Lunar Data Project/Lunar Data Node: Apollo Data Restoration Update

National Aeronautics and Space Administration

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The Lunar Data Node (LDN) was formed at the NASA Space Science Data Coordinated Archive (NSSDCA) under the auspices of the Geosciences Node of the Planetary Data System (PDS) to put relevant, scientifically important Apollo data into accessible digital form for use by researchers and mission planners. This is a continuation of the Apollo data restoration work started by the Lunar Data Project at NSSDCA in 2003.

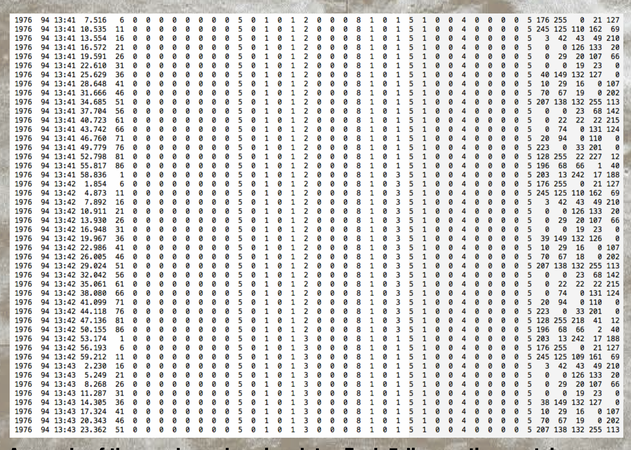
Long-term (1969-1977) surface data were collected by autonomous ALSEP (Apollo Lunar Surface Experiment Package) stations placed by the crews of the Apollo 12, 14, 15, 16, and 17 missions. Surface measurements were also made directly by the astronauts and data were collected from orbit by instruments on the Command/Service Module. The ALSEP data represent the only long-term information on the lunar surface environment, and as such are critical for studying the lunar domain and planning future lunar exploration.

The data are generally archived at NSSDCA although some have been found elsewhere by the LDN or members of the SSERVI Lunar Focus Group. Depending on original format, the data are being scanned from hardcopy or microform or read from magnetic media and converted into easily usable and transportable digital form. Metadata, ancillary data to aid in the use and understanding of the data, are also being collected from various sources (science reports, instrument manuscripts, archived microfilm and microfiche records, personal communications with instrument scientists) and incorporated into the individual data sets. This will include complete descriptions of the data, formats, processing history, instruments and missions, and contact information and relevant references. These data sets will be made available online and archived with NSSDCA and PDS to assure widespread distribution to the scientific and engineering communities.

We have recently received LASER funding to restore data and metadata from other Apollo experiments, these are included here.

Housekeeping Data

Most of the data from the ALSEP were sent back in the instrument telemetry stream and stored on sets of ALSEP work tapes. However, the general data from the ALSEP central station, primarily known as the housekeeping data, were transmitted back to Earth in a separate telemetry stream (Word 33) and stored on the housekeeping tapes. These data have been made available to us in raw form by Yosio Nakamura. The tapes contain data on all operations of the central station, including instrument status and ground commanding, as well as temperatures and power. We would convert the telemetry into digital (ASCII) tables giving the time history of all 5 ALSEP stations, The complete housekeeping data from Apollos 12, 14, 15, 16, and 17 are included in this set.



A sample of the raw housekeeping data. Each 5-line section contains one time-step of returned housekeeping data. We will reorganize the data for each measurement to create a coherent data set.

Densitometer Scans

Photographs taken from orbit during the Apollo 17 mission showing the lunar horizon were digitized by Jim McCoy in 1976 using a microdensitometer. These data are valuable in assessing the lunar horizon glow and the possible role of levitated dust on the Moon. The original digital files are no longer available, but paper copies of the computer printouts of the data are held by Tim Stubbs and Dave Glenar. We are scanning and using optical character recognition software with human validation to reproduce the digital data from the computer printouts, and will produce the appropriate metadata and archive the digital data and the scans with PDS.

