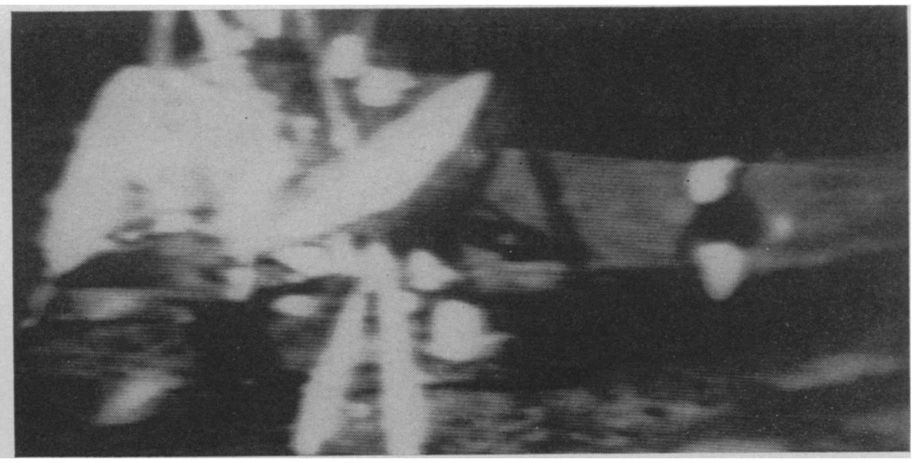


Mitchell drops to the surface only moments after Shepard fulfilled his long-sought goal of walking on the moon.

science news

OF THE WEEK

Man's third lunar landing: More time for science

Despite some difficulties, the Apollo 14 mission was undisputedly a great success

It was, in space lingo, a "go, no go" situation every mile of the way to Fra Mauro—from the launch to the first leap by Apollo 14 Commander Alan B. Shepard onto the hilly moon surface to the engine firing that propelled them on the trajectory back to earth.

"It's been a long way, but we are here," Shepard said as his feet touched the moon. And it had been. Not only for the National Aeronautics and Space Administration, which had tried once before to land astronauts at Fra Mauro in the unsuccessful Apollo 13 mission, but also for Astronaut Shepard, who had worked 12 years for this shot at the moon.

The 109-hour journey to the lunar surface was a master lesson in real-time solutions to problems which, if unsolved, could have aborted the flight.

But Apollo 14 was a success. From the nearly pinpoint landing within yards of the target on an eight-degree slope ("There was not a smooth place anywhere near the site," says Shepard), to the South Pacific splashdown at 4:05 p.m. EST Tuesday only 5 mi es from the waiting carrier New Orleans.

Throughout the difficulties the crew, whose roles rapidly switched back and forth from pilot to engineer to geologist to physicist, remained undaunted. When they were not flying or unraveling computer kinks, they were eager scientists anxious to ascertain new knowledge.

They began their geological descriptions of the lunar terrain even as they entered lunar orbit; they resumed only minutes after touchdown and the verbiage continued, except during sleep, during their 33 hours on the surface.

Of more than 215 lunar surface tasks related to setting up the scientific station and attempting their geological field trip, Shepard and the lunar module pilot, Edgar D. Mitchell, completed all but nine (all of which were secondary) in a breathless and hurried 9 hours and 19 minutes outside the LM.

The climax of their exploration came during their second surface period on a mountain climb toward the coveted rim of Cone Crater (SN: 1/23/71, p. 66). For 45 minutes they maneuvered in their bulky suits pulling or carrying their tool cart over the undulating surface around craters and through a field stewn with boulders, some as large as 45 feet long and 12 feet high. Time after time as they thought they had almost reached the elusive rim, or at least had it in sight, they were dismayed to see another crest still higher.

