Research tradeoffs for the next Apollo

The heat flow experiment lost with Apollo 13 won't be repeated until either 15 or 16 fly

As early as 1962, the National Aeronautics and Space Administration, with the National Academy of Sciences, explored scientific goals of the Apollo program. Three experiments emerged as required for fundamental measurements of the moon's gross properties: to measure lunar seismic activity, locate and measure magnetic fields, and measure the flow of heat to the surface.

Two of the three, a passive seismometer and a magnetometer, were deployed by the Apollo 12 crew. Another seismometer is scheduled for Apollo 14, as is a hand magnetometer.

But the heat flow experiment, which was lost in the failure of Apollo 13, will not get to the moon until next year at the earliest.

The decision was made last week to keep the heat flow test off Apollo 14 in December. It came after month-long reevaluations of the future site and experiment schedules in light of the holes left by the Apollo 13 failure. Apollo managers and scientists both preferred Apollo 13's target, Fra Mauro, over the intended Apollo 14 site of a mare, Littrow (SN: 5/16, p. 478). But the experiment decision was not as simple.

The heat flow, designed by Dr. Marcus Langseth of the Lamont-Doherty Geological Observatory, is a top priority experiment. Scientists believe that large planetary bodies possibly contribute two energy sources to their net surface heat flow: energy retained from initial formation of the planet and energy generated by interior processes. Measuring the moon's heat flow, then, would give valuable knowledge of the moon's interior and history. It would provide direct measurement of the rate at which the interior is losing energy to outer space.

In addition, the Apollo 14 experiments were designed for a mare. Sending them to the highlands is a compromise. This is particularly true of the active seismometer designed by Dr. Robert L. Kovach of Stanford University. This instrument is designed to determine properties of lunar rocks down to 2,000 feet beneath the surface by the detonation of 21 small explosives by astronauts on the surface, and ground-controlled firings of four mortar grenades to distances of from half a mile to a mile from the instrument array. Ideally, this is a flatlands experiment.

The decision to keep the active seismometer was based on the work and time needed to take it out. Nevertheless, it will have value. "I am optimistic of the results," says Dr. Kovach. He believes the instruments may be able to locate the original Fra Mauro material, buried under layers of ejecta (SN: 4/4, p. 353).

All the experiments together form a unit called ALSEP—Apollo Lunar Surface Experiment Package.

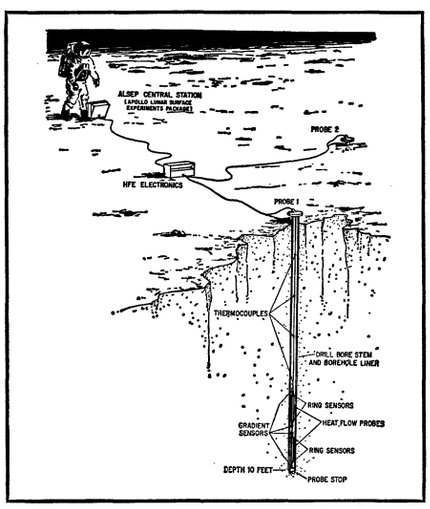
If the decision were made not to replace any experiments, the seismometer or any other instrument, with the heat flow, an alternative would have been to add the heat flow experiment to the system. Bendix Corp., the ALSEP contractor, and engineers at Houston's Manned Spacecraft Center, looked into both possibilities. The package could be broken into for replacement of experiments, or the heat flow could be added and plugged into the central power generator on the lunar surface.

Neither were fully satisfactory. The first alternative would require a major redesign and modification of the ALSEP, and either would require electrical wiring changes and extensive retesting. One time-consuming test required would be the thermal vacuum chamber in which the experiments are exposed to solar radiation and temperature variations from 250 degrees above to 250 degrees below zero F. That alone would take a month.

Tampering with a major redesign of the ALSEP was unacceptable to NASA officials, who don't want anything else to go wrong. Nor was the alternative of adding the instruments any more acceptable. Additional experiments would eat into the astronaut's tight rock collecting time. "The astronauts would not have adequate time on the moon to collect samples as well as deploy all the experiments," says Richard Green, manager of NASA headquarters Lunar Surface Experiments office.

"I would have to agree that too much would be upset by adding the heat flow on Apollo 14," says Dr. Langseth of the decision. "Hopefully it can be accommodated on the Apollo 15 flight rather than waiting until its second scheduled trip on Apollo 16."

Whatever flight carries the heat flow, however, Dr. Langseth hopes it is to a mare. Of the remaining sites, which include various geological terrains such as rilles and craters, only the original Apollo 14 site, Littrow, is a mare. "For geophysical measurements, the highlands are not very exciting for us," he says.



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Heat flow: Not for Apollo 14.

Dr. Langseth regrets not having hedged his heat flow bets. "Our problem in planning these experiments several years ago was that we were too conservative. We underestimated what the crews could do on the surface, so we wanted to wait for the heat flow until we found out. We were also success oriented. We believed that one flight would be enough for an experiment, and we didn't foresee the loss of Apollo 13." □