Apollo 17

At Taurus-Littrow

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Text by David A. Anderton

Preface

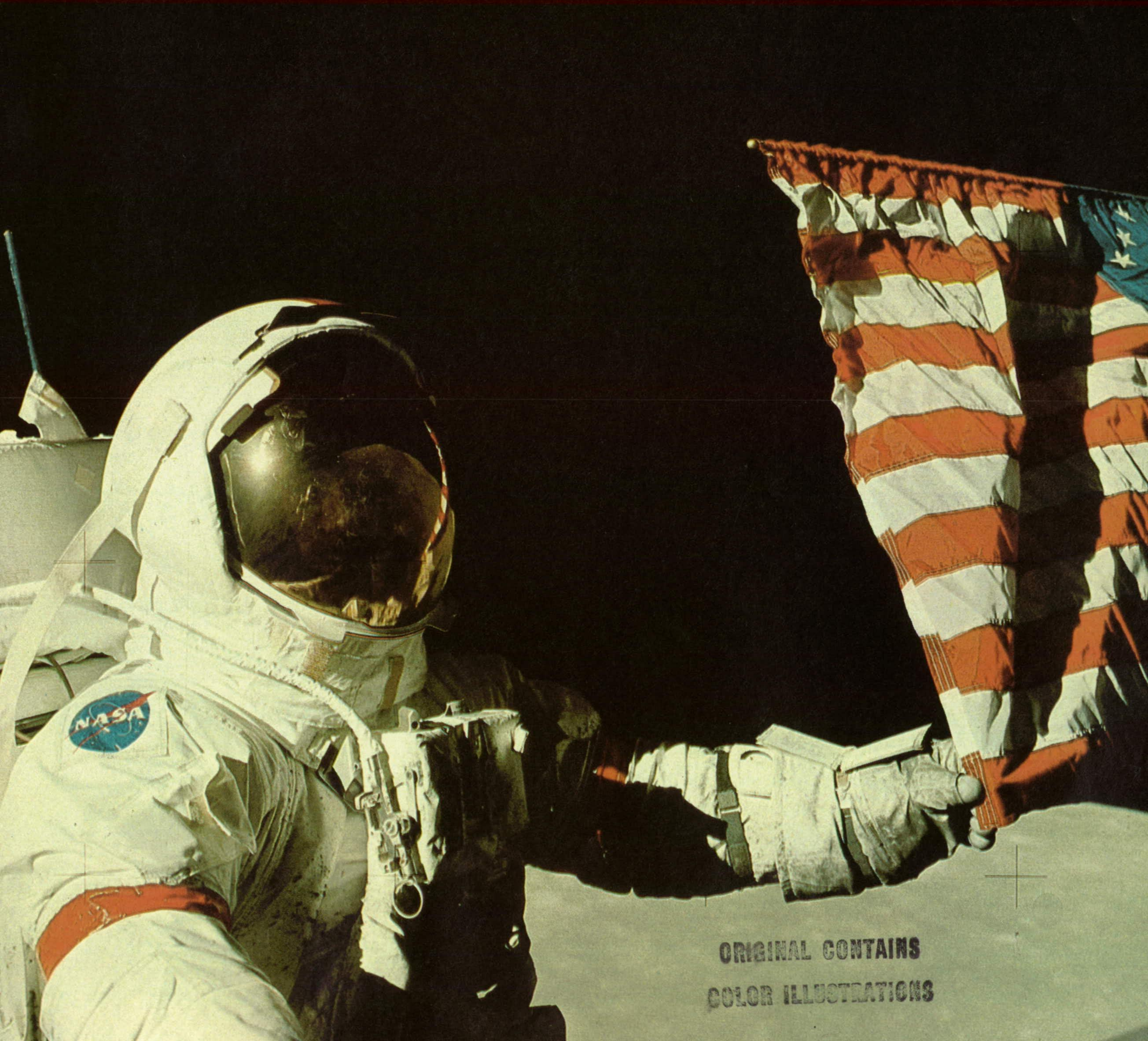
The Apollo 17 mission marked the end of the flight phase of lunar exploration. But in terms of analysis and understanding of the Moon, the Apollo 17 mission marked a point that was very near the beginning.

For the past three years, experiments placed on earlier Apollo missions have transmitted their measurements back to stations on Earth, sending dots and traces that slowly have drawn a picture of the Moon.

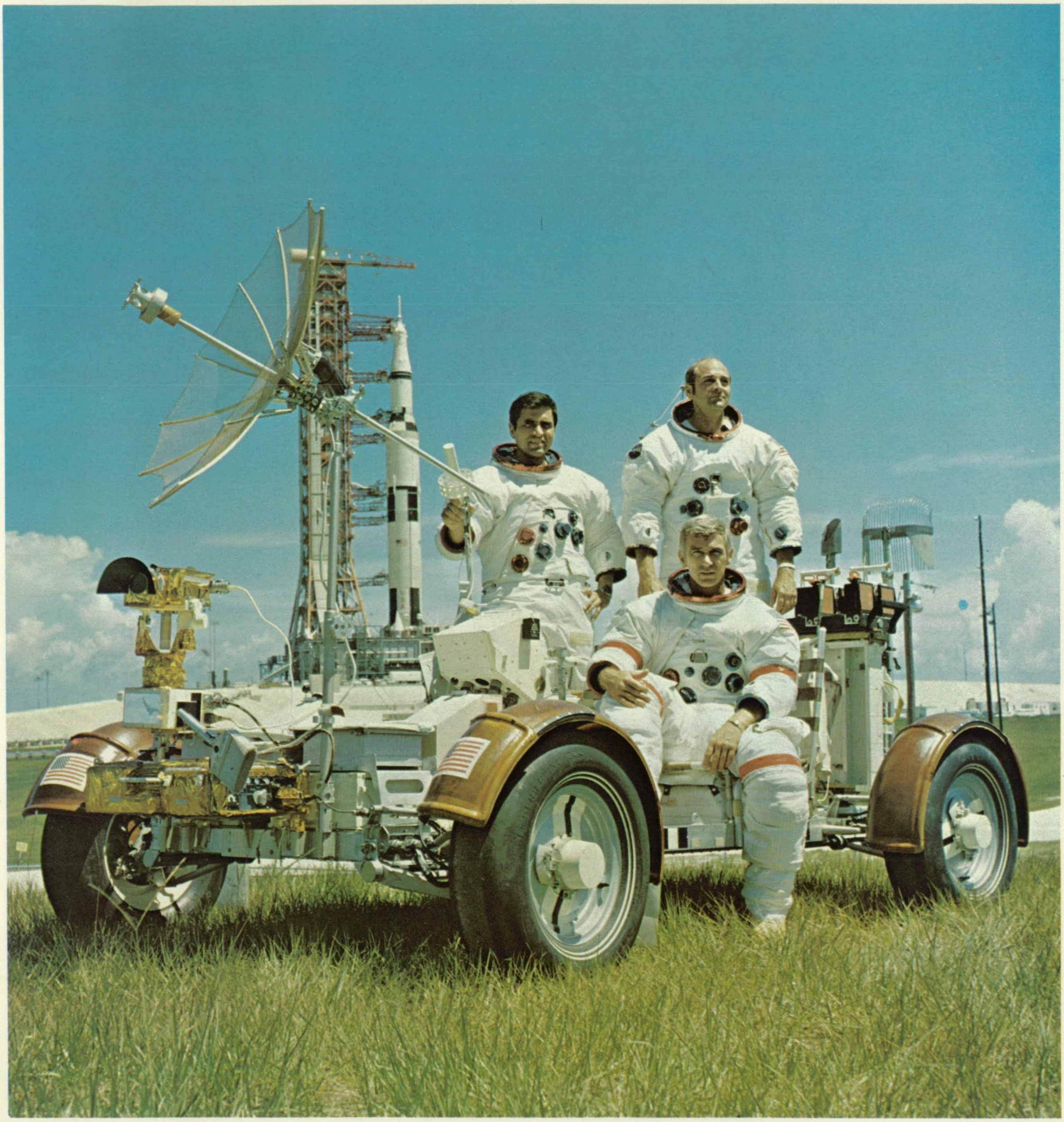
More than 23 billion data points had been received before the arrival of the Apollo 17 astronauts on the Moon; additional tens of billions will be added from the long lifetime experiments left by that mission.

Years from now, those measurements will still be adding to the knowledge of the Moon, the phenomena that formed it, and the cataclysms that molded its early history.

So after the centuries of philosophizing, of observing from the Earth, of assuming and hypothesizing and postulating and guessing, the first hard facts have become available with which to describe the evolution of another planet.



The crew of Apollo 17: Commander Eugene A. Cernan, seated on the lunar rover; command module pilot Ronald E. Evans, standing at right; lunar module pilot Harrison H. Schmitt, standing at left.



Introduction

Nothing can prepare you for the sights and sounds of an Apollo launching. Television, film, magnetic tapes and records are inadequate to convey the awe and the power of the experience.

The towering launch vehicle looms hundreds of feet above its pad into the humid Florida sky. On top, almost 122 meters (400 feet) above the nearest stretch of sandy ground, is a tiny truncated cone, mounting a single launch emergency escape rocket attached by a tower structure. Inside the truncated form are three men in space suits, their provisions, and the instruments and equipment that will take them to the Moon, protect them on its surface, and bring them home again safely.

Thousands of items, tucked away in corners, built into complex installations, stowed in bags, worn, sat upon, and secured to the spacecraft structure cram the Apollo command module. In spite of all of this equipment, the crew's quarters provide six cubic meters (212 cubic feet) —two cubic meters (71 cubic feet) per man—of habitable volume. That's about one phone booth apiece, a mini-environment for work and eating and sleep during the trips out and back.