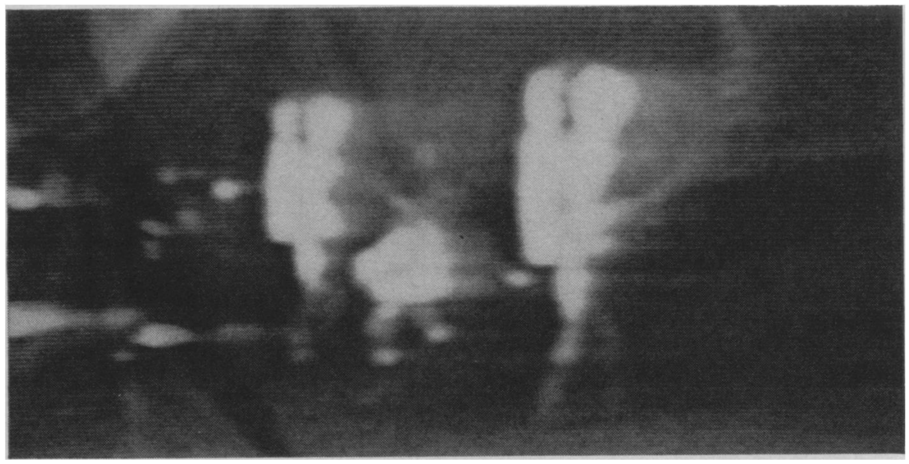
"A major problem was the undulating terrain," says Astronaut Mitchell. "We simply could not see more than 100 feet ahead." The two were stopped about 300 feet short of the rim by ground control, "It was just a matter of working against the clock," says Shepard of their frustrating climb. "Although it was a disappointment as a matter of challenge not to get up there," says Mitchell, "I feel we accomplished the scientific objectives."

The primary scientific objectives of Cone Crater lay in the area where the men turned back, in the boulder field that rims the crater. It was these boulders, originating from deep within the crater, that scientists wanted to sample.

A rock from one particular boulder could be just what the scientists ordered. The fractured boulder appeared light brown on the outside and white on the inside. Scientists have dated one type of very old lunar material called KREEP (SN: 1/23/71, p. 61) from the Apollo 12 samples at 4.6 billion years old. Some of the KREEP material is white igneous rock. The rock the astronauts bagged could be KREEP or it could be "any one of a range of gabbroic type rocks which have high percentages of plagioclase," says Dr. William Phinney, chief of the geology branch of the Manned Spacecraft Center. "That could include anorthosites." Plagioclase is one of the most common rock-forming minerals. Lunar anorthosites are thought to be part of the ancient lunar crust. Both gabbroic and anorthositic rocks were found in the Apollo 12 samples.

In addition to the promising white rock the men selected some 34 other rocks, including 4 or 5 relatively large ones and the specially requested football-size rock, which actually measures

Setting up ALSEP experiment pack.



Shepard's golf shot concludes a fatiguing excursion to area of Cone Crater.

about a foot in diameter. They took several core tube samples and dug a trench some 18 inches deep that revealed—to the joy of the scientists—three definite stratification layers. In all the two men were returning to earth with about 96 pounds of lunar soil and rock.

Because of the time-consuming mountain climb, several later stops on the traverse had to be deleted, such as Flank Crater, which the men were never sure they saw anyway. On the first EVA (Extra Vehicular Activities outside the LM) the ALSEP (Apollo Lunar Science Experiment Package) took longer than expected to set up. So the crater formation Doublet, to the north northwest of the LM, was bypassed. As a backup effort, however, the astronauts on their second EVA passed by and sampled areas around Triplet Crater to the east southeast of the LM.

The crowded time line on the surface was not their only frustration. In addition to the earlier problems with docking (SN: 2/6/71, p. 97) and with the lunar module battery, other difficulties on the way to the moon, some more serious than others, kept cropping up. Several lunar revolutions prior to the actual descent, an abort switch that controls the LM during powered descent was found to be faulty. If space officials, aided by engineers from the Massachusetts Institute of Technology, had not been able to come up with a new real-time computer program to circumvent the signal, the electronic spook could have caused an unintentional abort while the spacecraft was in descent to the moon.

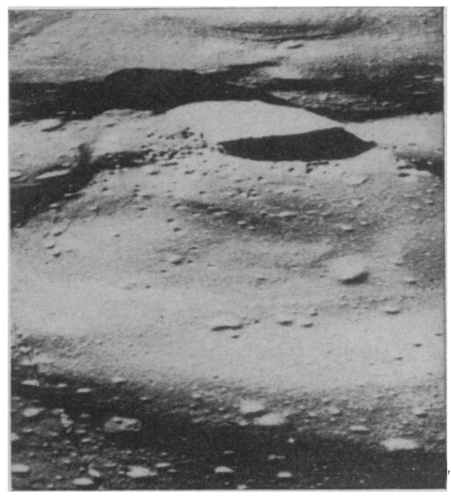
Another landing quirk that temporarily accelerated some pulses on earth was in the landing radar. It did not lock on: It was about a minute late.

