

PDS LUNAR DATA NODE RESTORATION OF APOLLO IN-SITU SURFACE DATA. David R. Williams¹, H. Kent Hills², Edward A. Guinness³, Paul D. Lowman⁴, and Patrick T. Taylor⁴, ¹PDS, Code 690.1, Goddard Space Flight Center, Greenbelt, MD, 20771, david.r.williams@nasa.gov, ²ADNET, NSSDC, Code 690.1, Goddard Space Flight Center, Greenbelt, MD 20771, howard.k.hills@nasa.gov, ³Department of Earth and Planetary Sciences, Washington University, St. Louis, MO, 63130, guinness@wustl.edu, ⁴NASA Code 698, Goddard Space Flight Center, Greenbelt, MD 20771, paul.d.lowman@nasa.gov, patrick.t.taylor@nasa.gov

The Apollo missions between 1969 and 1972 deployed scientific instruments on the Moon's surface which made in-situ measurements of the lunar environment. Apollo 11 had the short-term Early Apollo Surface Experiments Package (EASEP) and Apollos 12, 14, 15, 16, and 17 each set up an Apollo Lunar Surface Experiments Package (ALSEP). Each ALSEP package contained a different suite of instruments which took measurements and radioed the results back to Earth over periods from 5 to 7 years until they were turned off on 30 September 1977. To this day the ALSEP data remain the only long-term in-situ information on the Moon's surface environment.

The Lunar Data Node (LDN) has been formed under the auspices of the Planetary Data System (PDS) Geosciences Node to put relevant, scientifically important Apollo data into accessible digital form for use by researchers and mission planners. We will report on progress made since last year and plans for future data restorations.

Much of the ALSEP and other surface and orbital data housed at the National Space Science Data Center (NSSDC) at Goddard Space Flight Center are in forms that are not readily usable, such as microfilm, hardcopy, and magnetic tapes with older, obsolete formats. The LDN has prioritized the restoration of these data based on their scientific and engineering value and the level of effort required.

Data from four ALSEP experiments, the Apollo 14 and 15 Cold Cathode Ion Gage (CCIG), and the Apollo 12 and 15 Solar Wind Spectrometer (SWS), comprising six unique data sets, have been restored and delivered to the PDS Geosciences Node for archiving and distribution to the science community. The CCIG and SWS datasets are available online through the PDS Geosciences Node website (pds-geosciences.wustl.edu/missions/apollo/).

Heat flow data from the Apollo 15 and 17 ALSEPs has been read from magnetic tapes at NSSDC, reformatted, documented and are now available online at the NSSDC Lunar Data Project website (see below). These data will be further converted to PDS format, reviewed, and archived with the PDS Geosciences Node in 2010. These data are incomplete; a LASER (Lunar Advanced Science and Exploration Research) funded effort is underway to try and retrieve further heat flow data.

The Apollo 14 and 15 Dust, Thermal, and Radiation Engineering Measurements data, comprising tables of calibrated solar cell voltages over time, which give information on the degradation of solar cells and the lunar dust environment, are being scanned from microfilm. The Apollo 14 and 15 data have been scanned and optical character recognition software is being used to produce digital tables of this data for the PDS. These initial data are planned for release in 2010, with PDS data sets following in 2011. Raw dust detector data is also embedded in the ALSEP housekeeping and engineering data and we are looking into ways to extract this data, apply calibrations, and make it useful.

The Apollo 17 Lunar Atmosphere Composition Experiment (LACE) returned data for just under a year on the mass spectrum of particles in the tenuous lunar atmosphere. These data were stored on magnetic tape and have been read and converted to ASCII. They will be reformatted, appropriate ancillary data will be added, and they will be put through PDS review in 2010. We have LASER funding to analyze these data and compare them to other in-situ surface data sets. Separate LASER funded efforts are also ongoing to restore data from the Apollo 15 and 16 Lunar Surface Magnetometers (along with the orbital magnetometers) and the Apollo 14 and 15 Suprathermal Ion Detector Experiments.

The Apollo 14 Charged Particle Lunar Environment Experiment data, energy spectra of charged particles striking the lunar surface, have been read from magnetic tape, deciphered, and are being converted into Common Data Format (CDF) for addition to the online CDAWeb system and prepared for review and archive with the PDS in 2010.

ALSEP restorations under consideration for the future (2011-2012) include the engineering and housekeeping data, which could prove useful in designing future lunar stations, the Apollo 17 Seismic Profiling Experiment, the Lunar Surface Gravimeter, and the Lunar Ejecta and Meteorites instrument. Long-term returns from the geophones set up for the Apollo 17 Lunar Seismic Profiling experiment are also being considered for restoration.

Short term surface experiments unrelated to the ALSEP instruments were also performed by the astronauts while they were on the surface and the LDN is restoring data from these as well.

The Apollo 15 and 16 Soil Mechanics data, handwritten charts and plots from the Lunar Penetrometer, were evaluated at the PDS peer review. These have been digitized from the archival microfilm, put online at NSSDC, and are being prepared for submission to the PDS in 2010.

The Traverse Gravimeter was used by the Apollo 17 astronauts to map the gravity field at the landing site. The data are stored on microfilm and in published reports and have been put into digital tabular form and will be reformatted and submitted for PDS review in 2010.

The Active Seismic thumper experiment, performed by the astronauts on Apollos 14 and 16, returned data that has been read from magnetic tape and converted to digital formats. Appropriate metadata will be included and these data will be prepared as a PDS data set in 2010.

In addition to surface data sets, the LDN is also restoring data from Apollo orbital data sets

from instruments carried on the command modules and subsatellites. The Apollo 15 and 16 X-Ray Spectrometer data have been read from magnetic tape and put in digital tabular format and will be provided as a PDS data set when supporting SOLRAD data have been added in 2010. Future plans include restoration of the Apollo 15 and 16 Alpha Particle Spectrometer, Apollo 17 Far-Ultraviolet Spectrometer, Apollo 15 and 16 Gamma-Ray Spectrometer, Apollo 15 and 16 Mass Spectrometer, and Apollo 15 and 16 Subsatellite Lunar Particle and Boundary Layer Experiment data sets circa 2011-2012. NSSDC has also supported restoration of the Apollo Metric and Panoramic Photography by scanning the index files archived on microfilm, and the Lunar Data Node is involved in retrieving other data for restoration, such as the Apollo 17 Lunar Sounder and Infrared Radiometer experiments, which may be released as a PDS data set as early as 2011. We are still soliciting external feedback and suggestions on useful future data sets for restoration.

Metadata, ancillary information to aid in the use and understanding of the data, have been compiled and are included in these online data collections. The documentation covers complete descriptions of the data sets, formats, processing history, and relevant references and contacts, as well as descriptions of the instruments used to collect the data and mission history. At the end of this multi-year effort we will have the relevant data and associated metadata online and easily accessible to interested users from the lunar scientific and exploration communities.

The other LDN team members are: Ray Arvidson, Pam Clark, Jay Friedlander, Jim Garvin, Danny Hoag, Howard Leckner, Michael Liu, Allison Lopez, Stephanie McLaughlin, and Jeff Plescia.

The data sets and more information can be found at the NSSDC Lunar Data Project website nssdc.gsfc.nasa.gov/planetary/lunar/lunar_data/ and the PDS Geosciences Node website pds-geosciences.wustl.edu/.