Below the command module is the cylindrical service module, the name for a catchall structure that holds fuel and a propulsion system in addition to scientific instrumentation, oxygen and hydrogen tanks, space radiators, helium tanks, batteries, and the other components that will service and support the crew and their mission until the last leg of the voyage homeward.

And below that sits the lunar module, closed in now by panels that conceal its angularity and its spindly legs. The two stages of the lunar module will make the descent onto the lunar surface and serve as housing for the two astronauts between their excursions on the Moon. It will carry with them to the Moon a lunar roving vehicle, a four-wheeled automobile that will be used by the two astronauts to move rapidly over long traverses on the Moon.

The lunar module stands seven meters (23 feet) tall; halfway up is the front porch, where the first astronaut to emerge after lunar touchdown will pause before backing down the ladder and stepping off the footpad onto the Moon.

The lunar module has two stages. Joined, they make the descent to the Moon. For ascent, after the lunar exploration has been completed, the upper stage separates and serves as a single spacecraft for ascent, rendezvous and docking with the command module in lunar orbit.

The weight of the lunar module alone is more than 16,000 kilograms (35,000 lbs), a phenomenal number to those familiar with the early days of spaceflight, when payloads were measured by a few kilograms, and as few as one. A large, loaded moving van weighs on the order of 16,000 kilograms (35,000 lbs), for comparison. Or think of it in terms of eight compact cars. It's a lot of weight to transport to the Moon.

So there they stand, stretching almost 25 meters (82 feet) from the base of the lunar module housing to the tip of the rocket motors on the escape system tower. And below them, for another 84 meters (275 feet), are stacked the three cylindrical stages of the launch vehicle.

Start nearest the spacecraft, with the third stage, the Saturn S-IVB, almost seven meters (23 feet) in diameter and just over 18 meters (59 feet) high. It is loaded with liquid hydrogen and liquid oxygen propellants for its single J-2 engine which will deliver 926,367 newtons of thrust in the final phase of the powered flight.

The third stage and the spacecraft will be brought up to speed by the second stage, the Saturn S-II, a 10-by 25-meter (32.8- by 82-foot) cylinder with five J-2 liquid rocket engines delivering more than 5 million newtons of thrust.

That performance seems almost insignificant when compared to the first stage, the mighty Saturn S-IC, again 10 meters (32.8 feet) in diameter, but peaking at more than 42 meters (138 feet) high. At its base are five F-1 rocket engines, four in a cruciform around a central unit, and each good for almost 7 million newtons of thrust at takeoff.

Ready to go, the whole assembly of spacecraft and launch vehicle towers 119 meters (363 feet) above the launching pad, and weighs almost 3 million kilograms (7 million lbs).

Astronaut Ron Evans gets a last hug before entering the van to ride to the launch site.

Night Launch

It is the warm, muggy evening of December 6 on a sandy cape area east of Orlando, Florida, where the Banana River winds through marshes, where herons, pelicans, and alligators search the waters. Stretching toward the sky at Pad A, Launch Complex 39, the huge rocket is lit by banks of searchlights, delineating its whiteness against the darkening skies. The countdown is routine, smooth.

At 3 hours and 30 minutes before scheduled launch, there is a hold time built into the schedule. The clocks stop for one hour. Less than half an hour later, the doors of the Manned Spacecraft Operations Building open, and the Apollo 17 crew walk toward their transfer van, headed for their flight to the Moon.

Eugene A. Cernan and Ronald E. Evans and Harrison H. Schmitt: white and bulky in their flight suits, carrying their portable breathing and cooling systems, their faces shielded by the clear visors of their near-spherical helmets. Flashguns fire brilliant lights against their bodies; Evans hesitates, raises his right arm, bumps his body toward the cameras.

From the observation site, this has been seen on television monitors that dot the area. In the grandstand, there are thousands of reporters, writers, researchers. Ahead of the grandstand, between it and the small body of water in whose black surface the Apollo rocket is reflected, stand dozens of cameramen. And off at remote sites there are other cameras and cameramen, television and movie, still and recording cameras, to make this last flight perhaps the most thoroughly documented of all.

The countdown goes on, flawlessly. Across the way perhaps a quarter of a mile, a parade of official vehicles, blue and red dome lights flashing, makes its slow way out toward the launch site. Cernan, Evans and Schmitt are on the way to the Moon by van and auto, rolling on rubber tires at a few miles per hour, gingerly, easily, toward the waiting spacecraft. Two hours and 40 minutes before the scheduled departure, they clamber aboard the command module. They "ingress" the module, in NASA's awkward but precise terminology.

And then the checks of systems begin, right down to the final range safety checks. Two helicopters, one with a high-powered searchlight, patrol the beach area.

The searchlights at Launch Complex 39 bathe the scene in near-daylight, catching the wisps of venting oxygen as they drift slowly westward from the launch pad. The clock goes through T -5 minutes, and the count proceeds. Now at T -3 minutes, 6 seconds, the automatic sequencer starts to control the countdown. It performs each task, verifies that it is done, removes an interlock that prevents the next task from being done prematurely, or from being omitted, and does the next task. It does each, right down to 30 seconds, and the clock stops. Apollo control comes on the air to announce a hold, as it will do over the next two and one-half hours while the problem—a signal that the third-stage liquid oxygen tanks had not been pressurized—is solved by working out a safe alternate around that signal.

That alternate was developed on a "breadboard"—a working duplicate of the complex control systems—by engineers at the Marshall Space Flight Center in Huntsville, Alabama. Their solution was a workaround which they checked and rechecked to verify its reliability. It worked, and passed the checks, and the communications links between the two NASA Centers carried the details of the alternate procedure to the control room at the Kennedy Space Center.

Finally, after a second prolonged hold at T-8 minutes, the final countdown begins, continues through the 30 second mark to cheers from the watchers, and approaches the T–10 second mark.

Apollo Saturn Launch Control: "Ten . . . nine . . . eight . . . seven . . . ignition sequence started . . . all engines are started . . . we have ignition. . . ."

There is a short, intense burst of white flame at the bottom of the Saturn first stage; it blossoms to a huge burning whiteness, bright as the Sun, spreading outward through billowing clouds of steam and is surrounded, but not swallowed, in bright orange sheets of fire from the five rocket engines.

"Two . . . one . . . zero . . . we have a liftoff. We have a liftoff and it's lighting up the area, it's just like daylight here at Kennedy Space Center as the Saturn V is moving off the pad. It has now cleared the tower."

The enormous bulk of launch vehicle and spacecraft moved slowly, ponderously upward through the steam and flame. The only noise was the commentary from launch control and the cheering of the crowd in the grandstand.

The rocket began to climb into the night, above the searchlights now but needing no other light than the fire in its engines and the incandescent foxtail of flame streaming behind it.

And then, perhaps fifteen seconds later, the noise hit, a blasting, snapping, crackling roar unlike any noise before. The physical impact stopped the breathing momentarily, and then the metal roof of the grandstand began to rattle and shake under the hammering of the shock waves from the engine. They sounded like a rapid-fire series of cannon shots from a few yards away, sharp explosive bangs that were startling, unsteady, high-pitched and roaring at the same time.

And through all the blasting the launch vehicle slowly climbed through the blackness, its five-forked flame streaming orange light, illuminating the upturned faces of the shouting crowd. It began to turn into its slow curving path downrange, and the flames began to open up behind the rocket like a pale orange umbrella of fire as the atmosphere thinned and reduced the external pressure on the engines. The individual rocket engines burned like bright dots of orange behind the veil of paler orange as the Saturn booster continued to turn downrange and the fiery umbrella kept opening outward, seeming to fill the sky and cover the Cape.

Then the center engine was shut down automatically and a few seconds later, the outboard engines blinked out together. There was a brief pause, and then the white fireball of the second-stage engines igniting lit up the sky like a lightning stroke, and stabilized into a burning sphere of white light streaking toward the Moon like a rising star.