Other problems, not as serious, slowed the astronauts emergence onto the surface. They were delayed an hour by communications problems after putting on their lunar surface suits. Mitchell's suit developed a slow leak, and his surface glove was less than perfect. Command module pilot Stuart A. Roosa also had his share of frustrations with a malfunction in a sophisticated high-resolution orbital camera with which he was to photograph a candidate landing site.

And to cap it off, minutes after liftoff from the moon, the secondary guidance and navigation system called AGS (Abort Guidance System) went out. It was the same system the spacecraft had had to rely on during descent. Fortunately the failure during ascent occurred late enough to avoid a major problem. The crew, at least from ground observations, was unruffled over all these hurdles, and in an air-to-ground space press conference Monday night, Mitchell said of their problems, "I never doubted for a minute we were going to make it."

The scientific fallout from Apollo 14 made it all seem worthwhile. The first data came the day before touchdown with the impact of the Saturn S4B stage some 167 kilometers south southwest of the Apollo 12 passive seismometer.

Then on Sunday after the crew had set up on the moon the ALSEP 4, which scientists describe as the best scientific station to date, and was safely back in orbit, the LM ascent stage was crashed into the moon to obtain another reading on the seismometer. "For us the LM impact represents a new milestone in geophysical exploration of the moon," says Dr. Gary Latham of the Lamont-Doherty Geological Observatory. "It is the first event, manmade or natural, to be recorded simultaneously by two geophysical stations." The LM impact was about 70 kilometers from the new Apollo 14 station and about 117 kilometers from the Apollo 12 station. The signal from the S4B impact lasted about three hours; the LM signal, about one and one-half hours. The seismic signals were again of the very long reverberation character observed



NASA simulation

Crater's slope slowed the astronauts.

on previous impacts—a ring builds up and then decays (SN: 11/29/69, p. 493). Dr. Latham believes the scattering is produced by a highly heterogeneous upper structure, like a jumble of blocks. At least the upper few kilometers are very broken-up material, and the fragmentation may continue down 35 to 40 kilometers. "We find no evidence," he says, "of a major boundary similar to the base of the earth's crust to those depths."

The LM impact was picked up not only by the passive seismometer but also by other sensitive instruments in the ALSEP station, such as the charged particle lunar environment experiment (CPLEE) and the suprathermal ion detector experiment (SIDE). According to the principal investigator of the CPLEE, Dr. Brian J. O'Brian of Australia, the instrument detected the impact only 50 seconds after the event some 70 kilometers away. "Prior to impact the CPLEE experiment was quietly seeing low-energy electrons," says Dr. David Reasoner of Rice University. "Suddenly," he says, "the ion and electron fluxes increased from a factor of 10 to a factor of 50 above the original background level. The energy range was 50 to 200 electron-volts. The cloud of electrons and ions was thus traveling across the lunar surface at a velocity of some 18,000 miles an hour.

The SIDE experiment, in addition to detecting the LM impact, picked up gases in the LM area from the astronauts' suits and from the LM itself. But the Apollo 12 SIDE, which is still operable, had an even more dramatic role, says Dr. John Freeman of Rice University. "It said both hello and goodbye to Antares." About six and one-half minutes after the lunar module Antares' ascent engine ignited, the Apollo 12 instrument picked up ions from the rocket exhaust. The question facing scientists working with these experiments is how do these electrons and ions become accelerated to the high energies seen on the instrument. The answer could give insight into earth phenomena such as the Van Allen radiation belts and the auroras.

The cold cathode gauge also immediately began sending back data to earth. All of these instruments, which measure the lunar atmosphere or the solar wind or electrons and ions about the lunar surface, will have to go through a period of settling down before actual scientific data can be taken.

The active seismometer, however, yielded data during the astronauts' first walk on the surface. Thirteen of 21 small explosive thumper charges were successfully fired by Mitchell. Says Dr. Robert Kovach of Stanford University: "We were surprised that our signals [from the active seismometer] did not ring quite as much as we would have guessed based on the past passive seismic results. They were closer to what we have observed on earth." The velocity was surprisingly low, down to a depth of about 50 feet. "We did not see what we thought would be a major solid surface."

