

LUNAR DATA NODE: APOLLO DATA RESTORATION AND ARCHIVING UPDATE. David R. Williams¹, H. Kent Hills², Edward A. Guinness³, Patrick T. Taylor⁴, and Marie J. McBride⁵, ¹NSSDC, Code 690.1, Goddard Space Flight Center, Greenbelt, MD, 20771, david.r.williams@nasa.gov, ²ADNET Systems, Inc., 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, ⁴Code 698, Goddard Space Flight Center, Greenbelt, MD 20771, patrick.t.taylor@nasa.gov, ⁵Florida Institute of Technology, 150 W. University, Box 6647, Melbourne, FL 32901, mmcbride2009@my.fit.edu

Introduction: The Lunar Data Node (LDN) of the Planetary Data System (PDS) is responsible for the restoration and archiving of Apollo data. The LDN is located at the National Space Science Data Center (NSSDC), which holds much of the extant Apollo data on microfilm, microfiche, hard-copy documents, and magnetic tapes in older formats. The goal of the restoration effort is to convert the data into user-accessible PDS formats, create a full set of explanatory supporting data (metadata), archive the full data sets through PDS, and post the data online at the PDS Geosciences Node. This will both enable easy use of the data by current researchers and ensure that the data and metadata are securely preserved for future use. We are also attempting to locate and preserve Apollo data which were never archived at NSSDC. We will give a progress report on the data sets we have been restoring and future work.

Restoration involves reading the data from the original media, deciphering the data formats to produce readable digital data and converting the data into usable tabular formats. Each set of values in the table must then be understood in terms of the quantity measured and the units used. Information on instrument properties, operational history, and calibrations is gathered and added to the data set, along with pertinent references, contacts, and other ancillary documentation. The data set then undergoes a peer review and the final validated product is archived with PDS.

We have fully restored and archived through PDS seven lunar data sets: The Apollo 12 and 15 Solar Wind Spectrometer, 28-second and hourly averaged plasma parameters, Apollo 14 and 15 Cold Cathode Ion Gage graphs of atmospheric lunar density, and the Apollo 17 Traverse Gravimeter raw and corrected measurements. At the time of this writing a number of data sets have been restored and gone through PDS review and are in the final stages of lien resolution: the Apollo 14 and 15 Soil Mechanics Penetrometer results, the Apollo 14 and 15 Dust Detector microfilm, the Apollo 15 and 17 Heat Flow measurements, and the Apollo 15 and 16 X-Ray Spectrometer data. By the

time of the presentation these will be completed and archived with PDS as well.

We are currently in the process of restoring more Apollo surface and orbital data sets which we describe below.

The Apollo 17 Lunar Ejecta And Meteorite (LEAM) experiment: The LEAM experiment was designed to measure the direction and energy of particles striking the Moon's surface. It returned measurements for 3 years but the calibrated data were lost and never archived. The restoration of LEAM data is taking place in two parts. For the first part, we have scanned the experiment notebooks the P.I., O. Berg, generously lent to NSSDC. The notebooks contain information on the experiment, data, and calibrations. The second part is restoration of the last few months of raw LEAM telemetry. With information from the notebooks and published reports, we hope to translate the raw data into a calibrated data set.

Apollo 11, 12, 14, and 15 Dust, Thermal, and Radiation Engineering Measurement (DTREM) experiment: Also commonly referred to as the Dust Detector Experiment, this device measured the degradation of solar cell output over time at the lunar surface. The digital calibrated data were lost before they could be archived, the only remaining calibrated data, from Apollo 14 and 15, were held on microfilm at NSSDC. The raw telemetry data have been recovered from the ALSEP housekeeping data. Using the microfilm we have been able to create a calibrated digital data set for the Apollo 14 and 15 DTREM. The microfilm itself has also been scanned. For the Apollo 11 and 12 data we will have restored the raw digital telemetry but do not yet have the information necessary to convert this to calibrated data.

