalog pages, astronaut commentary, and surface photographs of the pre-sampled lunar rock. Panoramas give the user an idea of how the lunar surface appeared, while also showing the approximate location of the lunar samples relative to one another. Therefore, through the integration of Apollo lunar sample data into Google Moon, much of the history and science of the Moon can be preserved, utilized, and openly accessible to the public.

References: [1] Lofgren, G. E. et al. (2011), *LPSC XLII, Abstract #1867.* [2] Dawson et al. (2010), *NTRS.* [3] NASA World Wind Project Site, http:// http://worldwind.arc.nasa.gov/. [4] Kim, T. et al. (2009) *Advances in Visual Computing,* Vol.5875/2009, 700-709. [5] Fong T. et al. (2009), *LPSC XLI, Abstract #1233.* [6] Todd, N.S. et al. (2008), *NLSI.* [7] Google Inc., "Google Moon" http://earth.google.com/moon/ (Jan 2011). [8] Hurtado, J. et al. (2009) *University of Texas at El Paso Geology Dept.*
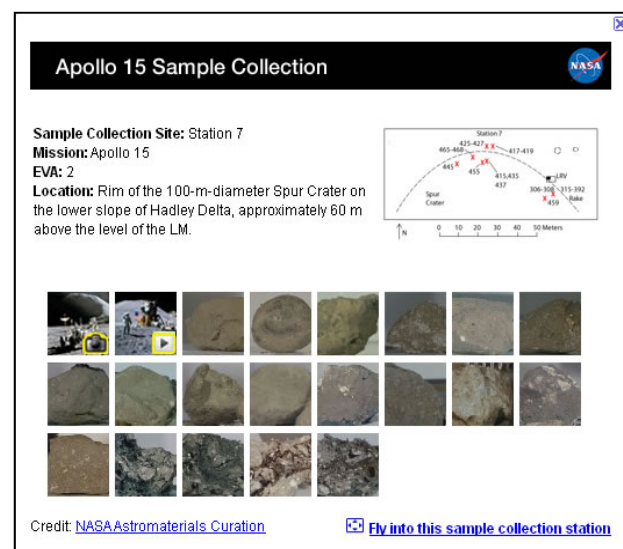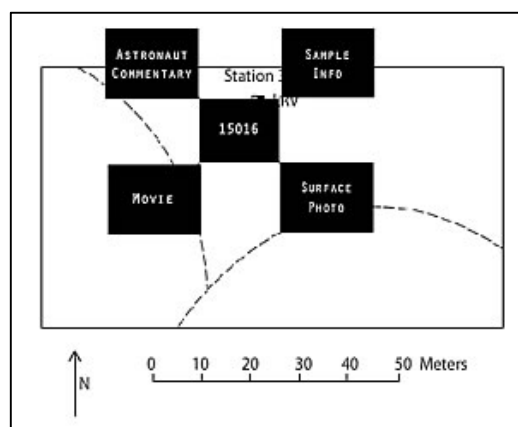

Figure 1 (left) demonstrates the expandable menu options found in the interactive station maps. Figure 2 (right) is a sample gallery for Station 7 in Apollo 15, showing the thumbnails of the lunar samples found at the station, a link to the interactive station map (top right), and links to the panorama and video footage.