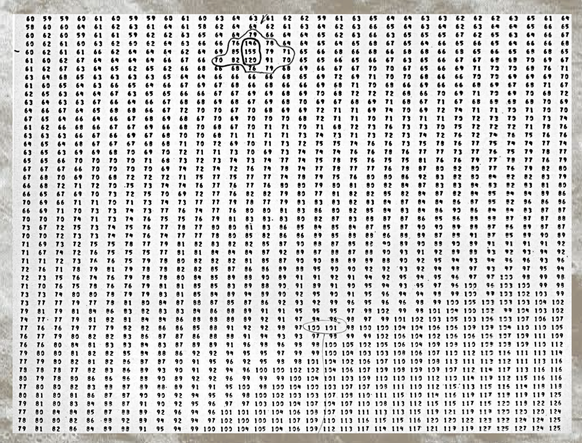
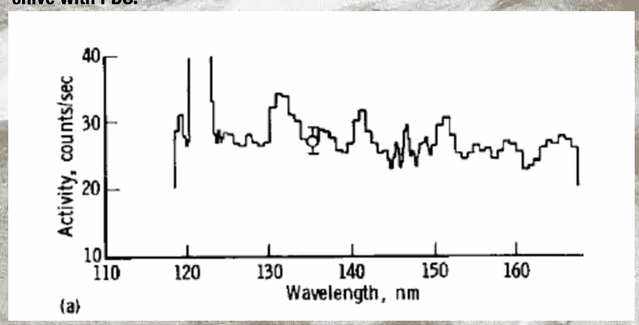


Image AS15-98-13311 (left) taken from orbit by Apollo 15, showing horizon glow possibly due to levitated dust. This image was digitized by Jim McCoy using a microdensitometer. Only the paper copies (right) remain.

Apollo 17 Far-UV Spectrometer

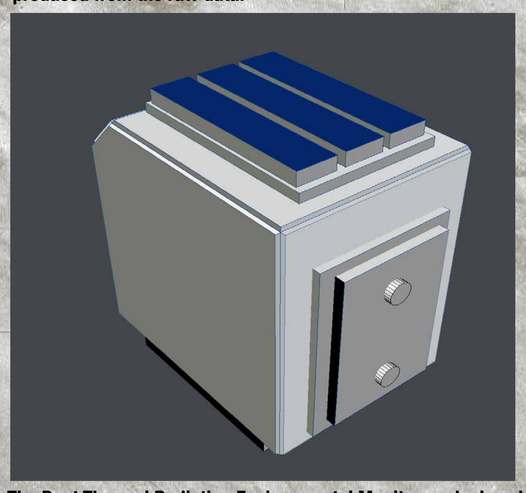
The Far-UV Spectrometer experiment on Apollo 17 consisted of an Ebert grating spectrometer mounted in the Apollo 17 Command Module which provided observations of the lunar surface, lunar atmosphere, zodiacal light, solar atmosphere emissions, Earth emissions, and galactic and stellar emissions. NSSDCA holds data from the Far-UV Spectrometer experiment on microfilm and magnetic tape, but typically translating the bits read from a tape into meaningful numbers is difficult without additional information. The microfilm will be scanned and the data used to decipher the magnetic tape data. All these data will be prepared for archive with PDS.



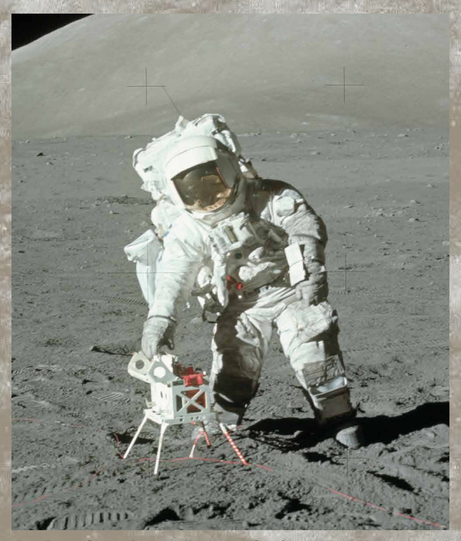
An example of data output from the Far-UV Spectrometer

DTREM

The Dust, Thermal, Radiation Environment Monitor, also known as the dust detector experiment, was carried on Apollo 11, 12, 14, and 15. A set of microfilm holding raw and calibrated DTREM data for Apollos 14 and 15 is held at NSSDCA, we have scanned the microfilm and created a data set of the raw scans. The raw data have been read from the ALSEP housekeeping tapes and we are using the microfilm data to back out the data formats and calibrations so a digital calibrated data set can be produced from the raw data.



