
". . . the heavens have become a part of man's world."
—President Richard M. Nixon, July 20, 1969.

Until Galileo brought it closer, the moon had always been a featureless ball of light in the sky. Since his day, it has been a craggy sphere of craters and mountains, but a still tantalizingly unattainable goal, separated from earth by 240,000 empty miles, part of an alien universe that has looked imperiously down on man like a microbiologist considering the puny life forms in a drop of water.

Now the moon is man's. The incredible accomplishments of Apollo 11 have changed it irretrievably in the eyes of human kind.

Like all journeys into the unknown, Apollo 11's epochal flight began on well-traveled ground. Another painstakingly detailed countdown. Another brave and well-drilled team of astronauts. Another launch from Cape Kennedy, honed to perfection and only three-fourths of a second off the mark. Another ascent into space and even the flight to lunar orbit, already the third of its kind, flawless almost to the point of monotony.

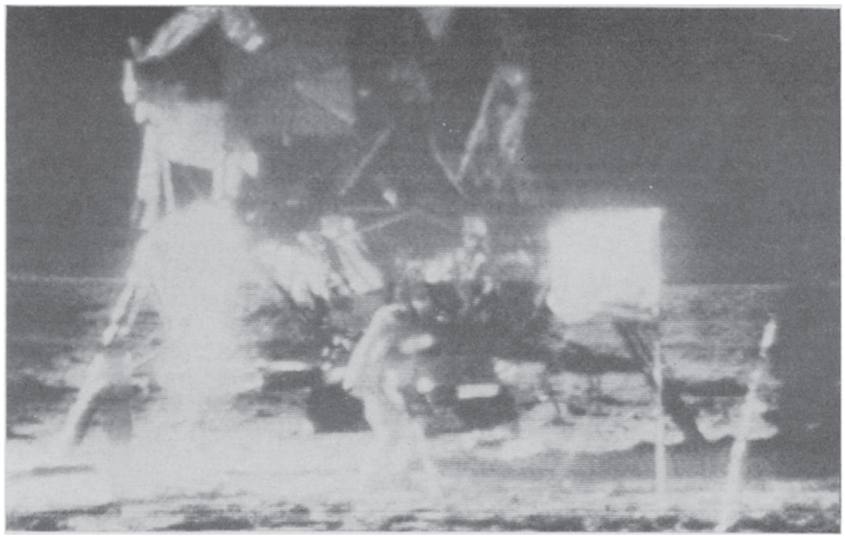
As with Apollo 8 in December, (SN: 1/4, p. 7) and Apollo 10 in May (SN: 6/7, p. 547), the spacecraft's main engine performed to within a fraction of a second, slowing the vehicle so it would be captured by the lunar gravity. Thus, Neil Armstrong, Edwin (Buzz) Aldrin and Michael Collins became committed to the moon, at 1:26 p.m. EDT on July 19, with some 28 hours remaining until one of the most momentous milestones in the history of man.

The wait was anything but monotonous. In their first lunar orbit, in fact, the astronauts apparently saw one of the strange fleeting transient events on the surface which had been intriguing astronomers for years. As the earth men peered down at the alien world below them Aldrin suddenly cried out, "Hey Houston! I'm looking north up to Aristarchus now—and I can't really tell at that distance whether I am really looking at Aristarchus—but there's an area that is considerably more luminated than the surrounding area. It just has—seems to have—a slight amount of fluorescence to it."

Armstrong echoed that one wall of the big crater did seem to be more illuminated than the others. A possible explanation for the sudden brightness may have been earthshine—the light of the sun reflected from earth—but the astronauts did not seem to think so. "I am not sure that I am really identifying any phosphorescence," Armstrong reported, "but that definitely is lighter than anything else."

Almost half of the 700 transient lunar events reported in the past have been observed in Aristarchus, and this one was given added weight when a group of observers on earth, known as the Lunar International Observers Network, or LION, reported a similar sighting also in Aristarchus an hour later.

Theorists remain noncommittal about the mysterious observations, though proponents of a volcanically active moon wonder about a possible connection. Transients were sighted from earth during Apollo 10, but none were seen then by the astronauts.



Wide World Photo from NASA

Bringing back a portion of the moon: Neil Armstrong scoops up a lunar sample.

Almost exactly a day after reaching lunar orbit, Apollo passed its next big step. With Collins remaining aboard the command module, Armstrong and Aldrin separated from it in the spidery lunar module to begin the descent to the moon.