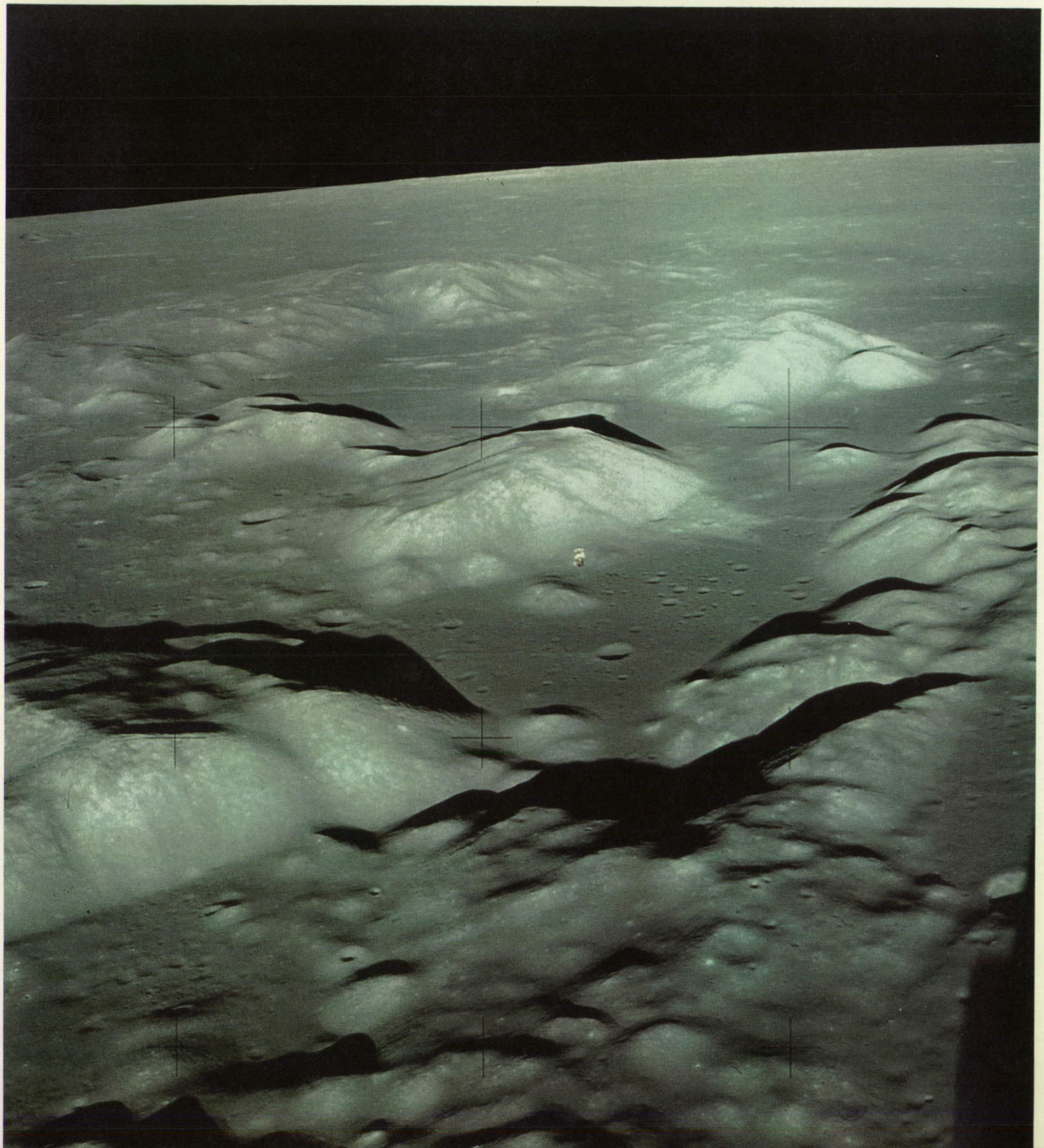
Foxtail flame from five rocket engines in the Saturn lights the sky and the ground around the launch complex. Photograph for Time, Inc. by Tony Linck.

From The Earth To The Moon

The approach path to Taurus-Littrow valley is visible against the mountain bases at the left in this view from the lunar module. The Sculptured Hills are the bumpy terrain at the bottom. The command/service module is seen in the distance.

About 12 minutes after liftoff, the on-board computers read out the maximum and minimum altitudes of the Earth orbit that had just been established. But this was simply a parking orbit for a short time, a time to catch the breath, figuratively speaking, and to get ready for the rocket engine firing that would launch the command and service modules across the long blackness toward the tiny Moon.

About 3 hours later, the Saturn S-IVB stage began its second burn, thrusting the spacecraft out of its parking orbit and heading it into space. For almost six minutes the rocket engine



Separation and Descent

fired, adding about 3,000 meters per second (10,000 feet per second) to the velocity of the speeding spacecraft. Now at 10,440 meters per second (34,250 feet per second), the spacecraft engine stopped and the astronauts were on course and on speed for the Moon.

That, too, was a routine trip. But the sights were new to two of the astronauts —Evans and Schmitt, who had not been in space before—and they could not tear themselves away from the windows during the parking orbit, or the flight outward. After one pass around the world, one radioed back: ". . . we had almost a completely weather-free pass over Africa and Madagascar. And the scenery both esthetically and geologically was something like I've never seen before . . . there were patterns like I haven't seen in textbooks. . . ."

Schmitt, the geologist, became interested in the weather patterns that he could see developing and changing on the Earth.

"It looks like Mexico in general is pretty nice, although there is a band of east-west trending clouds that start from the Gulf of California across Sonora, and probably up through New Mexico and over into Texas as far around as I can see. Southern California looks like it's in pretty good shape today, but northern California looks like it's probably overcast. And a major system probably associated with that stretches into the north western United States. But a band of clear weather . . . stretches from Arizona right on up through—I would guess—through Colorado, Kansas and probably into the midwest pretty well."

And Capcom answered, ". . . you're a regular human weather satellite."

Later, Schmitt called in with this observation: "Bob, you always wish that you had a poet aboard one of these missions, so he could describe things that we're seeing and looking at and feeling in terms that might transmit at least a part of that feeling to everybody in the world. Unfortunately that's not the case, but . . . I certainly hope that some day, in the not too-distant future, the guy can fly who can express these things."

The long hours passed, and then the Moon, which had been looming larger and larger, became the primary target of their thoughts and views.

It was the smoothest landing, closest to the planned touchdown point, of any of the Apollo missions. "Challenger," the lunar module, had undocked and separated from "America," the command/ service module, earlier, and its astronauts had completed the second descent orbit insertion maneuver without incident.

And now it was time to start the final descent toward the lunar surface. Astronauts Cernan and Schmitt, in constant contact with Mission Control at Houston, completed check after check preliminary to the actual firing of the descent engine that would lower them to the Moon. The checks completed and the go-ahead given, the final details of the pre-ignition sequence came over the voice link from Challenger:

"Ten seconds . . . fuel ullage; we've got ullage . . . two . . . one . . . ignition, ignition Houston . . . attitude looks good. . . ."

The descent engine had fired, applying its thrust to brake the coasting speed of Challenger and move it out of the lunar transfer orbit toward the vertical descent and touchdown.

"Challenger, you're go for enter," said Mission Control, and the final procedures began on board the lunar module. They were closing in on the landing site, and recognizing its features: "Okay, I've got the South Massif . . . I've got Nansen, I've got Lara and I've got the scarp . . . oh, are we coming in . . . oh, baby!"

Now just a hundred feet above the surface, the commentary came fast as Challenger eased toward touchdown.

"Eighty feet . . . going down at three . . . getting a little dust . . . very little dust . . . stand by for touchdown . . . down two . . . feels good . . . twenty feet . . . ten feet . . . contact!" Then the engine shutdowns, the switch closings, and the two astronauts had arrived at the surface.

"Okay, Houston, the Challenger has landed . . . tell America that Challenger is at Taurus-Littrow."

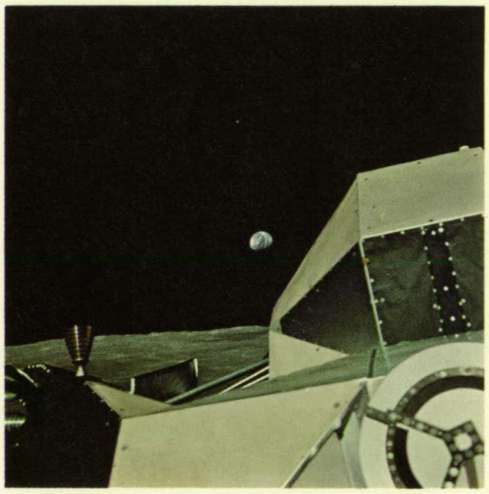
There was a brief time while the crew completed more checks and waited for permission from Mission Control to go on with the planned phases of the mission that would take them to the opening of the hatch and the exit onto the Moon.

"I'll check everything again. Let's just double-check. Okay. That hasn't changed . . . it looks good . . . the manifold hasn't changed . . . the RCS hasn't changed . . . ascent water hasn't changed . . . the batteries haven't changed.

"Oh, my golly, only we have changed!"

