Apollo returns: the work begins

The incredible spectacle of Apollo 11 is over, but the hard work is just beginning in the cloistered walls of the Lunar Receiving Lab

Photos: NASA

Moon rocks unveiled: "A very, very exciting time."

The step has been taken. Yet, though Neil Armstrong and Buzz Aldrin have trod the moon and arrived safely back on earth, with colleague Michael Collins, for an army of scientists around the world the big step is just beginning: unlocking the secrets of the cosmos with a few dirty chips of another world.

On the astronauts' part, except for their euphoria and presumably high adrenalin levels, they scarcely showed signs of having been in space at all, much less having landed on the moon. Armstrong lost perhaps six pounds during the eight-day Apollo 11 ordeal, Aldrin three and Collins none at all; each showed a slight loss of muscle tone, due to the days of weightlessness. From the time they were plucked out of the Pacific Ocean on July 24 through their arrival in Houston at the Lunar Receiving Laboratory and subsequent examination, space agency doctors proclaimed their health "fantastic," and "perfect."

But Apollo 11's mission was not—and is not—over. The spectacle has ended. Now it is the scientists' turn.

Their job is cut out for them. The LRL, first conceived some five years ago to protect both the samples from earthly contamination and the earth from possible lunar germs, is a fiendishly difficult place in which to work. Its strict safety precautions, such as keeping the samples confined to a vacuum and controlling the air and even the sewage flowing from one section to another, would make it difficult even to live from day to day, let alone perform delicate scientific analyses.

Meanwhile, as the researchers in the LRL were getting their bearings, two other teams were trying to take advantage of two pieces of equipment left on the moon by the astronauts. In the Houston Mission Control Center and in a nearby temporary office behind the LRL, a group led by Dr. Gary Latham of the Lamont Doherty Geological Observatory watched ream after ream of wavy lines unroll on paper charts. These were the messages from Apollo's lunar seismometer, sitting on the moon looking like a rather clumsy robot butterfly but perceiving tiny vibrations of the moon's material and transmitting them to earth.

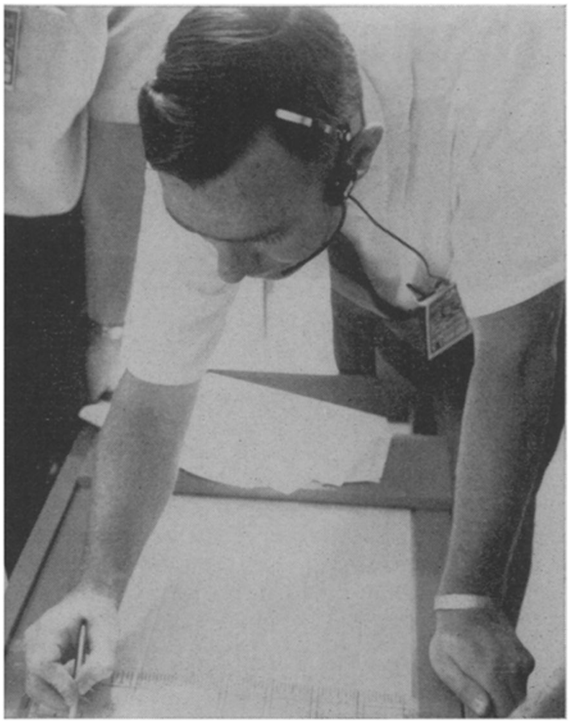
No sooner had Aldrin set it up on the lunar surface, than the touchy seismometer began detecting the astronauts' footsteps, as well as their other activites and the impacts of objects jettisoned from the lunar module before takeoff. Then, on July 22, the day after the LM's departure from the moon, the device recorded a substantial tremor, lasting perhaps five minutes, followed later by two more. The investigators were not sure after only a few days' study whether the tremors were meteor impacts or moonquakes, but the presence of surface waves in the recording offered some indication that the moon may have a distinct crustal layer, as does the earth, rather than being a relatively homogeneous sphere.

Soon afterward, the instrument detected a series of 14 unusual tremors similar to those given off by landslides on earth. The tremors occurred as the moon was approaching the hottest part of its two-week "day," and the heat could have caused the individual rocks in the lunar rubble to expand, creating lunar slides. If so, says Dr. Latham, the seismometer could be revealing "the initial stages of the process by which fresh, new craters are transformed to old," as the crater walls collapse inward, rounding off the crater rims and filling the bottoms with debris.

The heat of the lunar noon also threatened the seismometer itself, apparently because the takeoff of the LM damaged its insulation. As the peak of the heat passed, however, the temperature-sensitive transmitter seemed to be holding its own, despite being cooked as much as 75 degrees above its design level of 145 degrees F. Comparison studies hastily begun on earth with an identical instrument also added confidence, though the question then remained of whether the seismometer would continue to work after going through a frigid (minus 250 degrees) lunar night, even with radioisotope heaters to keep the transmitter to within minus 60 degrees.

Another kind of disturbance reported by the device had the seismologists wondering whether it was just a disturbance, or the most momentous discovery they could possibly make. A low-level, intermittent, but continuing reading from the instrument may be nothing more than the abandoned LM descent stage venting its propellants in the heat. On the other hand, it could mean not just moonquakes due to internal stresses, but a volcanically active moon. Only time, and possibly additional seismometers on future moon landings, will tell.

