

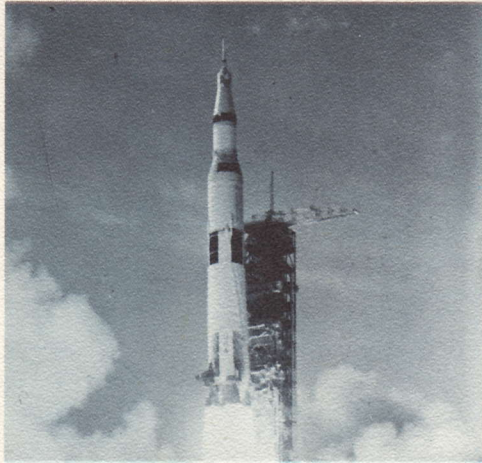
ALSEP NEWS

APOLLO 12
1st Anniversary
Edition

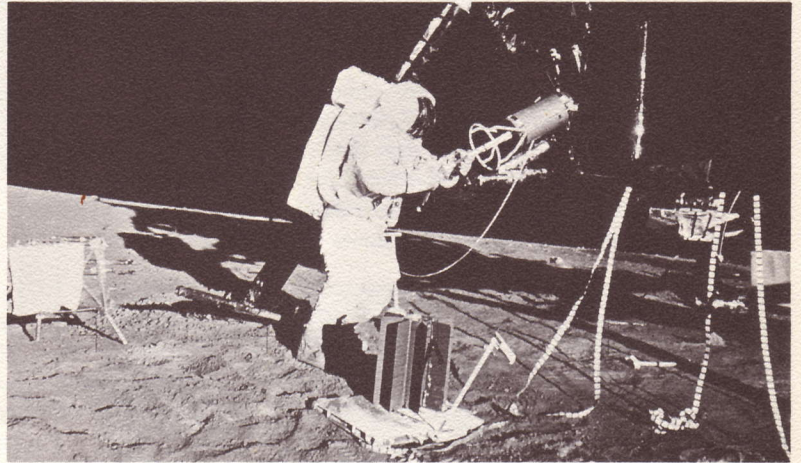
Ann Arbor, Michigan

19 November 1970

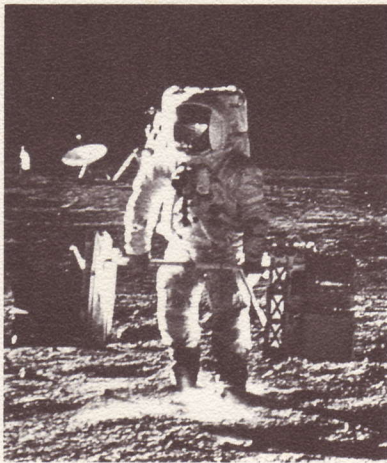
365 DAYS OF LUNAR HISTORY FROM ALSEP... AND STILL SENDING