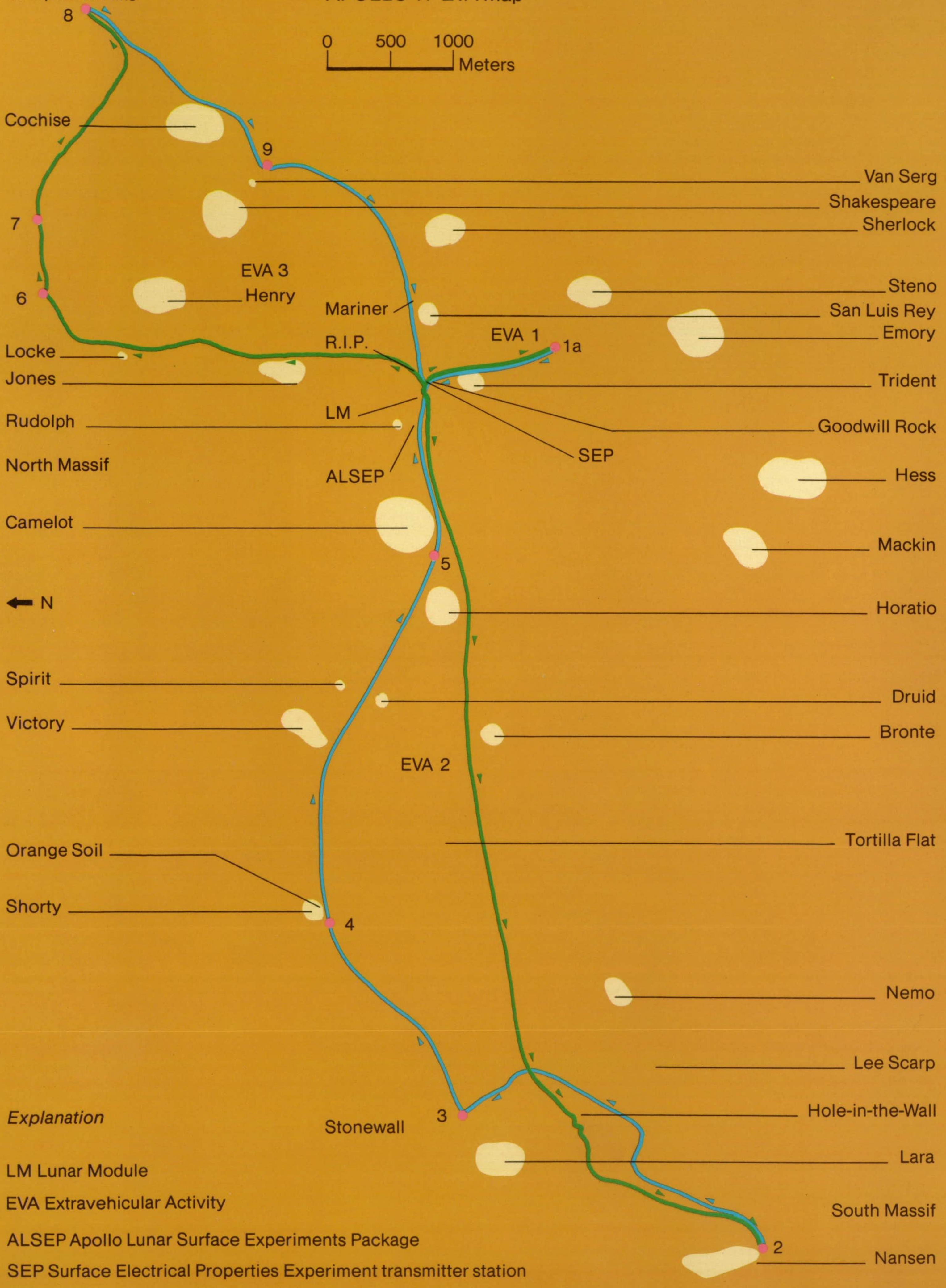
They had, just as other astronaut crews before them had changed. Somehow, the emotions of the moment, the enormity of the task just completed, the awe of being on the Moon, the stark beauty of its features, reach through the outer shell of objectivity and machinery that shields the astronauts.

"Only we have changed!" He said it for all of them, and for all of mankind. Man is on the Moon, and we've changed.



Challenger, the lunar module, has just separated from America, the command module, prior to the LM's descent to the lunar surface.

APOLLO 17 EVA Map



Explanation

LM Lunar Module

EVA Extravehicular Activity

ALSEP Apollo Lunar Surface Experiments Package

SEP Surface Electrical Properties Experiment transmitter station

EVA, The Sixth Lunar Surface Expedition

"The next thing it says is that Gene gets out." Astronaut Jack Schmitt, reading the checklist before their first moves outside the protective environment of the lunar module, had come to that line.

This was the beginning of the first extra-vehicular activity (EVA), the NASA jargon for moving and working on the lunar surface. Cernan, on hands and knees now and backing out of the tiny tunnel opening in the lunar module, edges along carefully, wary of getting stuck or hung up.

Cernan: How are my legs? Am I getting out?

Schmitt: Well, I don't know. I can't see your legs . . . I think you're getting out though, because there isn't as much of you in here as there used to be.

Cernan: Okay . . . my legs are out . . . Houston, Commander is on the porch of Challenger."

And now Cernan is backing down the ladder. "I'm on the footpad. And, Houston, as I step off at the surface at Taurus-Littrow, I'd like to dedicate the first step of Apollo 17 to all those who made it possible."

Then it was Schmitt's turn to descend the ladder and to step onto the lunar surface. After a quick walkaround inspection, and a first look at the surface around the landing site, Cernan and Schmitt freed the lunar rover from its berth, tucked into the lunar module. It came out, unfolding as it came, and stood ready for work. Sixteen minutes later, after a bit of difficulty getting the vehicle locked together, Cernan climbed aboard for a test drive.

"Can't see the rear ones, but I know the front ones turn, and it does move. Houston, Challenger's baby is on the road."

The test drive over, Cernan and Schmitt began to explore the area, Schmitt picking up rocks and commenting on their apparent structure. They fumbled, stumbled and fell, getting used to the strange feelings of moving in one-sixth the gravity force of the Earth. Cernan warned Schmitt: "You've just got to take it easy until you learn to work in one-sixth g," and Schmitt answered, "Well, I haven't learned to pick up rocks which is a very embarrassing thing for a geologist."

And then, just before they attached the television camera, Cernan called over to Schmitt, who was working hard at loading the rover: "Hey, Jack, just stop. You owe yourself 30 seconds to look up over the South Massif and look at the Earth."

They assembled and flew the flag, and after the now-ritual salutes and pictures, Cernan talked to Houston: ". . . this flag has flown in the MOCR (Mission Operations Control Room) since Apollo 11, and we very proudly deploy it . . . in honor of all those people who have worked so hard to put us here. . . ."

Then they unloaded the Apollo Lunar Surface Experiments Package (ALSEP), and assembled it into a barbell package for easier carrying. Schmitt made a gravimeter reading for calibration of that instrument, and they were off to deploy the ALSEP, Schmitt loping into the distance carrying the unit. But Cernan had knocked a fender off the rover by catching it with his hammer, and stayed behind to fix it. He made a temporary binding from an adhesive tape, and joined Schmitt at the ALSEP site.

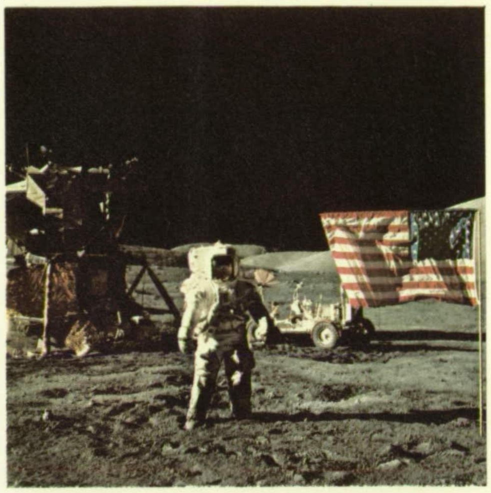
It was Cernan's job to drill the two holes for the heat probe experiment. "Man, is that thing biting," he said about the drill. And later, he added, "I'm in something tough down there now . . . must be in the mother lode. . . . Boy, the old fingers really suffer on these. . . ."

But he completed the job, with both probes driven to their planned depth. "Hey, Bob, just out of curiosity, what kind of heart rate has this drill been producing on me?" Cernan queried. And Capcom answered, ". . . you've been running at 120 pulse speed with peaks of 140 to 150 from time to time."

Cernan had to drill again, this time a ten-foot probe for the neutron flux experiment. He was beginning to feel the effects of the unaccustomed strain of working against the constraint of the pressure suit, and complained of arm pains when this job was done.

The next task was a rover ride to a point near the crater Steno, named after Nicholas Stenonis, a 17th century Danish scientist. On the way, the rover stopped briefly at the site selected for the Surface Electrical Properties (SEP) experiment, and Schmitt placed the transmitter on the surface. On toward Steno they went, and collecting rock samples, taking photos, and making a gravimeter reading for another point on the gravity profile traverse.

Astronaut Schmitt, the lunar module (left) and the lunar rover (right) pose with the American flag at the Taurus-Littrow base.



Astronaut Cernan, at the wheel, checks the lunar rover in a short test ride.

Then it was back to the Surface Electrical Properties experiment (SEP) site for deployment of its transmitter antennas, placing them carefully in a set of right-angled tire tracks driven on the location earlier by Cernan. On the way back the broken tape gave way on the fender splice, and the fender was lost somewhere on the surface. "Oh, it pretty near makes me sick at losing that fender," Cernan said.

Back at the lunar module after these jobs, Cernan and Schmitt dusted off the rover, and were getting ready to re-enter the module when Cernan was startled by something. "Hey, something just hit here! What blew? Hey, what is that?" Schmitt had the answer. "It's the styrofoam off the high-gain antenna backing."

Capcom called with a request for a complete description of what happened to the rear fender, and the extent of the damage. They planned to think and work on the problem during the rest period for the astronauts, and to get back to them with some temporary fix if possible. For the rest of the stay on the surface, Cernan and Schmitt spent the time dusting themselves off. "How'd you get so dirty?" asked Cernan, and Schmitt retorted, "Huh, just wait until I show you a picture I took of you."

All of the experiments had been emplaced properly, and all were checked out as operative. They had made 6 readings with the gravimeter, placed 2 explosive charges for the seismic experiments, taken 229 color pictures and 197 black-and-white pictures, collected one deep drill core and 17 samples of rocks and rake fragments, a total of about 13 kilograms (about 29 pounds).

Then up the ladder and into the lunar module, ending the first EVA. They closed the hatch and repressurized the module. The time of the EVA was 7 hours, 12 minutes and 13 seconds, and there were two tired astronauts at the end of that day's work.

"Oh, what a nice day . . . there's not a cloud in the sky," said Schmitt as he started his trip down the ladder for the second EVA. He joined Cernan on the surface and, after the usual first-thing checks, the two astronauts attached their new fender. This history-making event—the first automotive repair on the Moon—had been figured out at MSC while the crew slept. Essentially it consisted of taping together four plasticized map sheets that would not be used, folding them once and fastening them to the fender rails with clamps cannibalized from the optical alignment telescope lamp.

