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# Restoration and Reexamination of Data from the Apollo 11, 12, 14, and 15 Dust, Thermal and Radiation Engineering Measurements Experiments

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As part of an effort by the Lunar Data Node (LDN) we are restoring data returned by the Apollo Dust, Thermal, and Radiation Engineering Measurements (DTREM) packages emplaced on the lunar surface by the crews of Apollo 11, 12, 14, and 15. Also commonly known as the Dust Detector experiments, the DTREM packages measured the outputs of exposed solar cells and thermistors over time. They operated on the surface for up to nearly 8 years, returning data every 54 seconds. The Apollo 11 DTREM was part of the Early Apollo Surface Experiments Package (EASEP), and operated for a few months as planned following emplacement in July 1969. The Apollo 12, 14, and 15 DTREMs were mounted on the central station as part of the Apollo Lunar Surface Experiments Package (ALSEP) and operated from deployment until ALSEP shutdown in September 1977. The objective of the DTREM experiments was to determine the effects of lunar and meteoric dust, thermal stresses, and radiation exposure on solar cells.

The LDN, part of the Geosciences Node of the Planetary Data System (PDS), operates out of the National Space Science Data Center (NSSDC) at Goddard Space Flight Center. The goal of the LDN is to extract lunar data stored on older media and/or in obsolete formats, restore the data into a usable digital format, and archive the data with PDS and NSSDC. For the DTREM data we plan to recover the raw telemetry, translate the raw counts into appropriate output units, and then apply calibrations. The final archived data will include the raw, translated, and calibrated data and the associated conversion tables produced from the microfilm, as well as ancillary supporting data (metadata) packaged in PDS format.

The DTREM instrument comprised three solar cells and three thermistors mounted on a small box situated on the top northwest corner of the ALSEP central station sunshield. The instrument on Apollos 11, 14, and 15 had three solar cells mounted on top of the box facing upwards. The three cells were identical with the exception that one had a cover glass, one was exposed directly to space, and one was pre-irradiated to induce damage before mounting on the box. The pre-irradiated cell also had a cover glass. One thermistor was mounted on the outside of the west-facing wall of the box and the other two internally, one in the west-facing wall and one under the solar cells. The Apollo 12 Dust Detector also had three solar cells, but these were identical to each other in all respects, with the exception that one was placed on the side of the box facing east, one facing west, and one on top facing upwards. Unlike most ALSEP data, which were sent back to Earth in an ALSEP telemetry stream, the DTREM data were sent back with the central station housekeeping ("Word 33") data. The DTREM would take a set of measurements, cycling through the six sensors, and transmit every 54.34 seconds. Data from this experiment consisted of the photovoltaic output of the solar cells and temperatures measured by the three thermistors.

The Word 33 data were made available to NSSDC by Yosio Nakamura (University of Texas Institute for Geophysics). These comprise readings from each sensor in counts, from 0 to 255. We have used the calibrated data from computer output saved on microfilm at NSSDC to create translation tables to convert the counts into calibrated voltages and temperatures for the Apollo 14 and 15 data, which cover 6.7 and 6.2 years respectively. We will then be restoring the Apollo 11 data. Unfortunately we do not at present have the necessary translation or calibration to fully restore the Apollo 12 dust detector data, which covers 7.9 years. We plan to release these data in raw count format initially. These will still be scientifically useful because most of the information gleaned from examination of the DTREM data depends on relative changes in solar cell output rather than the absolute values in millivolts, and the calibration corrections made from reading to reading are very small.

Future plans include determining the translation and calibration for these raw counts and converting them to a full data set. These raw and calibrated data show various effects at LM ascent, sunrise, sunset, eclipses, and long-term signatures of dust deposition and thermal and radiation damage. The data clearly show the output of the cells diminishing with time at different rates due to some combination of dust, radiation, and thermal effects. We will discuss these findings in our poster. Once restored these data will be available to researchers worldwide for the first time to allow multiple investigations of the long-term effects of the dust, thermal, and radiation environment on the Moon.