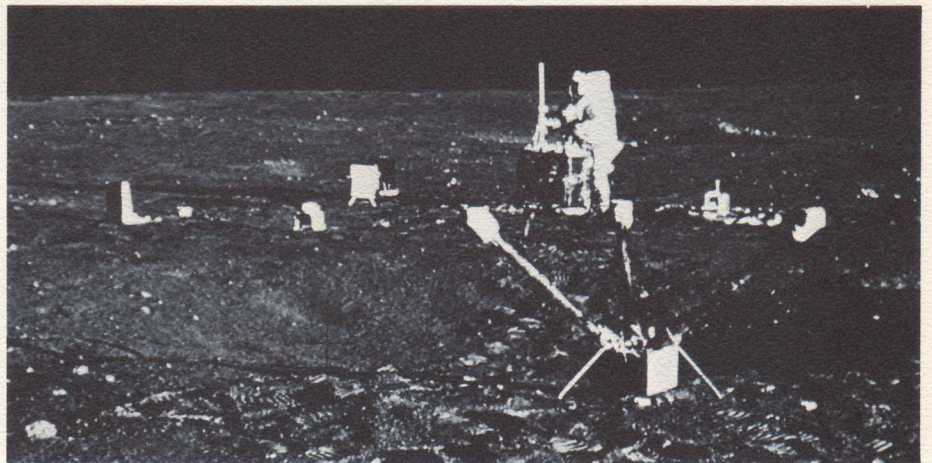
Apollo Launch



ALSEP and Fuel Capsule Removal



Transporting ALSEP



ALSEP Deployed

ALSEP, the Apollo Lunar Surface Experiments Package, has been transmitting scientific and engineering data from the Moon for one full year. The 19 November 1969 deployment of ALSEP on the lunar surface initiated the first long-term, on-site scientific exploration of another planet and its relationship to Earth. During the year of operation, ALSEP has provided data throughout 12 orbits of the Moon around the Earth, two solar eclipses, and one cycle of lunar seasons; it is now mid-summer at the ALSEP location on the Moon.

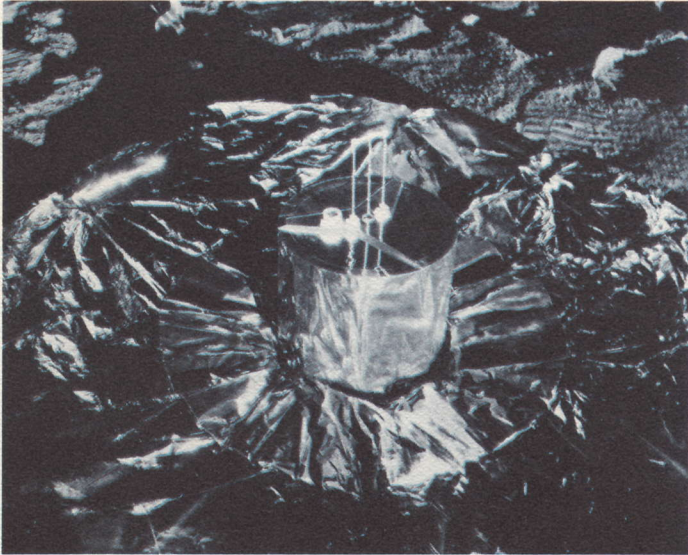
ALSEP carried five scientific experiments and a central station for power, command control, data processing, and transmission. The experiments include: a passive seismometer, a magnetometer, a solar wind spectrometer, a suprathreshold ion detector, and a cold cathode ion gage. The scientific and engineering measurements made by the experiments have provided significant contributions to man's knowledge of the lunar composition and environment. With the landing of future ALSEPs, a network of scientific instruments will be created to further enhance the gathering of data.

LUNAR SEISMIC EVENTS

The ALSEP Passive Seismic Experiment (PSE) is investigating the properties of the lunar interior through natural and manmade seismic events. Currently, data from the PSE indicate that the Moon is not stratified like the Earth as was once presumed, but is a collection of rock clumps which have not congealed. Impacts cause the Moon to vibrate much longer than similar impacts would on Earth.

The ALSEP seismometer on the Moon recorded 250 events, about one per day, during the first seven months of operation.

The two major seismic events recorded by the PSE seismometers have been the impacts of the Apollo 12 Lunar Module and the S-IVB stage of the Apollo 13 booster. The S-IVB impact signal was the largest event recorded to date and lasted for approximately four hours. Except for these manmade signals, the data received from seismometers have revealed that the Moon is an extremely quiet and stable body as compared to the Earth. However, a number of unique signals have been recorded. Of the signals recorded, 14 are remarkable in that they have been nearly identical and all occurred without exception at the time when the Moon was closest to the Earth—at perigee. At this point, the tidal strains are at their greatest level.