The Dust Thermal Radiation Environmental Monitor as deployed on Apollo 11, 14, and 15



Harrison Schmitt deploys the Surface Electrical Properties module on the Moon at the Apollo 17 site.

Surface Electrical Properties Experiment

The purpose of the Surface Electrical Properties experiment was to obtain data about the electromagnetic energy transmission, absorption, and reflection characteristics of the lunar surface and subsurface for use in the development of a geological model of the upper layers of the Moon. The crew set up the transmitter approximately 100 m from the LM and established the location of the receiver on the rover in relation to the transmitter for each data stop during the traverse. The recorder was then returned to Earth. The data are the complete set of measurements held on microfiche. These will be scanned and metadata will be prepared and archived with PDS.

The Apollo 16 Gamma-Ray Spectrometer over the Moon. The GRS was situated at the end of a long boom that extended from the Apollo Service Module.

Apollo 15, 16 Gamma Ray Spectrometer

Albert Metzger at JPL was an investigator on the Apollo 15 and 16 Gamma-Ray Spectrometer experiments, which used a boom-mounted spectrometer to conduct geochemical investigations of the lunar surface from orbit. He has sent twenty 9-track magnetic tapes and some CDROMs which contained raw and ancillary gamma-ray data. The raw data were never archived at NSSDCA. The only data archived at NSSDCA from this experiment comprise 2-degree by 2-degree averages of the returned spectra. We read these tapes and CD-ROMs, and are deciphering the data formats with the documentation supplied by Metzger and with other documentation and converting it into ASCII tables.

Lunar Data Node Experiment	Media	Apollo Mission	Status
Solar Wind Spectrometer	Mag. Tapes	12, 15	At PDS
Cold Cathode Ion Gauge	Microfilm	14, 15	At PDS
Soil Mechanics	Microfilm	15, 16	At PDS
Traverse Gravimeter	Microfilm	17	At PDS
Dust Detector	Microfilm	14, 15	Reviewed
X-Ray Spectrometer	Mag. Tapes	15, 16	Reviewed
Heat Flow Experiment	Mag. Tapes	15, 17	Reviewed
Lunar Atmos. Comp. Exper.	Mag. Tapes	17	Digital Form
Active Seismic	Mag. Tapes	14, 16, 17	Digital Form
Magnetometer	Mag. Tapes	12, 14, 15, 16	Digital Form
Charged Particle Environment	Mag. Tapes	14	In Process
IR Radiometer	Mag. Tapes	17	In Process
SIDE Total Ion Energy	Mag. Tapes	12, 14, 15	In Process
Horizon Glow Densitometer	Hardcopy	16	In Process
Lunar Ejecta and Meteorites	Hardcopy	17	Scanned
Gamma Ray Spectrometer	Mag. Tapes	15, 16	LASER Funded
Surface Electrical Properties	Film, Tapes	17	LASER Funded
ARCSAV Tapes	Mag. Tapes	All	LASER Funded
Housekeeping (Word 33) Data	Digital	All	LASER Funded
ALSEP Weekly Reports	Scanned	All	LASER Funded
Mass Spectrometer	Microfilm	15, 16	LASER Funded
Far-UV Spectrometer	Microfilm	17	LASER Funded
Alpha Particle Spectrometer	Mag. Tapes	15, 16	Future
Lunar Sounder	Film, Tapes	17	Future
Passive Seismic	Mag. Tapes	12, 14, 15, 16	Future