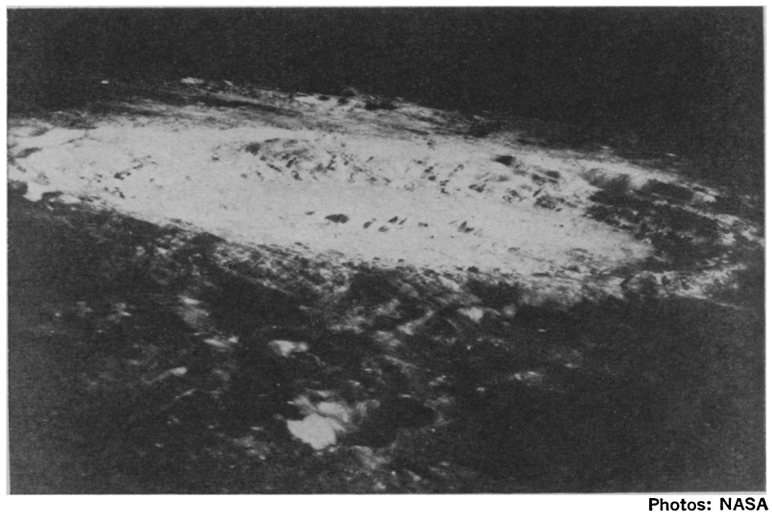
Man's return to the moon

A second attempt at a landing in the Fra Mauro region promises insights into the moon's history

by Everly Driscoll



Photos: NASA

Ejecta from crater Copernicus appears throughout Fra Mauro region.

When Apollo 14's giant Saturn 5 with its nearly 8 million pounds of thrust rumbles off the pad at Cape Kennedy on Jan. 31, the U.S. will have launched its second crew toward the much coveted geological area of the moon, Fra Mauro (SN: 4/4, p. 353).

With Astronauts Alan B. Shepard, Stuart A. Roosa and Edgar D. Mitchell will go emotions ranging from joy and anticipation to anxiety. More than nine months have elapsed since the deep-space eruption on April 13 that aborted Apollo 13 (SN: 4/18, p. 387) —the first mission to aim for Fra Mauro.

The fact that something unforeseen had indeed happened in space shook the National Aeronautics and Space Administration to the depths and threatened the future of manned lunar exploration in this decade. Now the spacecraft machinery that was once thought to be fail-safe after the near perfect flights of Apollos 8 through 12 will again have to prove itself. And the tried-and-proved Apollo team that guided the tattered Apollo 13 back to earth will again be on the front line.

NASA is placing high stakes on Apollo 14. Only three of what originally were to have been six Apollo missions after Apollo 14 still remain in the schedule; their future depends on the extent of Apollo 14's success.

To insure that success and optimize the scientific return, the spacecraft has been modified, equipment has been added and the astronaut schedule has been altered.

The spacecraft changes are a direct result of the Apollo 13 near tragedy. When an oxygen tank exploded and left the spaceship's command module without power, the astronauts had to rely on the lunar module for electricity, heat and water on the way home. Had the LM already been jettisoned, the result would have been fatal. To avoid such a disaster this time, redundant systems, including a third back-up oxygen tank, have been added to make the command module independent of the LM. Should all three tanks fail, the crew could still get back to earth: An extra battery that can supply 400 ampere-hours of electricity will be available. And for the astronauts, 40 extra pounds of potable water will be stowed in the command module.

These and other improvements, costing about $15 million, should buy a safe trip back to earth for the crew under conditions described by Mission Director Chester M. Lee as "worse case"—a failure in the command module while the lunar module is on the surface.

The delay of the launch by three months has resulted in extra crew training. Although every Apollo team spends hundreds of hours in spacecraft simulators responding to contingencies of every kind, Apollo 14's may hold the record. Astronaut Roosa will have spent close to 1,000 hours. Shepard and Mitchell have similar records for LM time, pressurized suit and extravehicular activity (moonwalk) practice. Their "contingency checklist"—what to do in case of trouble—says Roosa, "is about the size of the Montgomery Ward catalogue."

