Passive Seismic Experiment (PSE)

NSSDCA ID: 1971-063C-01

Mission Name: Apollo 15 Lunar Module /ALSEP
Principal Investigator: Dr. Gary V. Latham

Description

The Passive Seismic Experiment (PSE) was placed on the lunar surface as part of the Apollo 15 ALSEP package. The PSE was designed to detect vibrations and tilting of the lunar surface and measure changes in gravity at the instrument location. The vibrations are due to internal seismic sources (moonquakes) and external (meteoroids and impacts from the spent S-IVB and LM ascent stages). The primary objective of the experiment was to use these data to determine the internal structure, physical state, and tectonic activity of the Moon. The secondary objectives were to determine the number and mass of meteoroids that strike the Moon and record tidal deformations of the lunar surface.

The PSE unit was constructed principally of beryllium and had a mass of 11.5 kg, including the electronics module and thermal insulation. It was housed in a drum-shaped enclosure 23 cm in diameter and 29 cm in height. The enclosure was rounded on the bottom and rested on a leveling stool. The PSE consisted of two main subsystems, a sensor unit and an electronics module. The sensor unit contained three matched long-period (LP) seismometers aligned orthogonally in a triaxial set to measure one vertical and two horizontal components of surface motion. The horizontal component seismometers were very sensitive to tilt and were leveled to high accuracy by means of a two-axis motor-driven gimbal operated by ground command. A third motor adjusted the vertical component seismometer in the vertical direction. A fourth, short-period (SP) seismometer with a resonant period of 1 second measured vertical motion at a peak sensitivity of 8 Hz and a response range from 0.05 to 20 Hz. A thermal shroud and 6-W heater for thermal control comprised the rest of the experiment package. The thermal shroud was aluminized mylar which covered the instrument and the ground surrounding the base out to about 75 cm radially. A gnomon and level sensor were mounted on the top center of the shroud. Total power drain varied from 4.3 to 7.4 W.

The seismometers consisted of an inertial mass on a sensor boom suspended by springs and hinges, a capacitor plate and a damping magnet. The LP seismometers could function in a flat-response mode and in a peaked response mode. In the flat response mode, the LP seismometers had a natural period of 15 s. In the peaked-response mode, they acted as underdamped pendulums with a natural period of 2.2 s. Sensitivity to ground motion peaked sharply at 0.45 Hz in peaked response mode with a useful frequency range of 0.004 to 2 Hz. Maximum sensitivity was enhanced by a factor of 6 in the peaked response mode, but sensitivity to low-frequency signals was reduced. All seismometers could detect ground motions as small as 0.3 nm. At tidal frequencies, gravitational acceleration was measured by monitoring the feedback current used to center the seismometer mass. The sensitivity of the instruments was 0.008 mgal. The lunar surface impacts of the spent S-IVB and LM ascent stages were used as external calibration sources for the seismometers. The known mass and velocity of these stages at surface impact and the lunar impact point coordinates enabled the computation of energy generated at impact and the point of energy application. (The calibration characteristics were determined by measuring seismometer response to these energy sources.)

The seismometers were deployed on 31 July 1971. The ALSEP central station was located at 26.1341 N latitude, 3.6298 E longitude. The passive seismic experiment was deployed 2.7 meters west of the central station. Thermal control problems were encountered beginning on 13 August 1971 when the system could not maintain the desired temperature ranges. The lunar surface photographs indicated that the thermal shroud was not flat on the lunar surface which caused excess thermal leaks. This resulted in loss of some tidal data but otherwise data return was normal. Seismic disurbances were noted throughout the lunar day, but particularly near sunrise and sunset, these were believed to be due to expansion and contraction of the mylar shroud and/or the cable to the central station. The instrument was turned off on 30 September 1977 as part of the ALSEP station shutdown.

Alternate Names

- Apollo15ALSEP/PSE
- PSE
- Passive Seismic Experiment
- S031

Facts in Brief

Mass: 11.5 kg
Power (avg): 7.1 W
Bit rate (avg): 0.712 kbps

Funding Agency

- NASA-Office of Space Science United States

Discipline

- Planetary Science: Geology and Geophysics

Additional Information

- Apollo 15 Lunar Module /ALSEP
- Data collections from this experiment

Questions and comments about this experiment can be directed to: Dr. David R. Williams

Personnel

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Selected References

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