Down to 50,000 feet, the way to the moon had been pioneered by Astronauts Thomas Stafford and Eugene Cernan in the lunar module of Apollo 10. But the rest of the way would be where no man had gone before—the 10 most awaited miles in history. "You are 'go' to continue powered descent," radioed Houston's Mission Control Center, and the journey into the unknown began. "Hang tight," Armstrong said.

The task of navigating those last miles was a hairy one, in space parlance, even with all the equipment aboard the LM (dubbed "Eagle" to the command module's "Columbia") working perfectly. With about 2,500 feet to go, even the spacecraft's computer began feeling the strain, signaling with repeated alarm lights that it was being overworked.

At the last minute, with Eagle only a few hundred feet above the moon's Sea of Tranquility, Armstrong took over from the automatic guidance center to keep the spacecraft aloft slightly past the computer's chosen landing spot. "The auto-targeting was taking us right into a football-field-sized crater, with a large number of big boulders and rocks for about one or two crater diameters around us," he explained after. "It required . . . flying manually over the rock field to find a reasonably good area."

"We copy you down, Eagle" said Houston.

"Houston," said Armstrong, in the first human words spoken from another world, "Tranquility Base here. The Eagle has landed."

The landing site was a craggy badland, a "collection," reported Aldrin, "of just about every variety of shapes, angularities, granularities—every variety of rock you could find." From the astronauts' descriptions Tranquility Base was hardly the kind of site that space officials would have approved if they could have seen it in advance from close up. Fortunately, Eagle landed at a tilt of only four and one-half degrees from the vertical, a factor in ensuring a safe takeoff.

One disappointment, however, particularly to scientists waiting to learn everything possible about the rock samples the astronauts would bring back, was that no one knew precisely where Eagle had landed. "We were a little busy, worrying about program alarms and things like that in the part of the descent where we would normally be picking out our landing spot," reported Aldrin, "and aside from a good look at several of the craters we came over in the final descent, I haven't been able to pick out the things on the horizons."

Nor could Collins, orbiting overhead in Columbia, spot the lunar module, even when using the 28-power telescope of the command module's sextant. Analysis of rocket firings and other data enabled ground controllers to determine that Eagle was facing about 13 degrees to the right of its line of de-

scent, but even after preliminary study of the data tapes, the spacecraft's position could be narrowed down no farther than a circle about 6,000 feet across.

The most important item of business on the moon was to make sure that Eagle was in condition to leave again at any time. That done, the astronauts decided that the next item on the agenda following a meal, was a waste of time: The first men on the moon hardly felt like beginning their stay with four hours of sleep.

The two men thus began checking out their equipment, assembling their sample collection gear and getting ready for their historic walk on the surface of the moon.

Shortly before 11 p.m. EDT on July 20, with Aldrin guiding him out, Armstrong backed out through Eagle's forward hatch on his hands and knees.

He put his left foot on the moon at 10:56 p.m. EDT. "That's one small step for man," Armstrong said, "one giant leap for mankind."

After testing his mobility, Armstrong, in case some malfunction should necessitate a hasty departure, used a special scoop to gather a quick sample of lunar rock and stored it in a pocket of his spacesuit. "It's a very soft surface," he said, "but here and there where I plug with the contingency sample collector, I run into a very hard surface . . . it appears to be very cohesive material of the same sort."

Whatever the material is, samples of it have been the main scientific justification for the Apollo program. The astronauts seem to have found strong evidence for the moon's volcanic origins, a long-standing dispute among selenologists. Armstrong reported hard rock samples with vesicles, holes due to trapped expanding gases. He also described one that appeared to have "some sort of phenocryst," a large crystalline structure common in volcanic rocks, though also known in other igneous formations.

Armstrong then talked Aldrin down from the LM cabin. Examining the surface material himself, Aldrin reported what seemed to be a form of biotite, a dark, mica-like rock which on earth contains from two to four percent water. This water of crystallization does not necessarily mean there is any readily available water on the moon or any free water at all, but it might well indicate that in the moon's early history, water existed in the molten lunar magma.

Aldrin then erected one of the mission's three scientific experiments, a three-by-one-foot strip of metal foil unrolled like a home movie screen to capture particles from the solar wind. The screen was later retrieved for return to earth.

Armstrong spent considerable time gathering a large, though relatively unselective, bulk sample of lunar rock to enable as much scientific analysis as possible of the priceless material.