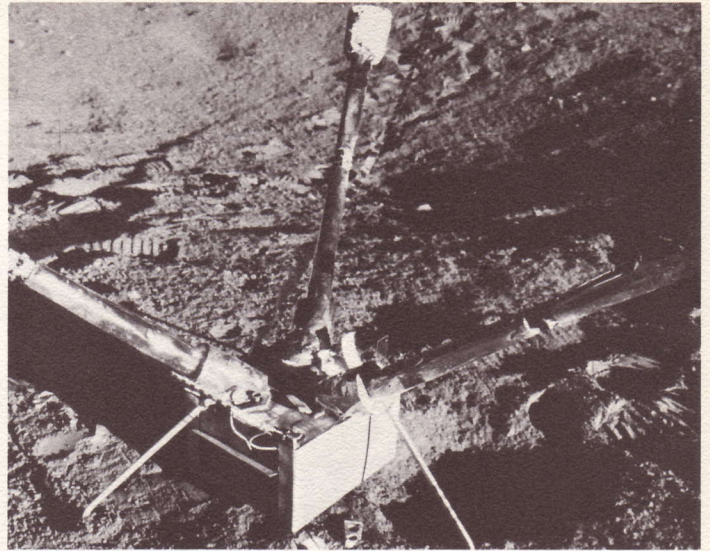
Passive Seismic Experiment

At such times, the attraction causes the surface of the Moon to bulge 20 to 30 inches toward the Earth. The 14 matched signals are believed to be moonquakes triggered by tidal strains. Because the signals are so nearly alike, it is theorized that they originate at the same point. The scientists have tentatively located this point in the crater Fra Mauro—just 50 miles south of the planned lunar landing site of Apollo 14—near a network of large rilles. It is speculated that the 14 moonquakes were produced by movements along the rilles or by the escape of cold gases or volcanic materials through openings produced by the tidal strains.

MAGNETISM ON THE MOON

The ALSEP magnetometer measures the static and dynamic magnetic fields on the lunar surface which are produced on remanent sources in the Moon and by electric currents generated on the Moon by the solar wind.

Immediately after the astronauts deployed the magnetometer, a steady field of 36 gammas was measured. Further gradient measurements of this field indicate that it was large in extent and was probably a fossil remanent of a larger field frozen in cooling lava.



Lunar Surface Magnetometer

Analysis of the time-dependent fields indicates that the large electric currents are generated deep in the interior of the Moon. Step transients or sharp changes in interplanetary field measurements simulated by Explorer 35 orbiting the Moon and by Apollo 12 instruments located on the lunar surface indicate an average temperature of approximately 800°K down to about $1/2$ the radius of the Moon and greater than 1200°K for material in the inner core.

LUNAR ION ATMOSPHERE

SIDE

The ALSEP Suprathermal Ion Detector Experiment (SIDE) and associated Cold Cathode Gage (CCG) are measuring the dynamics of the lunar atmosphere.

The ALSEP Suprathermal Ion Detector has established the existence of a variety of interesting phenomena which depend on the phase of the Moon. One such phenomenon consists of clouds of low energy ions seen during the lunar day and especially in conjunction with lunar sunrise and sunset. These clouds are highly suggestive of some form of local acceleration mechanism operating on what appears now to be a sporadic lunar ionosphere.

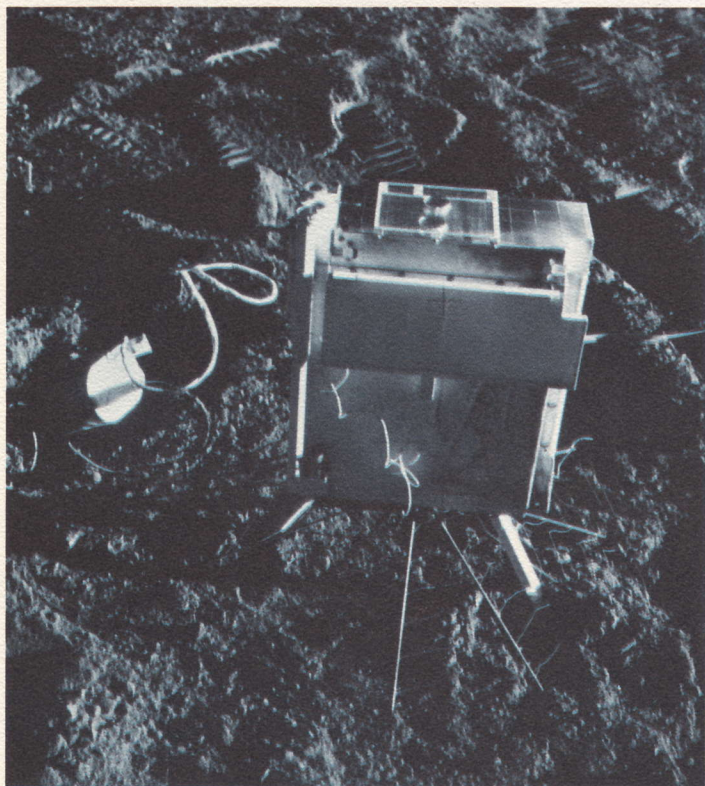
A second such phenomenon is the regular appearance of positive ions of high energy between one and seven days following lunar sunset. These ions are thought to have arrived at the Moon after having escaped from the Earth's magnetospheric bow shock wave. They represent an aspect of the Moon's ion environment that was heretofore unanticipated.