The reason for the seriousness of this apparently minor problem was the dust plume thrown up by the lunar rover wheel. Without that rear fender, the surface dust was thrown onto the astronauts and the equipment on the rover, aggravating an already annoying situation.

The fender fix worked, and the day's tasks began.

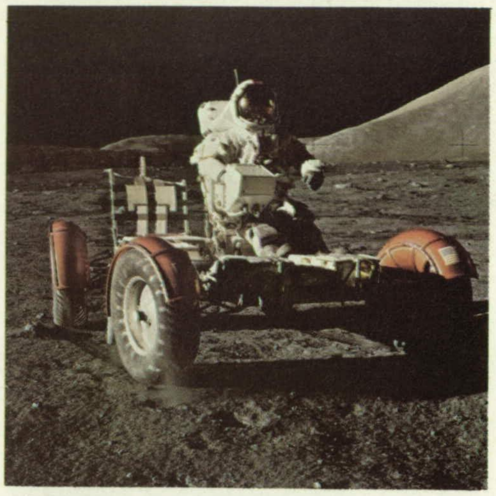
The first stop was scheduled to be Station 2, near the crater Nansen, named after Fridtjof Nansen, a Norwegian Arctic explorer. On the way, they drove south of the crater Camelot, and Schmitt described as they rode: "The surface is not changing in terms of the detail. The surface texture of the fine grained regolith still is a raindrop pattern. . . . Occasional craters show lighter colored ejectas all the way down to, say, half a meter in size. . . . Most of the brighter craters have a little central pit in the bottom which is glass lined. The pit is maybe a fifth of the diameter of the crater itself."

After more than an hour, during which they had stopped for samples and to set two more explosive charges, Cernan and Schmitt arrived at Station 2, lying at the base of the South Massif, at the contact area between the massif and the lunar mantle. Here the samples and observations were directed toward describing the massif bedrock and the light mantle.

Cernan and Schmitt spent almost an hour here, gathering samples and photographically documenting them and the region. Then they drove the rover on toward Station 3, the crater Lara, named after the heroine of "Dr. Zhivago." The same sampling routine followed, and they packed the specimens and headed on to Station 4, the crater Shorty, named after a character in Richard Brautigan's novel, "Trout Fishing in America."

And there, almost five hours into the EVA, Schmitt was standing on the rim of Shorty and calmly describing its physical appearance. Finished, he said that he was going to take a panoramic shot with the camera. He moved to do so, and then his excited voice cut through the

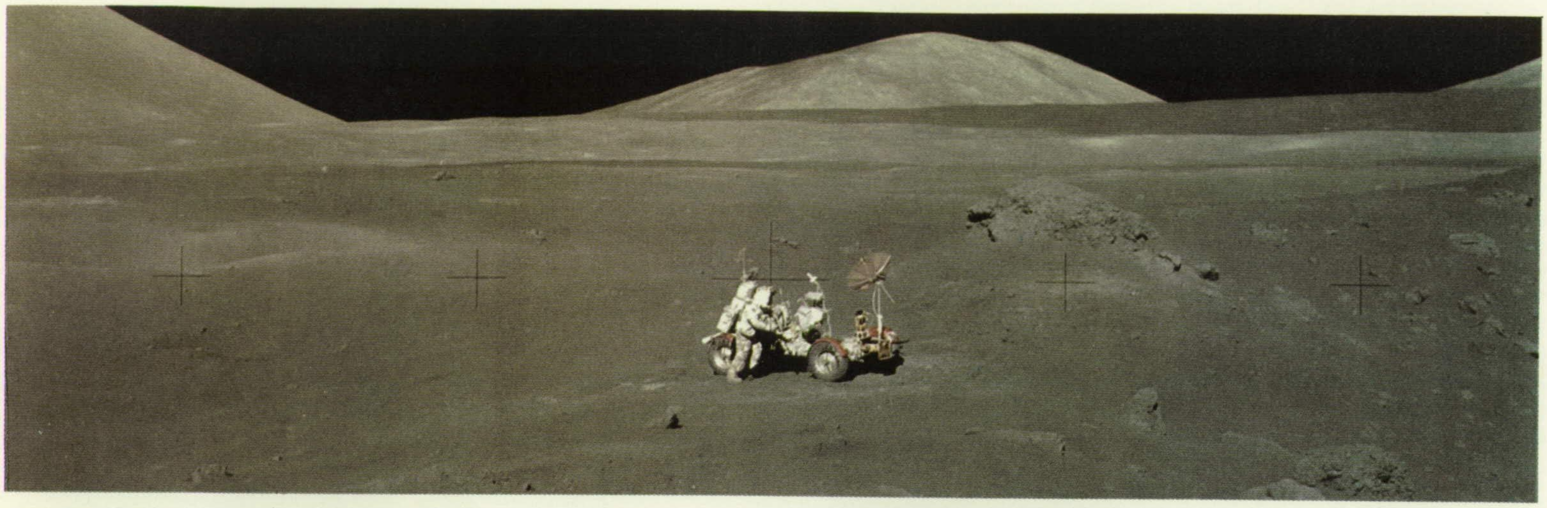
Finished with the check ride, the lunar rover is ready to roll.

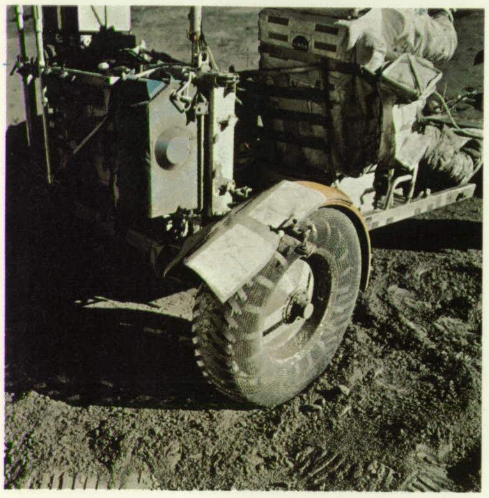


Astronaut Schmitt deploys the Surface Electrical Properties experiment. In the background is the South Massif.

Commander Cernan's gold visor reflects Astronaut Schmitt.

Station 4 with the lunar rover on the rim of Shorty Crater. The Family Mountains are in the background.





A temporary fender, taped together from plasticized maps, made a usable replacement for the original on the lunar rover.

Orange soil! Discovered during the second EVA, this patch of orange-tinted Moon hints at early volcanic activity. The tripod device is a gnomon used to determine the local vertical, direction, and color comparison.

transmissions: "There is orange soil!"
Cernan: "Well, don't move it till I see it."
Schmitt: "It's all over, orange!"
Cernan: "Don't move it till I see it."
Schmitt: "I stirred it up with my feet."
Cernan: "Hey, it is, I can see it from here!"
Schmitt: "It's orange!"
Cernan: "Wait a minute, let me put my visor up . . . it's *still* orange!"
Schmitt: "Sure is. Crazy. Orange . . . It's almost the same color as the LMP decal on my camera."
Cernan: "That is orange, Jack."

Quoting the words doesn't convey the sense of excitement that this discovery caused. And why? Because the presence of the reddish-orange material around the crater points to its volcanic origin, and suggests volcanic activity both before and after the formation of the light mantle.

Said Schmitt: "If I ever saw a classic alteration halo around a volcanic crater, this is it. It's ellipsoidal. It appears to be zoned. There's one sample we didn't get. We didn't get the more yellowy stuff, we got the center portion. . . ."

After this, the rest of the EVA was almost anti-climactic. They drove on to Station 5 at Camelot crater, collected samples, and then pushed on to the ALSEP site for another check of the lunar surface gravimeter. Indications were that the instrument was not working, and the scientists back in Houston wanted to make certain that it had been correctly installed and was level. Schmitt confirmed that.

They arrived back at the lunar module, cleaned up the rover and turned off the television camera. It had been a second full day. They had traveled a distance of about 20 kilometers (12 miles) and had worked on the Moon for 7 hours, 37 minutes and 22 seconds. They had taken 218 color photographs and 627 black-and-white photographs, and collected 56 samples weighing about 36 kilograms (80 pounds). The scientific experiments were working properly, except for the lunar surface gravimeter.

In the final minutes before mounting the ladder and entering the lunar module, Cernan looked around. "I stand out here and I look at that flag, and I look at the rover, and I look at those feet. It's still hard to believe." And Schmitt answered by wondering what they had done to deserve being out there.

". . . it's about 4:30 Wednesday afternoon, as I step out on to the plains of Taurus-Littrow's beautiful valley," said Astronaut Cernan at the start of the third EVA. He and Schmitt did their usual routine checks and make-ready tasks before setting out in the lunar rover about a half-hour later. They drove toward Station 6 at the base of the North Massif, stopping on the way at about half the distance for sampling of the surface.

They paused again at Turning Point Rock, named because it was a prominent landmark on their course and the place where they were to turn to head toward Station 6. That rock, perhaps 6 meters high, was photographed and observed at close range before the trip continued.

They parked the lunar rover on the slope near the base of the massif and began their sampling and documentation. "Man, here's a big white clast, and there's one on top about a foot and a half across, and here's one must be two feet across . . . three feet . . . and that's in the blue-gray," reported Cernan, describing some of the local rocks of a type that geologists have labelled "breccias," or rocks which are made of fragments of specific materials. Blue-gray, of course, refers to the color of the rock.

"Feel like a kid playing in a sandbox," said the exuberant Cernan, in the middle of his reporting. And then Capcom came on the air with instructions: "We're ready for you guys to leave this rock . . . and either get the rake soil and cores near that crater down below the rock . . . or else go on to some other different variety of rock. . . ."