Aldrin then set up the second scientific experiment, a passive seismometer equipped with a solar-powered transmitter designed to report lunar tremors on and beneath the surface for two years. "We've been trying since Ranger to get a seismometer on the moon," says Dr. Wilmot N. Hess, scientific director of the Manned Spacecraft Center in Houston. The device, which could settle the question of whether the moon is still volcanically active, easily picked up the astronauts' footsteps, the impacts of their rock sampling tools and the thumps of equipment jettisoned from the LM cabin before departure.

Unfortunately, however, reportedly because of a difficulty with a ground station, data from the seismometer were not being received when they could have been used to confirm the arrival of another visitor to the moon: the Soviet Union's unmanned Luna 15, launched the day before Apollo and predicted by some observers to be an attempt to gather a moonrock sample and return it automatically to earth. The Soviet probe apparently crashed about 500 miles northeast of Apollo in the Sea of Crises.

The seismometer, although operating, was seriously overheating after two days; it appeared that it might not survive the lunar noon.

The other experiment is, essentially, nothing but a mirror carefully aimed at earth.

The laser beam reflector will enable scientists to measure the distance between the earth and moon down to six inches.

The unique reflector is made up of 100 quartz retro-reflecting prisms specially designed to reflect the light directly back to its source. Because the speed of light is known and can be measured down to nanoseconds (billionths of a second), it is possible to find the distance between the reflector and light source by measuring the exact time it takes for the beam to make the round trip—a journey of some two and one-half seconds.

The laser beam source in the experiment's initial phase is the Lick Observatory's huge 120-inch telescope near San Jose, Calif. Even before the astronauts returned to their lunar lander, scientists at Lick were firing a pulsed ruby laser through the telescope toward the laser reflector. They failed to hit the reflector in their first tries but felt this was because the lunar landing site was not yet precisely known. Observatory director Robert Kraft said there was also a chance the blast from the lunar module may have tipped the reflector over.

The laser beam reflectors will also help clarify whether the force of gravity, which holds the moon, in orbit, is slowly diminishing, as a present theory suggests. If the theory is correct, the laser will detect the moon's orbit increasing by an extremely small fraction each year.

By using the moon as a reference point, the wobbling of the earth on its own axis (called Chandler's wobble) can be studied. And, because earthquakes appear to be related to Chandler's wobble, a greater understanding of the wobble could lead to scientists' predicting earthquakes.

The experiments deployed, the astronauts set about gathering a group of carefully selected samples intended to be as well-documented and diverse as possible. Coring tubes hammered into the lunar ground were used to extract material from below the surface; other samples were placed in special containers for analysis of any gases they might give off.

Geologists on earth, however, while elated about the prospect of a first-hand study of another world, are less than content. The lack of an accurate known position for Eagle means that the samples can never be precisely related to the area from which they came. In addition, the core samples were gathered from areas where the astronauts had already walked, mixing and compressing the potentially revealing layers of lunar material.

After more than two hours on the lunar surface, the astronauts returned to the LM, shared a short, fitful rest and prepared to leave the moon. The ascent into lunar orbit, where Collins awaited, began and continued in the same almost flawless style as the outbound trip to the moon.

With all three astronauts once again aboard Columbia, the command module left lunar orbit on schedule for the Thursday splashdown in the Pacific. There the three were to encounter a strange combination of heroes' welcome and plague-bearers' quarantine. Sealed in a specially built isolation van the astronauts were to arrive Sunday in Houston for three weeks of incarceration in the Lunar Receiving Laboratory, with scientists in the LRL, designed to protect both the samples from earthly contamination and the earth from potential lunar germs.

Next is Apollo 12, now scheduled for November, with Astronauts Charles Conrad, Richard Gordon and Alan Bean. They could spend up to three days on the moon, including more than twice as long outside the LM, and will deploy a more elaborate array of experiments.

Right at home

NASA

Dr. Berry: Maybe longer next time.

"Walking on the moon is very comfortable," Neil Armstrong casually declared as he bounced around the lunar surface. And, though he admitted he had to be careful that his feet were beneath him, the first man on the moon did not fall over (some scientists had feared that the moon's gravitational field, one-sixth that of the earth's, would be too weak to stimulate the balance mechanism in a man's inner ear) and did not float away.

Neil Armstrong and Edwin (Buzz) Aldrin have proved that man can go to other worlds.

"My opinion was that they moved about easier and had more stability and everything than I might have thought," flight director Clifford E. Charlesworth said after Armstrong and Aldrin completed their moon walk. Cavorting about in the lighter gravity posed no unanticipated problem. Nor, in fact, did anything else. If anything, those watching over man on the moon found he performed even better than they had hoped.