Another change is the result of a health lesson learned from Apollo 13: a three-week preflight quarantine for the crew. A few days before Apollo 13 lift-off, command module pilot Thomas K. Mattingly had to be grounded due to exposure to rubella, and back-up pilot John L. Swigert substituted.

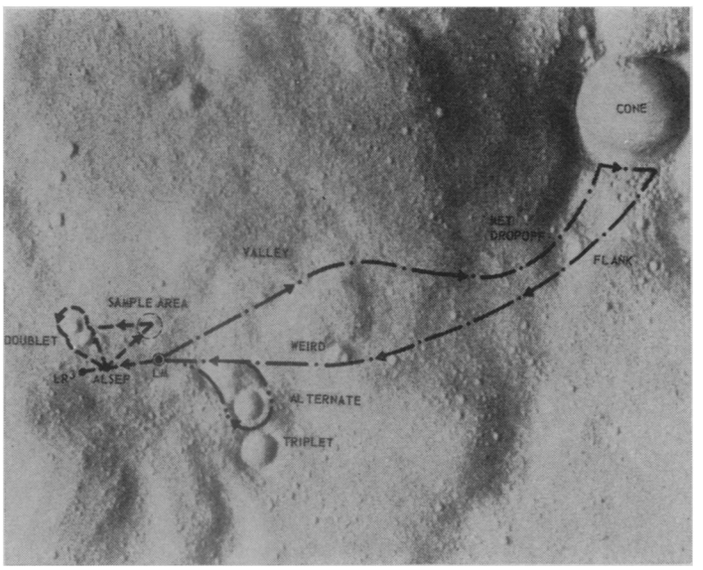
The mission duration has been shortened by one day as another safety precaution. This eliminates the extra 24 hours in orbit after the lunar module again docks with the command module (SN: 1/2, p. 2).

The commander of the sixth manned voyage to the moon, Alan B. Shepard, has waited 12 years for this trip. It was nearly 10 years ago, on May 5, 1961, that Shepard became the first American in space aboard Freedom 7, for a 15-minute, suborbital flight. For command module pilot Roosa and lunar module pilot Mitchell, this will be the first space trip.

The target for their flight is the same as that for Apollo 13, but the touchdown spot itself has been moved to what appears to be a smoother area about 400 feet to the south of the original spot.

The Fra Mauro region survived as the landing site because of its anticipated wealth of geological information about the history of the moon. The two- to four-mile radius that the men will explore is some 80 kilometers north of the ancient Fra Mauro crater for which the area is named. The entire Fra Mauro formation is a hilly range that extends radially southeasterly from the rim of Mare Imbrium basin. Geologists believe that the range was formed by ejecta from the impact that carved out the 700-mile-wide circular basin. Some of the ejecta could be from as deep as 100 miles within the moon. The ejecta blanket, deposited over the original Fra Mauro material, is characterized by braided, ridgy, hummocky knolls and smooth surface textures. The depth of the ejecta becomes thinner as it extends away from the basin rim to the south.

After this material was deposited, much of it was then buried again by ejecta—perhaps volcanic—from primary and secondary craters. Debris from the crater Copernicus, a relatively young, large crater near the rim of Imbrium basin, appears throughout the formation. Then on top of all of this is the rather thin veneer of unconsolidated particulate debris called the lunar regolith. Geologists believe



In two periods of four to five hours each on the lunar surface, the moonwalkers expect to travel a total of more than two miles.

Mitchell, Shepard in LM simulator.

that material representing this great diversity of events and ages could be found near the landing site.

Recent changes and some planned additions to the surface equipment will allow Astronauts Shepard and Mitchell to make the most of their 8 to 10 hours on the lunar surface. Cone Crater, about a mile from the intended landing spot, is of high priority. The crater is estimated to be from 300 to 400 feet high and 250 feet deep. Around its rim are boulders, some as large as automobiles, that geologists believe to be very old material from deep within the crater. Aided by their two-wheeled cart, which will carry their supplies and tools, and by added emergency oxygen in their life-support systems, the astronauts will walk the mile to the crater and attempt to go to the rim and sample the boulders.