Schmitt answered, ". . . going down to that crater is not a problem; getting back up is."

Capcom: ". . . it's not that vital to get to that crater . . . if it's that much of a job to get down to it and back up."

Schmitt: "Okay. Bob, we don't move around from here too much. I tell you, these slopes are something else."

Before they left the site, Cernan called in an accident report: "Houston, we've got a couple of dented tires." "What's a dented tire?" queried Capcom, and Cernan responded, "A dented tire is a little . . . golfball size or smaller indentation in the mesh. How does that sound to you?" "Sounds like a dented tire," said Capcom. But the damage was negligible and would not prevent the lunar rover from continuing to do its job.

At Station 6 Astronaut Schmitt chips a sample from a large boulder.

Apollo 17 Commander Cernan in the lunar module.

From Station 6 to Station 7, just off the slopes of the massif was a matter of a five-minute drive. First things first at the site; Capcom asked Cernan to dust off the mirror and the lens of the television. And Cernan came back with, "You know what? I'm getting tired of dusting. My primary tool's the dust brush. . . ."

By working at both stations 6 and 7, the astronauts had documented the structure of the base of the massif, first a distance up the slope and then a distance into the plain at its foot. At Station 8, another position at the base of the massif, they continued their geological field trip, with sampling and documentation. And Schmitt made some observations on lunar locomotion: "This is the best way for me to travel, up hill or down hill . . . like this two-legged hop . . . Man, I can cover ground like a kangaroo!"

Cernan continued to comment on the dust and the way it got into everything. ". . . we sure are giving this suspension system (of the rover) a workout . . . I can't even see it . . . everything's getting awful dusty." Schmitt, confirming that, added, "Boy, everything is stiff. Everything is just full of dust." But Cernan had the last word: "There's got to be a point where the dust just overtakes you and everything mechanical quits moving."

They left Station 8 after 47 minutes of sampling and headed on to Station 9, on the rim of Van Serg crater and near the rims of three others: Shakespeare, Cochise and Gatsby.

After about a half hour of work in the area, Capcom advised the astronauts that it was time to go, and suggested that they leave ". . . immediately if not sooner to head for Station 10." There was a brief flurry of activity, and then Schmitt's voice broke through in excitement. "Come here, Gene, quickly. We can't . . . we can't leave this. This may be the youngest mantle over whatever was thrown out of the craters." "Take pictures of it," answered Cernan, and then speaking to Capcom, he added, "Bob, we've got to take five more minutes . . . what Jack's doing is he's dug a trench in the southwest-northeast direction and he discovered about three inches below the surface a very light gray material . . . a possibility here is that . . . this upper six inches of gray material . . . is the latest mantling in the area and the light-colored debris may be what's left over from the impact."

Capcom, now concerned about the duration of their stay on the surface at this distance from the protection of the lunar module, came on again: "Okay, I copy. I understand. But we'd like to get you going, in case you didn't get the clue."

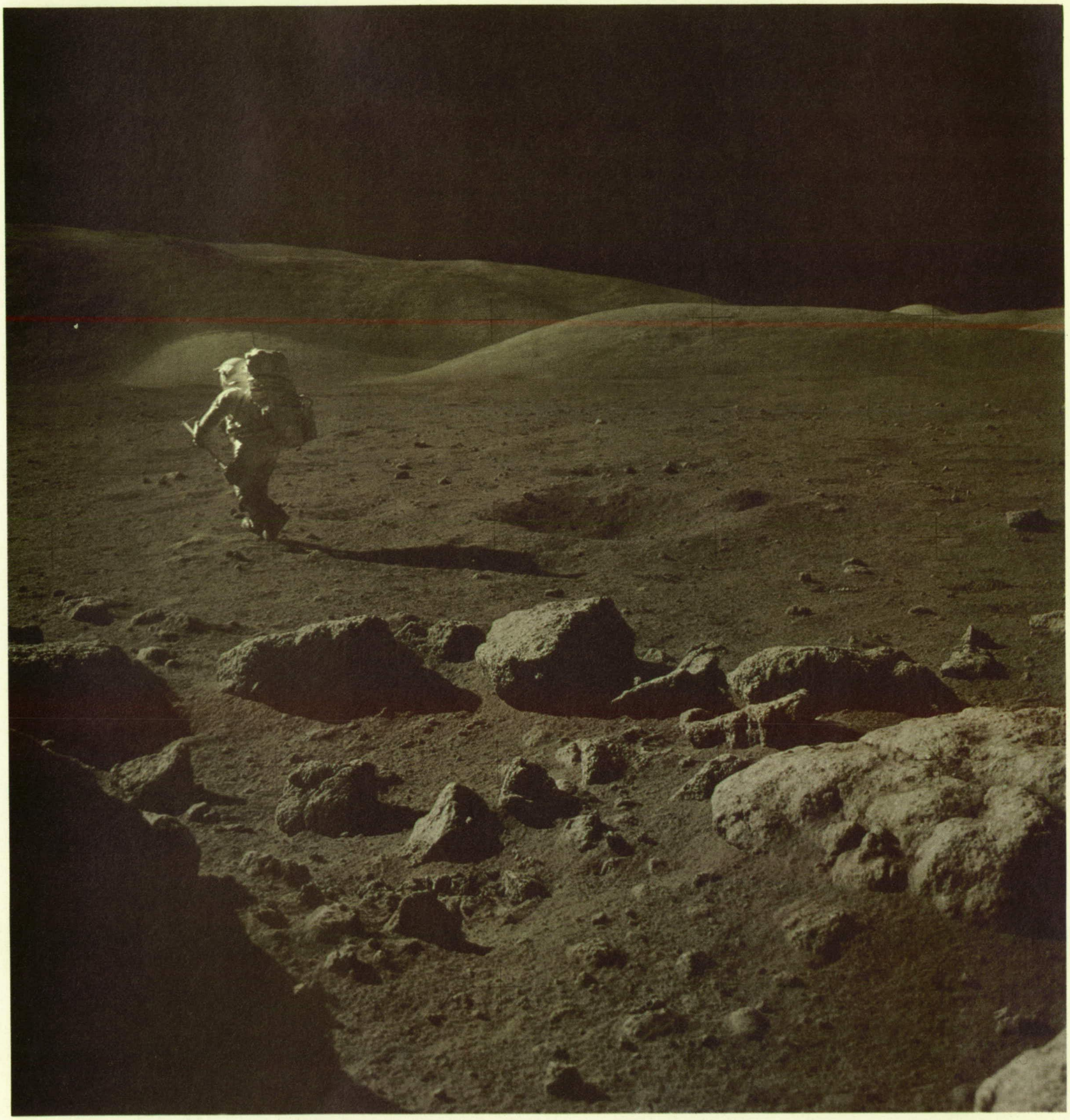
But Schmitt, ever the professional geologist, was reluctant to leave this exciting and unexpected find, and Cernan seemed to share his view. Schmitt took photos; they started to make ready to go back when Capcom reprieved them: "We've had a change of heart . . . and we're going to drop station 10 . . . and we're going to get a double core here . . . then we're going to leave and go back. . . ."

Cernan and Schmitt worked harder now, with Cernan starting to drive the core while Schmitt was still arguing with Capcom about whether or not it was even going to be possible. They got the core

Astronaut Schmitt collects a sample of the lunar surface using his special rake.

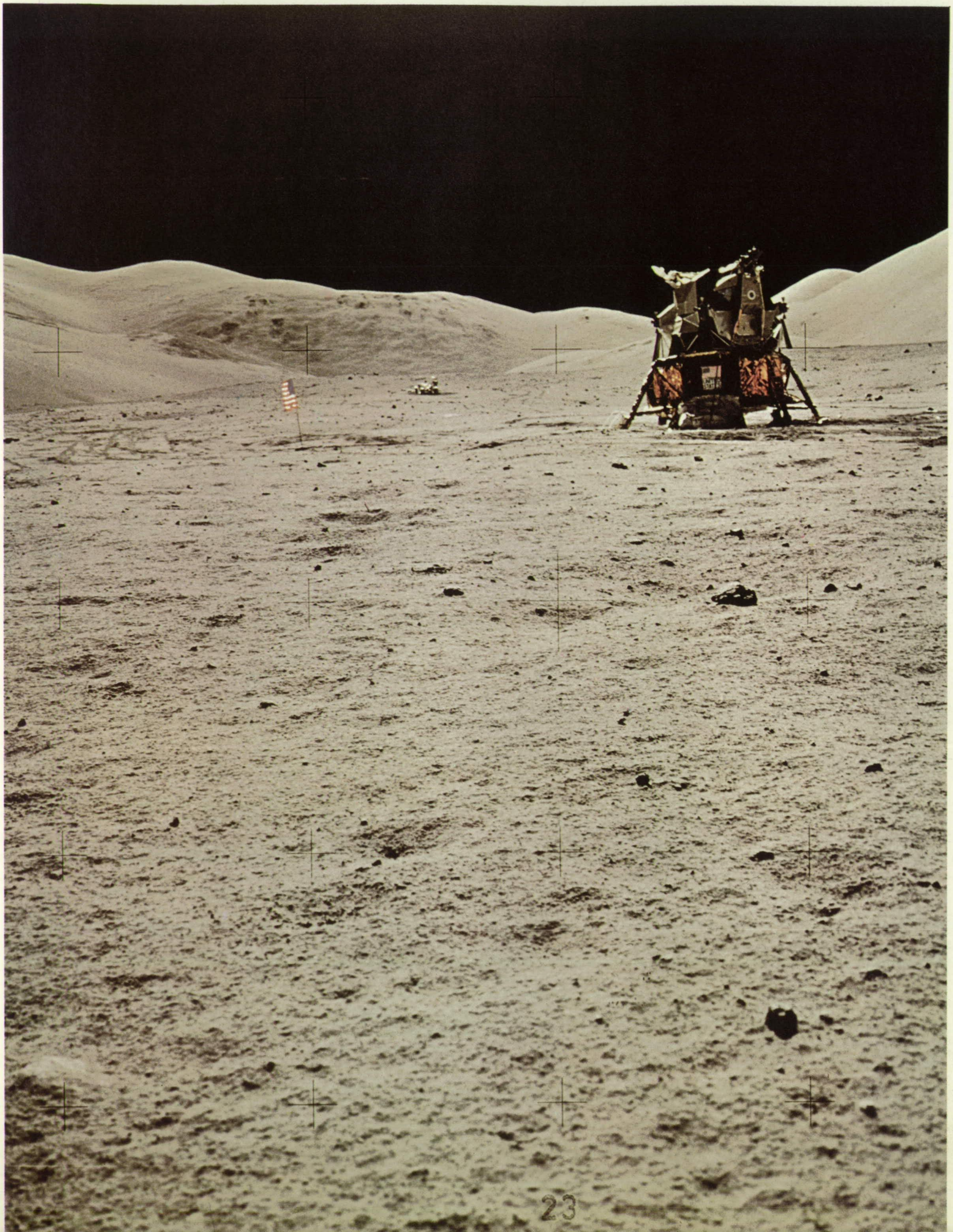
Moonlight through the window of the lunar module lights this photograph of Dr. Schmitt.