Apollo 14 and 15 Suprathermal Ion Detector Experiment (SIDE): The SIDE instrument measured the flux and energy of ions reaching the lunar surface. Each experiment operated for many years. The data were archived at NSSDC on magnetic tape in older binary format. The tapes have been read and a portion of the SIDE data converted to modern digital format.

Apollo 14 Charged Particle Lunar Environment Experiment (CPLEE): The CPLEE was designed to measure the energy spectra of low-energy particles striking the lunar surface. The experiment returned data for over 6 years, with some periods of intermittent operation. These data were archived at NSSDC on magnetic tapes in now-obsolete formats, but they have been read and largely restored to a modern digital format.

Apollo 16 Active Seismic Experiment: The active seismic experiment comprised a string of geophones and a "thumper" to generate a seismic pulse. The data from this experiment were archived at NSSDC on magnetic tape in a form that was translated by an outside user (M. Brzostowski) and converted to a modern digital format. We are now creating the necessary metadata to accompany these data.

Apollo 17 Lunar Atmospheric Composition Experiment (LACE): The LACE experiment returned data for just under a year on the mass spectra 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.

Apollo 15 and 16 Gamma-Ray Spectrometer (GRS): The GRS orbited the Moon in the Apollo service module and returned data on the geochemical composition of the lunar surface. No raw data were archived from this experiment, but recently one of the investigators (A. Metzger) sent magnetic tapes and other documentation to NSSDC. We are currently attempting to read these tapes to ascertain if the GRS raw data are accessible.

Apollo 17 Infrared Radiometer: The Infrared Radiometer was an orbital instrument which measured the thermal emission from the lunar surface. These data were never archived with NSSDC but W. Mendell has agreed to reformat the data and provide it to the NSSDC with the appropriate documentation.

Apollo 12, 15, 16 Surface Magnetometers and Apollo 15, 16 Orbital Magnetometers: Concurrently, related work in a separate LASER proposal led by Peter Chi is being done to recover tapes with magnetic field data from Apollo 15 and 16 Orbital and Surface Magnetometers. These data are planned for recovery, reformatting, and archive with PDS through the LDN.

Apollo 15 and 17 Heat Flow: The heat flow experiments ran from 1971 and 1972 until 1977. The heat flow data that were archived with NSSDC were incomplete, only covering a small portion of this time period. We have prepared those data for archive with PDS, but are looking to find more of the heat flow data as well as the necessary calibration values to convert the raw telemetry. We would appreciate any information on locating these missing data.

Future Restorations: We are also planning for the future restoration of a series of data sets. These include restoring and archiving the full ALSEP (Apollo Lunar Surface Experiments Package) housekeeping data. These data contain the instrument status, command history, and general health (temperatures, voltages, etc.) of the lunar surface experiments and central station. These data have been preserved by Y. Nakamura, we will format the data for PDS and add the necessary metadata. The ALSEP Weekly Reports, a large set of papers documenting the status of all the ALSEPs on a weekly basis, has been uncovered and scanned at the LPI library. We plan to create PDS data sets around these scans so that the valuable information contained in these reports can be properly archived. The NSSDC holds a set of photographic indexes of the Apollo 15, 16, and 17 Metric and Panoramic Cameras on microfilm. These were scanned for use by the LROC team. We plan to archive the scanned microfilm and possibly the digitized indexes from these cameras. A number of Apollo 17 images of the horizon were scanned using a densitometer to study horizon glow. These now only exist as paper copies showing the number outputs of the scans. These densitometer scans will be digitized so a useful digital data set can be archived with PDS. The Apollo 15 and 16 Mass Spectrometer data are archived at NSSDC on microfilm, we will scan the microfilm records, produce the associated metadata and create a PDS data set. The Apollo 17 Surface Electrical Properties data plots, instrument explanation, and technical reports are held on microfiche at NSSDC. The microfiche will be scanned and a digital version created which can be archived through PDS.

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/.