The portable hand magnetometer revealed another remarkable fact about the new site. It measured a magnetic field at the moon surface at two locations—one of 101 gammas close to the LM, the other of 42 gammas near the rim of Cone Crater. This compares to the 37-gamma field at the Apollo 12 site. "This tells us," says Dr. Gene Simmons of MSC, "the magnetic field of the surface of the moon varies spatially."

Of the moon landing Commander Shepard says, "Apollo 14 has been a smashing success, but I don't really think we will be able to assess at this point what the contributions will be." The scientists agree that it was a success. Dr. Paul Gast, chief of lunar and earth sciences division at MSC, and other scientists who came to MSC during the flight were all grins over the operation of the new station and over the fact that the astronauts had been able to return to the station right before they entered the LM to realign the antenna to improve telemetry strength. Dr. Gast says of the Apollo 14 feat, "The astronauts' capability as field geologists on the lunar surface should not be sold short. Their only limit was time." And Dr. Robin Brett, also of MSC, summed up the nine days this way, "Every time a new crew goes to the moon, it is always exciting and surprising."

Apollo 14 was no exception. □

ENVIRONMENT MESSAGE

Leadership on land

Since World War II, the real estate business has boomed as houses, highways, shopping centers and other uses of land have proliferated in response to a growing and increasingly affluent population. The result in many instances has been ugliness and waste. Land-gobbling freeways have been built through rich agricultural valleys instead of on the less tillable hillsides. Garish commercial strips have blighted new suburban developments. Forests and shrubbery have yielded to bulldozers clearing space for new subdivisions. Zoning laws have often been weak and ineffective—or easily manipulated by real estate interests. And Adam Smith economics have been the primary ruling force in land use decisions.

Just as President Nixon's Keynesian 1972 budget was an unexpected departure from traditional Republican fiscal policies, so his second annual environmental message this week is a major departure from the usual Republican attitude of hands-off business—especially in the area of land use. "Our goal must be to harness the powerful mechanisms of the market place, with its automatic incentives and restraints, to encourage improvement in the quality of life," the President said. But despite this lip service to free enterprize, what really is envisioned in the message is a major shift toward government planning.

The President proposed legislation for a national land use policy which would "encourage the states, in cooperation with local government, to plan for and regulate major developments affecting growth and the use of critical land areas." The program would spend $100 million in Federal funds over the next five years to assist the states in land use planning. More important, the President said that steps would be taken through executive action "to assure that federally assisted programs are consistent with the approved state land use programs." Since nearly every new land use development receives Federal assistance of one kind or another—from Federal Housing Administration insured loans for home buyers to Environmental Protection Agency grants for sewers—this control mechanism could be a powerful Federal weapon against reckless development. The land use proposal was the major new initiative in the President's message. But earlier proposals were strengthened, or extended, in what environmentalists see as a message which recognizes the realities of a deepening environmental crisis. Among its other proposals:

- An emission charge on sulfur oxides.
- Doubling of Federal funds for sewer and sewage treatment construction.
- Streamlining of pesticide regulation.
- Regulation of toxic substances before they are placed on the market.
- Regulation of noise pollution.
- A number of other land use proposals, including an urban parks program, preservation of historic buildings, expansion of the wilderness system, regulation of power plant siting and regulation of the environmental effects of surface and underground mining.

Most of the proposals will require Congressional action. At a press conference this week, Russell Train, chairman of the Council on Environmental Quality, Interior Secretary Rogers C. B. Morton and EPA Administrator William D. Ruckelshaus told newsmen that the proposals are not just broad generalities; they have been spelled out in detail in 300 pages of proposed legislation, most of which will go to Congress this week. □

SYMMETRIC FISSION

Over or around the hump

That nuclear fission can occur has been repeatedly demonstrated. How it occurs is still a subject of investigation after 30 years.

One of the first pictures of nuclear fission put forth was the liquid-drop model suggested by the late Niels Bohr. He proposed that the matter of a nucleus was a kind of uniform fluid and that a fissioning nucleus was like a drop of liquid that had become too large for its surface tension to hold in a spherical shape. Gradually it deformed itself until it split into two.

Liquid drops split symmetrically into two equal parts. But nuclei that fissioned did so asymmetrically, into unequal parts. So the original liquid-drop model appeared less than adequate.

Nevertheless, at the annual meeting of the American Physical Society in New York last week—a meeting that nowadays seems noteworthy more for politics than science—the discovery of symmetric fission of the sort envisioned