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ALSEP 12 FIVE YEARS OLD AND STILL GOING STRONG

Five years ago two American astronauts placed and left on the Moon a remote scientific instrument package. Five years and over 21,000 Earth-to-Moon commands later this set of instruments continues to radio back to Earth information about the Moon's seismic activity, the energy hitting the surface from the Sun and the Moon's weak magnetic field.

Original specifications for the Apollo Lunar Scientifc Experiment Package (ALSEP 12) called for the instruments to last for one year after the return of Apollo 12 astronauts Pete Conrad, Alan Bean and Richard Gordon.

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Don Wiseman, one of the men originally responsible for the hardware development at NASA's Johnson Space Center (JSC), Houston, attributes the long life to basically simple design with basically durable materials. "It was a bare bones design; basically sound," Wiseman said.

According to W. "Ike" Eichelman, JSC's chief technical monitor for the ALSEP, the basic ingredient in the longevity of the instrument packages is their atomic power plants. Due to several factors -- the Moon's environment, the cosmic irradiation, and others -- the generating units have actually performed better on the Moon than ever predicted using simulated environments on Earth. Eichelman estimates that ALSEP 12 will last at least two more years, or seven times longer than its original life expectancy.

The need for remote data from the Moon centered about certain questions best answered with continuing data from which a trend could be established; questions like what is the Moon's internal structure and temperature, what processes are responsible for the present structure of the lunar surface, what is the pattern and distribution of seismic activity on the Moon, how do solid body properties and processes on the Moon compare with those on Earth?

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The ALSEP series which included similar packages for Apollo missions 14 through 17, was designed to return lunar scientific data to Earth in the areas of geology, geophysics, geochemistry and astrophysics.

Each ALSEP was carried to the Moon in two compartments aboard the Lunar Modules and placed in position by the astronauts during their forays about the Moon's barren surface. Although each ALSEP contained a number of identical instruments, each one was different in distinct ways from the others. Each, however, was powered by a Radioisotope Thermal Generator (RTG) which transforms atomically generated heat into about 75 watts of energy at 16 volts.

The instruments consisted of a passive seismic device, an active seismic array using mortar rounds to set up shock waves, two ion detectors, a solar wind spectrometer, a particle detector, magnetometers and instruments to measure heat flow from the Moon's interior.

Although there were earlier instrument packages which were soft-landed on the Moon prior to the Apollo missions, the ALSEP packages have been the longest lived, most sophisticated package of sensors ever designed and placed on the Moon.

Dr. Palmer Dyal, a NASA lunar investigator at Ames Research Center in California, has derived measurements of the Moon's magnetic field from the Apollo ALSEP magnetometers. His estimates show the Moon's magnetic field to be about 1,000 times weaker than the Earth's and the result of a probable one-time magnetism. No significant dipole field exists on the Moon at present -- which means a magnetic compass would be absolutely useless on the Moon. The Earth's field, in contrast, derives from internal processes of our planet.

A powerful magnetic field is generated deep within the Earth by the constantly rotating molten metal core. This core functions like a dynamo and develops a field measurable many thousand miles into space. In contrast, the main lunar magnetic field consists of near-surface fields highly variable in magnitude and direction.

Dyal says "that the lunar magnetic field can be viewed as a sort of magnetic tape recording of conditions on the Moon more than three billion years ago." These investigations have also led to other tentative conclusions concerning the interior structure of the Moon. From magnetic data Dyal has figured the abundance of free iron on the Moon at about 2.5 per cent by weight. Total iron content of the Moon is about nine per cent by weight. The Earth is about 30 per cent iron by weight.

Signals received by the seismometers have definitely established the existence of Moonquakes. These are associated with activity deep within the Moon 700 to 1,200 km (420 to 720 mi.) and with shallow activity produced by thermal heating and cooling during the lunar day and night. A third class of seismic events may be associated with processes within the lunar regolith.

One of the most surprising results was the long duration and ringing nature of seismic signals from the Moon -- completely different from that observed here on Earth. This is explained by the diffusive propagation of the shock waves as a result of intense scattering, particularly near the lunar surface. The diffusion is enhanced by low attenuation due to the lack of water and other volatiles in the pores of the lunar rocks. For this reason, seismic studies based on reflected signals cannot be used to the same advantage on the Moon as they are on Earth.

Other important findings based on the seismic data are that the lithosphere (solid part) of the Moon is 700 to 1,200 km (420 to 720 mi.) thick, much thicker than the Earth's. The Moon's core is probably near the melting point. Scientists, however, are waiting for a large meteorite impact similar to one which occurred two years ago to confirm their theories about the Moon's core.

Seismic energy of the Moon has been found to be about 10 orders of magnitude less than the Earth's, and due to the Moon's thick lithosphere, there is no crustal plate movement like on Earth.

The heat flow measured by ALSEP instruments was surprising. It is about half that of the Earth's. It places strong constraints on the radioactivity of the Moon and indicates differentiation and upward concentrations of radioactivity early in the Moon's history. Previous models of the Moon's radioactivity were based on chondritic meteorites and terrestrial rocks. Bulk radioactive concentrations consistent with the heat flow measured on the Moon indicate that those models are inaccurate. Other findings indicate that, in comparison to the Earth, the Moon is depleted in volatile elements like iron, sodium and potassium.

Seismic, magnetic and heat flow data from the ALSEPs indicate a differentiated Moon well along in its evolutionary history -- further along than the Earth.

The ALSEP instruments have also been successful in obtaining a better picture of the Earth's magnetosphere -- a realm of trapped particles. As the Earth orbits about the Sun it is continually in the flux of high energy particles emitted by the Sun.

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When these particles approach the Earth's magnetic field they are deflected outward further into space. By using information from the suprathermal ion detector, cold-cathode ion gage and solar wind spectrometer, scientists have been able to look at Earth's solar atmosphere with more precision than ever.

One of the striking results has been the discovery that solar particles exist in stronger concentrations on the Earth's anti-Sun side than had been predicted. The implications and mechanism for this interesting turn are not yet known.

Data from the five ALSEPs is received by NASA's tracking network 24 hours a day. This information is stored on computer tapes and mailed to the Johnson Space Center. The computer tapes are duplicated and sent along to the dozen principal investigators still analyzing the data. Through the National Space Science Data Center data tapes are made available to the scientific community at large. Several times each week, NASA engineers and technicians monitor the ALSEP instruments "live" from the Moon looking for problem areas or performing general maintenance checks.

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