Rake in hand, Dr. Schmitt sets out across the lunar surface to collect samples.

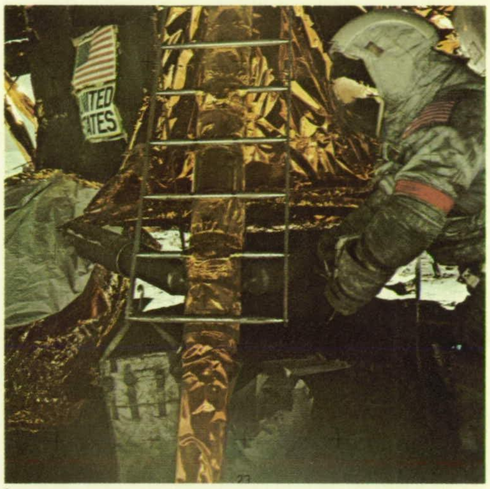


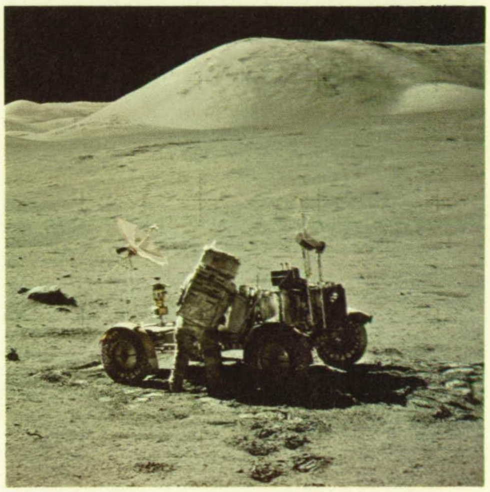
Geologist-Astronaut Schmitt places a gnomon —a local vertical and color standard—near a huge split rock at the base of North Massif in this mosaic of two photos.

The lunar module and the U.S. flag were photographed during EVA 3. In the background are the Sculptured Hills.



At the end of EVA 3, Astronaut Cernan unveils the mission plaque.





Astronaut Schmitt at the lunar rover with South Massif in the background.

and then Capcom asked for a special sample from the shallow trench that Schmitt had dug earlier. Capcom added, "We'd also like to have you moving in 4 minutes. That's with wheels rolling in 4 minutes."

There was more argument, Cernan saying that he didn't know if that could be done, Capcom insisting, and Cernan saying that they could not get that special sample in 4 minutes. Capcom agreed to eliminate it, and Cernan said, "Let's roll."

They left Station 9 and headed back to the lunar module, calling in observations as they passed craters on the way back. At about 5 hours and 44 minutes after they had set out, they arrived back at the home base for the last time this trip. They still had work at that site: photography, a final check of the ALSEP, and the tasks of clean-up after the continuing problem with the lunar dust. But there were some other, non-work tasks that remained, too, and Cernan, as commander of the Apollo 17 mission, was its spokesman. He spoke to the International Youth Science Tour that was in Houston that day, watching some of the activity by television transmission from the lunar surface. Cernan told them that, ". . . Jack has picked up a very significant rock . . . composed of many fragments, of many sizes and many shapes, probably from all parts of the Moon, probably billions of years old. But a rock of all sizes and shapes, . . . and even colors, that have grown together to become a cohesive rock outlasting the nature of space, sort of living together in a very coherent, very peaceful manner . . . we'd like to share a piece of this rock with so many of the countries throughout the world. We hope that this will be a symbol of what our feelings are. . . ."

And Schmitt added that portions of the rock will be sent to museums or other agencies in each of the countries represented by the young people in Houston on that day.

Then Commander Cernan again, speaking for Apollo 17 and all the Apollo missions that came before: "We'd like to uncover a plaque that has been on the leg of our spacecraft . . . I'll read what that plaque says . . . 'Here man completed his first exploration of the Moon December 1972 A.D. May the spirit of peace in which we came be reflected in the lives of all mankind.' "

It was a serious moment, but it wasn't the finale of the spectacle. That finale would have been the last routine checks before boarding the lunar module. But Capcom had some final words about the lunar surface gravimeter experiment, which still wasn't working; the scientists wanted to make one more try.

So Capcom told Schmitt "Tap sharply on the gimbal with the UHT (Universal Handling Tool) and then reverify the level."

Schmitt: "You mean tap on the thing that swings?"

Capcom: "That's what they say."

Schmitt: "You always wanted to do that, didn't you?"

Capcom: "Yeah, that's right."

Schmitt: "How much is sharply?"

Capcom: "Sharply is sharply. It's probably not heavily, but sharply. Fairly light, but sharply."

Schmitt: "Okay, here it goes. I did it . . . that was sort of a moderate tap."

Capcom: "Go ahead and hit it harder."

Schmitt: "Okay. Okay? I can hit it harder yet."

That didn't do it, and Schmitt was released to work on other tasks. But a few minutes later, back came Capcom, with more instructions. "We'd like to return to the surface gravimeter, Jack . . . we'd like you to rap even more sharply, more strongly on the gimbal another three times."

Schmitt: "Okay, Bob. Here come the raps. About three times. Okay."

Capcom: "Okay, Jack, that's really fighting it pretty hard."

And still there were no measurable results. And, after more talk and tasks, Capcom finally closed out the experiment attempt: "Okay, Jack, we're ready to leave the ALSEP."

"I hate to do that, Bob. I'm sorry about this gravimeter," said Schmitt.

And Capcom responded, "Well, you're not the only one . . . there's a whole room full of people that are sorry."

For the last time, they closed out the check list, moved the sample bags into the lunar module, and prepared for the last steps up the ladder.

"Okay, you guys, say farewell to the Moon," said Capcom, and Cernan answered, "Bob, this is Gene, and I'm on the surface . . . as we leave the Moon at Taurus-Littrow, we leave as we came, and, God willing, we shall return, with peace and hope for all mankind."

Ascent From Taurus-Littrow

The nearly full Moon looms serenely in the black sky for the crew of Apollo 17.

The mission operations control room is again crowded, in contrast to much of the flight when many of the control and monitoring positions are not needed. But now perhaps fifty specialists sit at consoles on which are displayed television presentations of data, curves, pictures. On the edges are amber lights in a matrix, with an occasional one blinking on and off. On the wall ahead, there are three large panels. The left shows columns of printed parameters for the ascent. On the center panel are four graphs, showing precomputed curves of performance for the ascent phase. On the right, the projected television picture from the surface shows momentarily, then is replaced by another chart.

Communications are established between the surface of the Moon, the orbiting module, and the communicator in the mission operations control room. There is a pre-liftoff go-no-go check in the room, with the voice of flight control querying each major desk in turn and getting the sharp, "Go!" from each.

Now the room is quiet, and the controller's voice comes on again. "Make your transmissions nice and slow, guys. Let's keep it very cool." And there is a quiet assent among the desks.

On the lunar surface, Cernan and Schmitt have completed their preparations for the ascent into lunar orbit and the rendezvous with Evans in the command/service module. They pressurize the lunar module, and start the last checklist of actions before the final countdown to ignition. Cernan tells what he is going to do in those last seconds, and Schmitt acknowledges.

Cernan's voice comes on, counts down the last seconds. The watching audience in the viewing area sees, on television screens, the spidery-looking lunar module standing desolate and lonely on the surface. Then there is a burst of action; particles blast away from the invisible flame of the ascent engine, and the upper stage of the lunar module detaches smoothly and lifts into the lunar heavens.

Steadily, smoothly, rapidly it rises, reducing into a barely recognizable geometric solid, and then to a glow of light in the blackness. Across the television screens it moves, off the lower left-hand corner. There is a collective intake of breath by those watching.

Then the data points and communications come rapidly.

Across the projected images at the front of the control room, red and white data points march in orderly lines, easing around the predrawn curves, aligned with yellow curves on yellow grids. They crowd in almost perfect agreement with the computed data, and the voices between ground and the ascent stage continue to confirm that all is going well.