The interaction between the Moon and the ions in the Earth's magnetic tail is, of course, an area of continuing interest. Complex energy spectra with rapid time variations in intensity are seen as the Moon emerges from the geomagnetic tail and enters the so-called magnetosheath region between the magnetotail and the bow wave.

Apart from these repetitive or diurnal phenomena, several singular events have been recorded. Probably the most dramatic is the lunar impact of the Apollo 13 S-IVB. Approximately 20 seconds after impact, the ALSEP instrument indicated a large rise in the flux of suprathermal ions at

the Apollo 12 ALSEP site. This burst of ions continued to build and was sustained for about eight minutes. During this time, several mass spectra were obtained that indicated that the suprathermal ions were of impact rather than solar wind origin. The peak energy of these ions went as high as 500 electron volts during the event. An event similar in nature but smaller in magnitude was seen during the impact of the Apollo 12 LM ascent stage.

An additional singular event was the partial lunar eclipse of 16 August 1970. During this eclipse, the SIDE reported dramatic flux enhancements and spectral variations, including a double-peaked energy spectrum. Unfortunately, the eclipse coincided almost exactly with the arrival of a solar wind enhancement on Earth that set off a large magnetic storm and unusual auroral displays. It is therefore impossible to resolve whether the solar wind enhancement or the eclipse caused the remarkable effects seen in the SIDE data. Data from additional magnetic storm periods and/or eclipses will be useful in the interpretation of these data.



*Suprathermal Ion Detector Experiment
and Cold Cathode Gage*

CCG

Designed to sense lunar atmospheric pressure, the Cold Cathode Gage measures the presence of particles from which it interprets the density of the atmosphere. It also senses the loss rate of contaminants left by the astronauts and the LM.

The Cold Cathode Gage operated for approximately 14 hours after ALSEP deployment. It was shut off by apparent electrical arcing in its 4500 volt power supply due to outgassing in the electronics as it became heated in the hot vacuum environment of the lunar day. During its operation, it showed that:

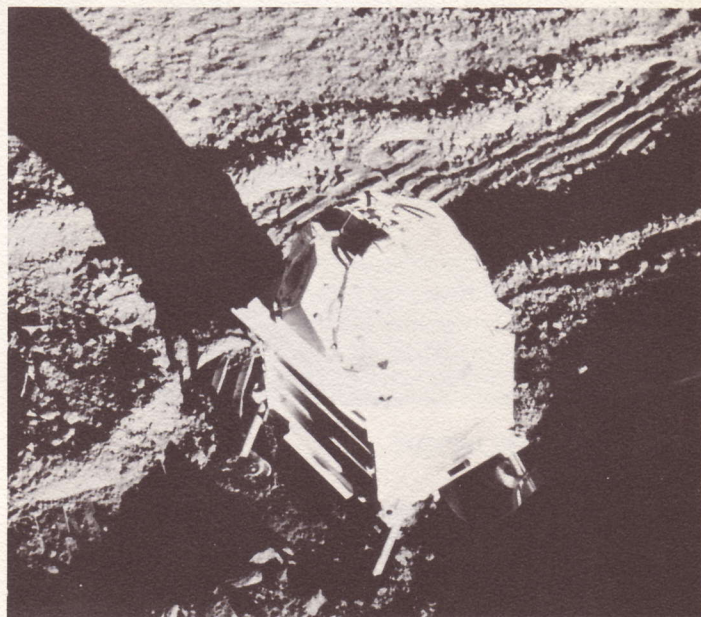
- The natural lunar atmospheric pressure (9×10^{-9} torr) is about one-hundred-billionth that of Earth's atmospheric pressure.
- Contaminant gases from landing operations did not raise the local atmospheric pressure above 9×10^{-9} torr.
- The gas cloud around an astronaut on the lunar surface exceeded the upper range of the gage (approximately 10^{-6} torr) as far as several yards away from the astronaut. But no perceptible residual contamination at the 10^{-8} torr level remained around the gage for longer than a few minutes after astronaut departure.

