

NLSI FOCUS GROUP ON MISSING ALSEP DATA RECOVERY: PROGRESS AND PLANS. L. R. Lewis¹, Y. Nakamura², S. Nagihara³, D. R. Williams⁴, P. Chi⁵, P. T. Taylor⁶, G. K. Schmidt⁷, and E. J. Grayzeck⁴, ¹Retired, formerly ALSEP Systems Engineering Manager, San Gabriel, CA 91775 (LYACHLewis@aol.com), ²Institute for Geophysics, University of Texas at Austin, Austin TX 78758-4445, ³Department of Geosciences, Texas Tech University, Lubbock, TX 79409, ⁴Goddard Space Flight Center, National Space Science Data Center, Greenbelt, MD 20711, ⁵IGPP, University of California at Los Angeles, CA 90095, ⁶Goddard Space Flight Center, Greenbelt, MD 20771, ⁷NASA Lunar Science Institute, Ames Research Center, Moffett Field, CA 94035.

Introduction: The presidential mandate in 2004 to get man out of low-Earth-orbit resulted in a renewed interest in lunar science and the results of the 35-to-40-year-old science investigations conducted on the Apollo lunar landed missions. On the six Apollo landed missions, the Astronauts deployed the Apollo Lunar Surface Experiments Package (ALSEP) science stations which measured active and passive seismic events, magnetic fields, charged particles, solar wind, heat flow, the diffuse atmosphere, meteorites and their ejecta, lunar dust, etc. Today's scientists are able to extract new information and make new discoveries from the old ALSEP data utilizing recent advances in computer capabilities and new analysis techniques. However, current-day investigators are encountering problems trying to use the ALSEP data. In 2007 archivists from NASA Goddard Space Flight Center (GSFC) National Space Science Data Center (NSSDC) estimated only about 50 percent of the processed ALSEP lunar surface data-of-interest to current lunar science investigators were in the NSSDC archives. Even less of the experiments raw data were in the NSSDC archives. For about three years a group of mainly unpaid volunteers has been performing the preliminary efforts necessary to locate the missing raw and processed data and get it into the NSSDC archives. Also the current-day lunar science investigators found most of the ALSEP data, then in the NSSDC archives, were extremely difficult to use. The data were in forms often not well described in the published reports and rerecording anomalies existed in the data which could only be resolved by tape experts. To resolve this problem, the DPS Lunar Data Node was established in 2008 at NSSDC and is in the process of successfully making the existing archived ALSEP data available to current-day investigators in easily useable forms.

Formation of NLSI Missing ALSEP Data Recovery Focus Group: In July of 2010 the NASA Lunar Science Institute (NLSI) at Ames Research Center established the Recovery of Missing ALSEP Data Focus Group in recognition of the importance of the current activities to find the raw and processed ALSEP data missing from the NSSDC archives.

History of ALSEP Data: The data archiving requirements proposed to the original ALSEP experiments PIs were that all their instrument raw data and all their processed data were to be archived. Also their original raw data tapes, most of the processed

data plots, etc. were to be boxed and stored at a National Record Center (NRC) location. Unfortunately due to several factors [1], the PIs were not required to satisfy the proposed requirements. Very little raw data were archived by the original PIs. As mentioned previously, only about 50 percent of the processed data-of-interest to current investigators were archived in NSSDC. Also, some of the PI teams made value judgments and only archived the processed data they felt were "scientifically important" or only what was important to their investigations. One of the goals of the Focus Group is to attempt to archive what was originally intended the ALSEP PIs were to have archived.

During most of the ALSEP operations (July 1969 to end of February 1976) a JSC group received the range tapes from the NASA ground stations and the JSC group extracted the experiment raw data and forwarded the appropriate raw data tapes to each experiment PI team. These tapes were called "PI tapes." From July 1969 to March 1973 the range tapes were kept as the archival ALSEP records. Starting in April 1973, at the end of each day the JSC extraction group made a raw data tape called an "ARCSAV tape" for each of the 5 operational ALSEPs containing all the raw experiment data sent out to the PI teams that day. After April 1973 new range tapes were routinely recycled. At JSC the range tapes to be archived and all the ARCSAV tapes were stored in boxes and periodically shipped to an NRC location for long-term storage. In March 1976, as a cost saving measure, the data extraction/PI distribution function was transferred to the Passive Seismic Experiment PI Gary Latham's facility at University of Texas-Galveston. Latham's group performed the function from 1 March 1976 to end-of-mission on September 30, 1977. The UT-G facility produced "work tapes" which were equivalent to ARCSAV tapes and were retained at their facility.