The other instrument on the moon is much simpler—a mirror. A research team led by Dr. Carroll O. Alley of the



Dr. Latham: Fresh craters to old.

University of Maryland is seeking to bounce laser light off the reflector through the 107-inch telescope at McDonald Observatory in Texas, aided by others at Lick Observatory in California. The Russians and French are also expected to try. Because even the coherent beam of a laser expands over the earth-moon distance, however, only about one 10-billion-billionth (10^{-19}) of the laser light transmitted gets back to the receiver on earth, so reception is difficult even under ideal conditions. The researchers believe that they may have hit their target, but Dr. Alley feels that by far the best time will be when night comes to the site of the reflector for two weeks beginning Aug. 3.

Despite all the activity between earth and moon, the stars of the post-Apollo 11 show are the lunar rocks in the LRL. As the moment approached for opening the first rock box, the tension grew among the scientists and technicians filling the tiny sample operations area. Earlier, a gas sample drawn (after several false starts, due to the tricky sealed glove-cabinet used to let a researcher in a normal atmosphere work with samples in a vacuum) from the box had shown a pressure considerably higher than that on the moon. This probably indicated a slight leak in the seals. But the rocks were the thing, and the scientists were eager.

But the infernal gloves, which weigh 15 pounds each, slowed things down until the tension was just about unbearable. At last, almost eight hours behind the schedule, technician Jack Warren squinted through a waterfall of perspiration and lifted the lid. "It's open!" cried LRL manager Dr. Persa R. Bell and chief Manned Spacecraft Center scientist Dr. Wilmot N. Hess, in unison. "For earth scientists and planetologists," declared MSC's Dr. Robin Brett, as Warren cut through the inner plastic bag enclosing the rocks, "this is a very, very exciting time."

The first sight of the rocks brought a letdown, however, as the entire rock surface, tantalizingly out of reach within the cabinet, was covered with an opaque, black powder, apparently acquired in transit. "Sort of the 'shake and bake' method," said one observer.

"It was a rather disappointing experience," recalls Dr. Clifford Frondel of Harvard. "I found that there was not a single mineral that I could identify," adds LRL curator Dr. Elbert King, "and being a mineralogist, I find that somewhat embarrassing."

Seismometer and reflector on moon.

As more and more scientists looked at the rocks, however, their secrets began to unfold, until little more than two days after opening the first rock box, a fair working background had begun to emerge.

Generally, the scientists agreed that most of the rocks are igneous, formed by heat, either of internal pressure or of meteor impacts, or perhaps of volcanic activity. Many samples are rich in tiny cavities caused by expanding gas, essentially fossilized bubbles. After much discussion, in fact, Dr. Eugene Shoemaker of the California Institute of Technology finally declared that "the evidence is overwhelming that the mare are built up by lava flows." Such activity may have been so recent that the surface of Mare Tranquilitatis, where Apollo 11 landed, may be less than 500 million years old—a significantly short time compared to the estimated four-or-five-billion-year age of the earth. Even Dr. Harold Urey, for 20 years a staunch minority in favor of a nonvolcanic moon, admitted that it might be time to reconsider.

Chemically, the moon rocks were seen by the LRL researchers as a gratifying confirmation of the findings of Surveyor 5, 6 and 7 that the moon consists largely of silicon-rich basalt similar to earthly rock. Spectroscopic analysis of a tiny 50-milligram fragment by Dr. Ross Taylor of the University of California at Berkeley indicated 49 percent silica, 12 percent iron, 12 percent calcium, 10 percent alumina, 8 percent magnesium, 7 percent titanium oxide and traces of nickel, similar to those in earthly basalt.

A surprise is the relatively high amount of titanium, reportedly at least three times as great as that in even the rarest earthly basalts. Yet the unusual abundance seems to have been confirmed by the original Surveyor experimenter, Dr. Anthony Turkevich of the University of Chicago, who recently refined and corrected his data to produce the higher figure. Though the Apollo 11 sample may prove not to be representative of the average mare material, the unearthly amount of titanium could pose a problem for the theory that the moon was torn from the earth's side, or even that the two bodies were formed simultaneously.

The most unusual discovery in the LRL rocks so far, however, has been the abundance of tiny, glassy beads, ranging in size from microscopic to a few tenths of an inch, and in color from yellow to brown to clear. The surprise, says Dr. Shoemaker, is not that there are beads, but that there are so many. The beads, he believes, were formed by the liquefication and then hardening of material thrown up from the silicon-rich surface by incoming meteorites. Micrometeoroids constantly bombarding the moon from space ought to break up most of this glass, but since the beads are so plentiful, he reasons, there must be less dust in interplanetary space than previously believed.

Dr. Frondel believes the beads are condensed out of surface materials burned into a gas by the impact of the meteors. "Nope," says Dr. Shoemaker. "Zero chance."

If the surface material were vaporized, he says, the gas molecules would have so much energy that they would escape into space rather than condensing and falling back onto the surface in such large numbers.

More light will be thrown on this and other questions in the remaining weeks of analysis in the LRL and later by the 142 principal investigators, most of whom, it now appears, will get roughly the sort of sample they desire. In the words of the National Aeronautics and Space Administration's Dr. William Greenwood, "It's like a book with many chapters." ◇