SOLAR WIND

The first scientific objective of the ALSEP Solar Wind Spectrometer Experiment (SWE) investigation was to determine the nature of the interaction of the Moon with the solar wind. The solar wind is the top layer of the atmosphere of the Sun (often called the corona), which is completely ionized and is expanding out into space at a high supersonic velocity in all directions. Such an ionized gas is termed a plasma.

Assuming that some differences could be detected between the physical properties of the solar plasma on the Moon and in space, the second goal of the solar wind experiment was to relate these differences to physical properties of the Moon. The third goal was to use the solar wind itself and provide data for studying the temporal changes of its properties.

To date, a preliminary analysis has been made of the first nine lunations (the 29 1/2 days of a lunar day-night cycle), and the results in all of them have been quite similar. Four distinct regions are observed.



Solar Wind Experiment

During a typical lunation, the instrument detects no plasma for two periods. One is during the entire 14-day lunar night when the Moon itself is between the Sun and the ALSEP site. The second is for 4 1/2 days when the Earth is nearly between the Moon and the Sun; here the geomagnetic field has excluded the bulk of the plasma so that what little bit does penetrate into this region is below the SWE level of sensitivity. This is the geomagnetic tail region.

Plasma that has been less strongly perturbed by the Earth's field is measured for about three days on either side of the tail region. There are five remaining days when the observed plasma parameters are consistent with those that have been observed on various space probes far away from any planetary body.

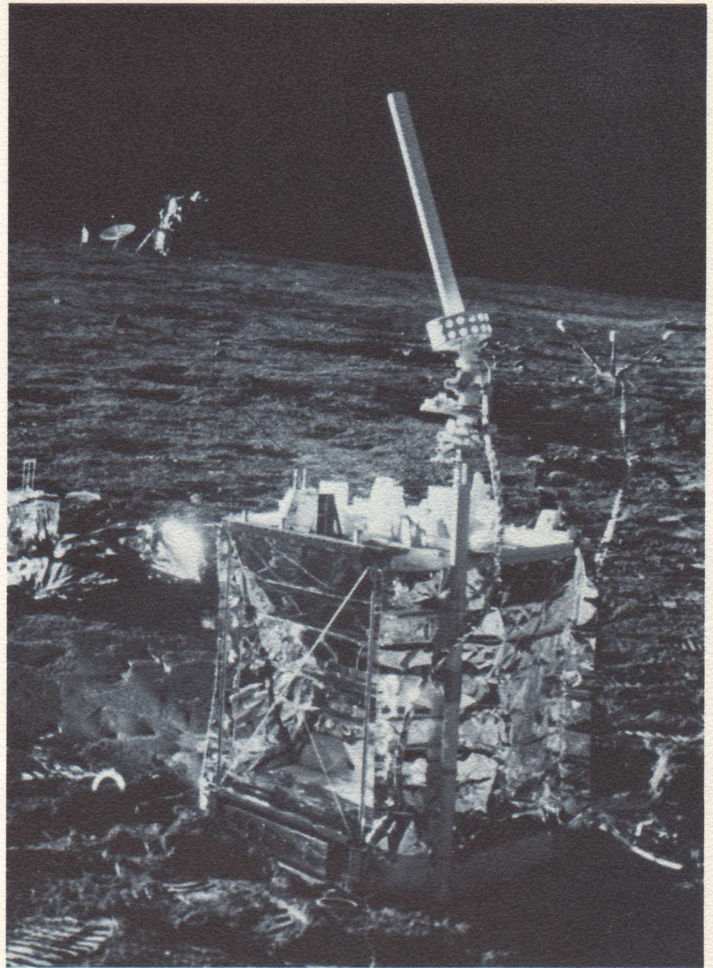
These same four plasma regimes—the lunar wake, the magnetotail, the transition region or “magnetosheath,” and the unperturbed solar wind—have also been observed by the lunar satellite Explorer 35, which began making observations near the Moon in July 1967. Explorer 35 carried a plasma probe that is basically similar to the SWE. The consistency between the observations of the two instruments demonstrates that the perturbation of the solar wind by the Moon is very small, and thus accomplishes the first goal of the SWE.