Said Dr. Charles A. Berry, the astronauts' chief physician, "I couldn't be happier with their physiological state. It's phenomenal." What Dr. Berry called "beautiful data" showed that neither Armstrong nor Aldrin expended dangerously high amounts of energy, that neither overheated—inside the bulky space suits the temperature stayed near 68 degrees F., while outside it varied from minus 150 degrees in the shade to 40 to 90 degrees in the sun—that glaring sunlight did not cause even temporary blindness, and the heart rate never exceeded safe limits.

"However, Neil was working pretty hard at the end of the walk when he was loading rock samples aboard the LM," Dr. Berry said. "His heart rate hit 160 for 12 minutes. It would have been bad for him to keep that up for long. He was getting short of breath." Aldrin's peak heart rate was 125 beats per minute. Even on earth it is normally lower than Armstrong's.

"Things went so well," says Dr. Berry, "it is possible to consider a longer moon walk on Apollo 12, scheduled to fly in November, though no decisions will be made until all biomedical data are evaluated after splashdown. Nor have we any plans now to add additional biomedical tests in flight." While heart rate, blood pressure, heat expenditure and oxygen uptake are measured in flight, highly specific biomedical readings including possible loss of red cell volume, muscle protein and bone calcium have yet to be taken (SN: 7/19, p. 61).

According to Charlesworth, "The biomedical instrumentation was very outstanding. We had a moment of fright just before going EVA (Extra Vehicular Activity) in which we felt that we were beginning to lose biomedical data . . . but as soon as they got outside of the LM the data cleared up and we had good data throughout the EVA. It must have been some type of an electrical interference inside the LM itself. The crew performed just about as expected and just about what our predicted metabolic rates were for the various activity phases of the EVA. They were right on normal."

The one feature of life on the moon that was less than perfect was sleep, or more appropriately, the lack of it. Though the astronauts had Seconal on board they never took it, nor any other drugs. After getting plenty of rest prior to the moon landing, enough, in fact, to push the moon walk four hours ahead of schedule with Dr. Berry's blessing, sleep in the cramped LM quarters was almost impossible on the moon. "Man's first sleep on the moon was not drugged and it was lousy," Dr. Berry observed. "Their maximum sleep was one hour to one hour and 15 minutes." Orbiting above in the command ship, Michael Collins slept soundly.

None of the data accumulated so far from Apollo 11 proved that man can live for long periods in space. Nor will it. But, there is no evidence that he cannot. And, in any case, he can go back to the moon. ◇

A MOTE UPON TWO SEEDS

What has happened to awe?

Perhaps it has simply become unfashionable, uncool, or perhaps because it leaves a man exposed and small, men have learned to cover it up.

In any event, it is a delicate quality, easily lost in our sophistication or trampled beneath the quick shoes of technological progress. And it is an abiding frustration to a writer that the quality of awe is so difficult to preserve on the printed page as anything more than a pretty—or petty—clustering of adjectives.

The awe of man's reaching the moon is not in the deafening roar of a skyscraper-high rocket atop a pillar of fire, nor is it the prodigious size and shape of the Apollo program, nor even in the vision of Neil Armstrong and Buzz Aldrin risking their lives in the tradition of Columbus and Vasco da Gama. These, even these, are details, nuts and bolts—the details that the intellect must have for realization, but insignificant next to the scope of the event itself.

This incredible event, dreamed of for uncounted thousands of years, should seem as cosmically significant as it is. To the U.S. space program, or even to the 20th century, it is a mere technological triumph, a scientific coup such as Sputnik I or the Salk vaccine. But it is a truly awesome mark on the total timeline of mankind.

To really know what man has wrought, you must disencumber your mind. Be a caveman, with no more thought of space travel than of splitting the atom, and try to feel the aching human distance between earth and moon. It is far greater than the usually given 240,000 miles.

Be an early Egyptian, the moon no more attainable than Ra or Isis.

Then imagine earth, a microscopic seed in the universe, and man, a tiny mote upon the seed. How presumptuous to reach across time and space from one seed to another.

Try, briefly, to ignore the flashy rockets and the heroic astronauts. Try to feel the smallness of man and the vastness of what he is doing.

After two million years, man has stepped out of his world onto another. And, by incredible fortune, we are alive at the instant he did it.

—Jonathan Eberhart