Other targets for documented sampling include a valley area and two smaller crater formations—Doublet and Triplet. Shepard will attempt to land the LM, Antares, between these crater formations.

Other differences from Apollo 13 are in the surface science. If all goes as planned, the astronauts will set up the scientific package, ALSEP (Apollo Lunar Science Experiment Package), about 300 feet to the west of the LM. ALSEP-3 contains one new experiment which should yield extensive data about the multilayered terrain around the site—an active seismic apparatus. This device differs from the passive seismometer (which will also be deployed for the third time) in that it records seismic signals made intentionally by the astronauts. Three geophones, a geophone line, four grenades, a pole called a thumper containing 21 small explosive charges and the data tie-in to the central power station make up the seismic package. Astronaut Mitchell will place one geophone 10 feet from the central station and the other two spaced out at 150-foot intervals. Then he will walk back along the line. At 15-foot intervals he will arm and fire the thumper pole. The principal investigator for the experiment, Dr. Robert Kovach of Stanford University, will then be able to study the velocity of the shock through the moon and the damping of the vibrations as they travel through the lunar material. By knowing the location and time of the explosions, he and his colleagues should be able to determine the type of rocks at shallow depths in the moon.

The same geophones will be used to supply data on soil at greater depths when four rocket-propelled explosive mortars are activated sometime during the next year from ground control. Four grenades will be launched one at a time to explode on impact. The smallest grenade will contain 0.1 pound of explosive and travel about 500 feet; the others will have successively greater power and range, up to the fourth grenade, which will contain a pound of explosive and travel almost a mile.

Another new experiment on this trip is a portable magnetometer. It will be carried on the cart, the MET (Mobile Equipment Transporter). It will measure magnetic fields of plus or minus 50 gammas on one scale and plus or minus 100 gammas on another. This instrument has added significance since the discovery of a magnetic field of 35 gammas near the Apollo 12 landing site (SN: 11/28, p. 414).

Two other ALSEP experiments could be considered new on Apollo 14, although both have flown before. The charged-particle lunar environment experiment was flown on Apollo 13 and lost; the cold cathode ionization gauge was flown on Apollo 12 but quit working after a day on the lunar surface. Both could add considerably to the knowledge of Fra Mauro.

The CPLEE will measure the proton and electron fluxes from 10 to 70,000 electron-volts at the lunar surface, and study their energy distribution and time variations. It will also measure the solar wind particles directly and observe how they are affected by any lunar charges on the surface.

The cold cathode gauge is contained in the same packaging as the suprathermal ion detector. The Apollo 12 ion detector has been recording events for more than a year. The CCIG's potential has taken on added significance since recent activity has been observed in the Fra Mauro crater region. Some scientists believe outgassing occurs in this crater region as the moon is in its closest approach to the earth. The CCIG will be pointed in the direction of the crater and will measure pressure of any lunar ambient atmosphere down to a thinness of about a millionth of the earth's atmosphere.

About his expectations for the nine-day trip, Astronaut Mitchell says, "At this point in time I think we are only learning how to ask questions [about the moon].

"I would suggest," he says "that discovering everything we would like to know and need to know about the moon [in three or even] six landings is somewhat tantamount to trying to describe what the North American continent is by sampling it in six spots for just a few hours each."

Despite this gentle chide of those who perhaps tend to expect scientific miracles of each manned lunar flight, the astronauts have stressed their confidence in the improved spacecraft and the chances of a successful mission.

"We are happy to be getting into the air again as far as NASA is concerned," says Shepard. "Unfortunately, although we as pilots consider that Apollo 13 was a successful mission, there is a certain stigma attached to it and we hope Apollo 14 will be able to remove that." □