The accomplishment of the second and third goals depends upon the detailed comparison of SWE data with solar plasma measurements in space at the same time. This comparison has been seriously hampered by the lack of plasma measurements on Explorer 35, as its plasma probe ceased producing interpretable data about one month prior to the Apollo 12 mission. Detailed correlations require that a plasma probe in space simultaneously be: (1) reasonably near the Moon, (2) in the same plasma regime as ALSEP, (3) turned on and operating in the proper data mode, and (4) tracked by a telemetry receiving station. All these conditions are rarely satisfied simultaneously by any of the space probes now active, and it has not yet been possible to find sufficient simultaneous data to make significant progress in accomplishing the second and third goals of the experiment. With the continued normal operation of the SWE and the ALSEP, and with the prospect of a second identical instrument on Apollo 15, it is still hoped that these goals can be achieved.

An unexpected bonus came with the discovery that the impact of the Saturn upper stage, the S-IVB, produced such a large quantity of ionized gas that it was clearly detectable by the SWE even though the impact was 135 kilometers away. This observation opens the interesting possibility of studying the motion of gas clouds produced by meteorites striking the Moon, if any sufficiently large impacts occur during the lifetime of the ALSEP instruments. The S-IVB impacted to the west of ALSEP at a time when the sun was a few degrees below the horizon to the east. In this configuration, it might have been expected that the solar wind would sweep the gas cloud from the impact away from ALSEP. Actually, however, two distinct clouds were observed—the first approaching predominantly from the north between one and three minutes after impact, and the second from the northeast between five and eleven minutes after impact.

DATA FROM THE MOON

Measurements of lunar characteristics are valuable only when returned to Earth and to the scientific and engineering personnel capable of interpreting the significance of the measurements. The ALSEP central station provides the power command control, data processing, and transmission system for these measurements. Operating successfully in the harsh extremes of the lunar environment (-300°F to +180°F) the central station has accepted and executed over 6500 commands and returned more than three billion data measurements over the one terrestrial year period.



ALSEP Central Station

FUTURE LUNAR EXPLORATION

The four remaining Apollo missions, Apollo 14 through Apollo 17, will also carry ALSEP to further the scientific investigation of the Moon. The subsequent ALSEPs will consist of varying experiment arrays to supplement and complement those scientific experiments already operating on the lunar surface. For example, additional seismometers will be deployed to make up a seismic sensing network. Further particle and field measurements will be made with magnetometers, gravimeters, and ion detectors. Thermal characteristics of the lunar surface will be explored with a heat flow experiment.

The ALSEP to be carried on Apollo 17, presently the last planned Apollo mission, is designed for a two-year operational life. Each of the earlier ALSEPs will be operational for a minimum of one year. The continuing long-term scientific measurement and data collection of lunar exosphere, surface mantle, and whole body properties are essential to the understanding of the Earth-Moon relationship and the solar system. The one-year anniversary of the first ALSEP marks a major milestone.

The Apollo Lunar Surface Experiments Package transported to the Moon by Apollo 12 was developed under the direction of the National Aeronautics and Space Administration Manned Spacecraft Center by the Bendix Aerospace Systems Division.