Until just recently these thousands of range and ARCSAV tapes for the period from July 1969 to February 1976 were "lost" and only over the last year have partial records of their history been found by members of the Focus Group. Unfortunately, the NRC records show in 1980 most of the JSC originated ALSEP boxes in NRC were removed and not returned to NRC. This was at a time period when there was a great scarcity of reliable magnetic tapes and GSFC was scavenging all sources for possible reusable tapes.

Thus, there is a possibility that they were recycled, but to date we have not found a documented case where an ALSEP ARCSAV tape was degaussed and used over again.

The Focus Group Approaches: The Focus Group has two parallel approaches to recovering the missing ALSEP data:

The first effort is to reconstruct as much of the original ALSEP raw data as possible from recovered range, ARCSAV, and work tapes. Fortunately, the raw data from the time period the UT-Galveston performed the extraction/PI data distribution function, i.e. 1 March 1976 to end-of-mission on 30 September 1977, were retained by UT-Galveston and are available. In the early 1990s all these raw data were retrieved by UT-Austin from the "work tapes" and archived in IRIS (Incorporated Research Institution for Seismology) and NSSDC archives. Many of the current-day lunar scientists have used these raw data for their investigations. Some of these investigators found important discoveries in data the original PI teams had judged not to be scientifically important enough to be included in processed data they sent to NSSDC archives. Examination of the archived ALSEP experiment data from 21 July 1969 (Apollo 11 EASEP deployment) to 29 February 1976 show there are little raw data in the NSSDC archives. Currently Focus Group members are attempting to locate the many thousands of missing range tapes and ARCSAV tapes containing the raw ALSEP data for this time period [2]. However, there is the possibility some of these raw data may be permanently lost.

Thus a second effort by the Focus Group is to make direct contacts with the original PIs or PI team members to attempt to find (1) the missing experiment raw data and/or original PI data tapes, (2) the experiment's processed data missing from the NSSDC archives, (3) the missing experiment "Rosetta stones" (i.e., conversion programs to convert the raw data into science and engineering units, apply calibrations and other corrections needed, etc.), and (4) to obtain access to any boxes of data and data tapes originally sent to NRC for storage by the PI or PI team. NRC box accession numbers and permission from PI or PI's institution are essential to obtaining access to PI's data boxes.

As part of the preparation for contacting the experiment teams we needed to specifically determine what data were missing from the NSSDC. A Focus Group team member prepared tables and bar-graphs of when ALSEP operations performance records predicted specific ALSEP experiments were outputting complete data, degraded but definitely useful data, or data of questionable value [3]. These predictions were compared to those periods when Dave Williams' (NSSDC PDS Lunar Data Node) latest listings

showing the ALSEP data currently in the NSSDC archives [4]. Comparison of the two results gives the processed ALSEP data missing from the NSSDC archives which could be obtained directly from the PI teams. Almost all the raw data before 1 March 1976 except for a 3-month period from April to June 1975 are missing and are desired to be obtained from the PI teams.

Contact Results. To date the Focus Group and NSSDC contacts with Magnetometer PI, Palmer Dyal; Passive Seismic team member, Yosio Nakamura; Dust Detector PI, Jim Bates; and Lunar Ejecta and Meteorite PI, Otto Berg have been highly successful. Contacts at the Heat Flow Experiment PI's (Marcus Langseth, deceased) institution and his PI team have yet to produce satisfactory results.

There is *an urgency* in making these PI and PI team contacts as many of the PIs and key PI team members are deceased, others have retired or are impaired. A desirable goal would be to complete these contacts in 2011. Some direct funding would expedite the efforts as several of the group are unpaid volunteers.

Notes and References: [1] The large amounts of data produced by the unanticipated long ALSEP system lifetimes, PI requested changes in requirements, and the manner in which funding was rapidly terminated, etc. [2] Nagihara, S. et al. (2011) *LPSC XLII Search and Recovery Efforts for ALSEP Data Tapes*. [3] Lewis, L. R. et al. (2010) *NLSI Forum 3*, Poster #105. [4] Bates, J. R. et al. (1979) *ALSEP Termination Report, NASA Ref. Pub. 1036*. [5] Williams, D. R. et al. (2010) *NLSI Forum 3*, Poster #80, and private communication, January 2010.