IMPROVING THE ACCESSIBILITY OF THE APOLLO SEISMIC DATA: ARCHIVING AT IRIS AND
THE PDS
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Introduction: Many seismic experiments were deployed on the Moon by the astronauts during the Apollo missions as part of the Apollo Lunar Surface Experiments Package (ALSEP). The experiments began in 1969 with Apollo 11, and continued with Apollo 12, 14, 15, 16 and 17. We are creating easily-accessible archives from the ALSEP Passive Seismic Experiments. Over 13,000 arrivals from seismic events were recorded on the Moon during the duration of the Apollo experiments [1]. However, the seismic traces are not currently easy to access, as Apollo pre-dates the advent of NASA’s Planetary Data System. Thankfully, the data from the passive experiments have been preserved from the original magnetic tapes [e.g. 2], which unfortunately is not the case for all ALSEP experiments [3]. The original data are in a binary format that must be extracted. Data which have been wholly or partially extracted are currently available from Geoscope (a research network run by Institut de Physique du Globe in Paris—IPGP) and the Japan Aerospace Exploration Agency (JAXA). We will archive data from both the short-period and mid-period instruments. Note that the mid-period instruments were formerly known as 'long-period' instruments, but we use the current convention.

Data Archiving: The Apollo instruments had a variable sampling rate (Fig. 1), which depended on the temperature [e.g. 4]. This presents a major problem to the seismologist using the data, and also the archivist. The timestamp was recorded on Earth, under conditions when the connection to the 'Standard Time' (an accurate time measurement used before the advent of Global Positioning Systems) was sometimes lost. When Standard Time was lost, the computer recorded the time, but this was frequently very inaccurate.

The data were originally stored in binary formats on magnetic tapes. We have imported the original mid-period data files into a simple format (.csv) and developed code which detects incorrect timestamps. We also developed code which takes the .csv files and creates SEED files (a standard format used in seismology for reading and sharing seismic data, which is also used by...

Fig. 1: The variability of the sampling interval for each of the stations during 1973. Sampling is averaged over approximately 15 minutes. The plots show alternating periods of lunar night (purple) and lunar day (white). The red lines show the nominal sampling interval (0.1509434 s). Our goal is mitigate this problem by providing timestamps along with the seismic data, in an easy to download format.
InSight and has been adapted by PDS). Our code is written in Python and uses ObsPy (a widely used Python-based tool for seismic processing, [5]).

We will keep an additional 'track' which will record the timestamp as recorded on Earth which would be distributed with the data from the horizontal and vertical components. We will also interpolate the data in this track to provide a corrected time when standard time was unavailable. We will thus provide five tracks for the mid-period instruments (Fig. 2) and three tracks for the short-period instruments. These will contain a timing trace, a frame trace (to link back to the original magnetic tape) and the components of motion.

The data will be archived at both IRIS (Incorporated Research Institutions for Seismology) and the PDS (Planetary Data System). Easy access to these data will ensure that these valuable data continue to be used to learn more about the Moon. It will also support future missions, such as the Lunar Geophysical Network [6].

Fig. 2: The plot shows the five tracks of data we will provide in the SEED files. The top three traces show the data traces MHZ, MH1 and MH2 (the 1 and 2 refer to the two horizontal components which did not point north and east). The x-axis is seconds after the P arrival time, and the y-axis is in digital units (DU). The fourth trace AFR shows the frame count (a complete record contained 90 frames, with 4 samples per frame). The fifth trace ATT shows the timestamp (seconds since 1970-01-01) recorded at the ground station. The seismologist can see how the sampling rate varies using the ATT trace.

References: