ACTIVE SEISMOMETER

Grenade launches on moon delayed

There are now two scientific stations operating on the moon, the ones of Apollo 12 and 14. On July 31 the Apollo 15 station is to be set up. The three sites form a triangle, simultaneously recording and transmitting to earth data on such things as seismic activity, magnetic and particle fields and the solar wind.

Power for the scientific experiments is supplied by a radioisotopic thermoelectric generator. The SNAP 27 reactor uses plutonium 238. Barring failure of the electrical components, the station could theoretically continue to send data to earth for about as long as the half-life of the plutonium, 87 and a half years. The Apollo 12 station has now been working for 19 months.

But a testy problem has come up at the Apollo 14 site that will involve some trade-offs. One of the instruments, an active seismometer that consists, in part, of a grenade launcher to bombard the moon at varying distances from the station (thus giving scientists data on the moon's subsurface structure) was set up too close to the station.

Numerous ground simulations have revealed that the mortar blasts would rend the sunshades of the central station, allowing direct sunlight to fall on its electronics. This would cause it to fail. In addition, the blasts would blow up the skirts of the passive seismometer and degrade its thermal-control unit.

NASA has now decided to delay firing the grenades until at least six months after the Apollo 16 station has been set up in March of 1972. The scientists will thus have at all times, three operating stations.

SEISMOLOGY

Possible lunar hot spots

Dr. Gary V. Latham of the Lamont-Doherty Geological Observatory is the principal investigator for the two lunar passive seismometers left at the Apollo 12 and 14 sites. By studying the nature and duration of the seismic signals from meteoroid or manmade impacts or from moon quakes or other activity, he and other scientists can establish tentative models of the moon—the kind of material through which the signals pass (the subsurface structures or layers) as well as the type of activity generating the signals.

As a result of almost five months of data from the Apollo 14 seismometer to compare with the Apollo 12 one, Latham has modified his view of the lunar substructure. He now believes that the moonquakes, previously thought to be shallow activity, are occurring at significant depths within the moon—from 30 to 400 miles. The maria regions still appear to be mantled by a heterogeneous zone that scatters seismic waves. The depth of the surface material is unknown, although he thinks it could be as deep as 30 to 60 miles. But below that surface area is a zone that transmits waves, "very, very efficiently," he says. "So efficient that we are seeing impacts from all over the moon. . . ."

And finally, Latham has identified 11 "active" or "quake" areas. One of these is in a zone 400 miles north or south of the midpoint between Apollo 12 and 14. This source generates waves each month "like clockwork"—five and three days before perigee (when the moon is closest to the earth and the tidal strain is at a maximum). The signals appear to be more like those from volcanic activity than from quakes. From this Latham suggests that the source of the activity could be a small isolated pocket of magma (heated by radioactive decay) under pressure at depths between 30 and 400 miles. The effect of the tidal strain would be to pump this fluid material into small cracks. The cracks are thereby extended a small amount each month.

ION-DETECTION

Release of lunar gases

It seems reasonable to expect that when a meteoroid hits the moon, or a quake occurs, gases trapped in the moon's surface might be released by the activity. Scientists have been looking for such a correlation. Several instruments could measure the gases; one is the suprathermal ion detector (SIDE).

Although the SIDE detectors of Apollo 12 and 14 have monitored numerous cases of gas release (some seen by only one, others by both), only one of the cases has coincided with a seismic event. That was in April.

The Apollo 14 SIDE has detected some rather puzzling ions that fall within the atomic mass range between 16 and 23, which would include water vapor. Since no water has been found on the moon, however, the ions are probably from the venting of the lunar module.

THE SOLAR WIND

Rapid expansion of bow wave

The two scientific stations on the moon—the Apollo Lunar Surface Experiment Packages (ALSEP)—circle the earth each month. They pass through the earth's bow shock, the magnetopause, magnetosphere and the magnetic tail. The instruments, particularly the magnetometer, the suprathermal ion detectors and the solar wind spectrometer, can determine the solar wind's direction, velocity and density. The solar wind, ionized gas blown continually from the sun, determines magnetic fields in space, affects cosmic rays, affects the position of the earth's magnetosphere, replenishes the Van Allen radiation belts and influences the auroras.

On Feb. 14, during the lunar night, the Orbiting Geophysical Observatory circling the earth (OGO 5), Explorer 35 circling the moon, and ALSEP on the moon each saw an intriguing phenomenon. At that time the moon was nearly 100,000 kilometers in front of the earth's bow shock wave. OGO was fairly close to it. Rather suddenly the solar wind plasma flux dropped. "The plasma flux going down meant that there was less solar wind pressure on the magnetosphere and on the shock wave in front of the earth," says Dr. Conway Snyder of the California Institute of Technology's Jet Propulsion Laboratory. "The smaller amount of pressure allowed the bow shock to expand over and pass the ALSEP station on the moon."

Tentatively, Dr. Snyder estimates the speed of the bow shock wave expansion to be of tens of kilometers per second. The precise speed will be easier to measure when a second solar wind spectrometer is placed on the moon by the Apollo 15 astronauts.