Slowly the data points move along, slowly approaching the ends of the lines and the attainment of lunar orbit. This is critical now; the ascent stage must orbit within closely defined dimensions to rendezvous with the command/service module in the inky reaches of space.

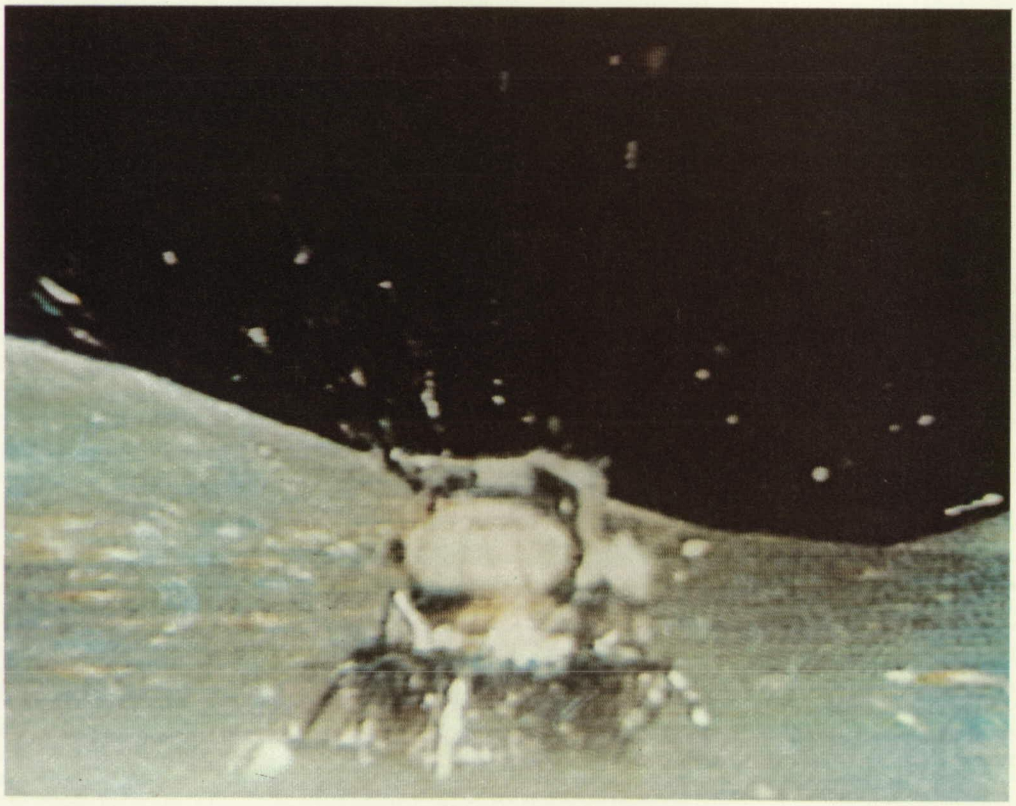
And now they reach the ends of the lines, and the red and white circles and crosses hide the nominal values figured earlier as datum lines. Cernan's voice calls off the orbital parameters from his on-board computer, and the control voice affirms. They are in lunar orbit.

Someone in the control room starts to applaud. Everyone joins in a collective gesture of relief, pride, joy, enthusiasm. And they file out, in twos and threes, as the voices continue to affirm the orbit, to discuss the advisability of "tweaking" it for more precise alignment of the two spacecraft, and to work on fixing or improving the communications which are giving some minor problems.

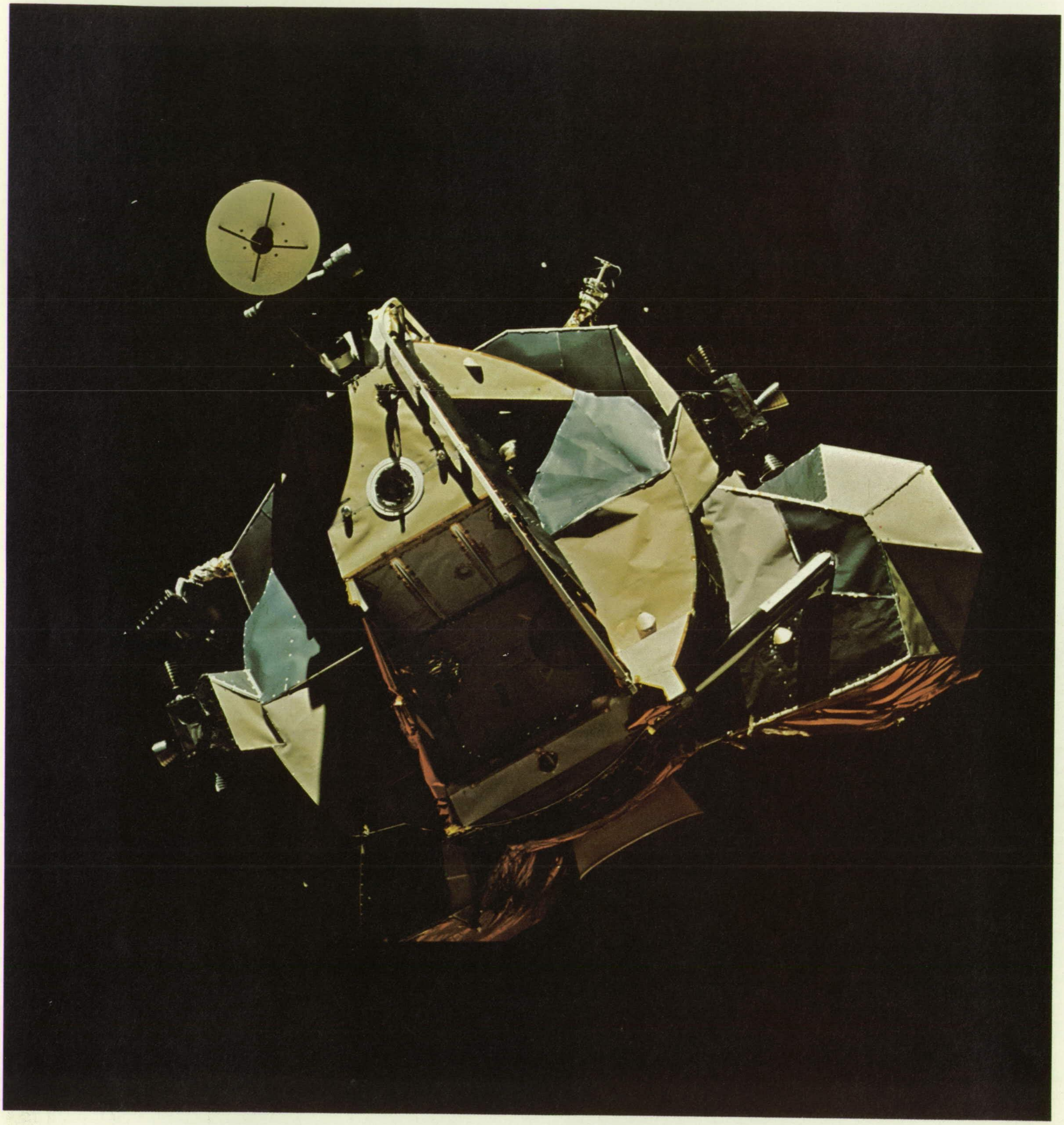
But the major task has been done. The Moon is below now and they are waiting for the rendezvous.

The television camera mounted on the lunar rover scans the lunar surface, still in a wide-angle setting from tracking the ascent. There, apparently far off, stands the descent stage of the lunar module, alone now, its task done. The camera zooms in for a closer look at the metallic spider in predatory pose, its golden legs glistening in the strong pale light. The camera holds on the module for a moment, and then cuts off. The screen is ribbed with bright bands of color, and the Moon's surface and the lonely module are blotted from sight.

A color television monitor in Mission Control records the instant of lift-off as Challenger's ascent stage begins the first leg of Apollo 17's trip back to Earth.



Challenger's ascent stage is the rendezvous target as Ron Evans eases the command/ service module through the docking maneuver. Astronaut Cernan's face is seen in triangular rendezvous and docking window on the right of the LM.



Rendezvous With America

And now in lunar orbit, Challenger and America eased toward each other for the critical rendezvous in lunar orbit, the achievement of the concept that made the entire Apollo mission possible. The Challenger ascent stage moved into an elliptical orbit around the Moon, closing to within 16.2 kilometers (9.3 nautical miles) of the lunar surface and reaching a maximum distance of 88.7 kilometers (47.9 nautical miles). Astronaut Evans, in the command/ service module, was in a near-circular orbit 114.8 kilometers (62 nautical miles) above the surface.

Challenger saw America first, at about 207 kilometers (112 nautical miles). Houston transmitted orbital corrections to Challenger, so that the two orbits would be brought together for the final phase of the lunar rendezvous. Then Evans' voice came through, confirming that he could see the Challenger spacecraft.

Challenger, behind America, closed rapidly on the spacecraft. Evans, in America, said: "I just started picking you up on the telescope . . . I don't care what you look like, come on back. I was going to shave and look nice for you, but I didn't have time. . . ."

Soon after, both spacecraft moved behind the Moon and their signals were lost. Hidden from the monitors on Earth, Challenger's ascent engine again thrust-sharply and briefly, nudging the spacecraft out of its elliptical orbit into an intersecting path with the course of the command module. Then out of the shadow they came, checking in with Houston and getting down to the fine details of rendezvous.

"I can see your thrusters firing now, Ron."

More exchanges of closing data, and then Evans said, "Looks like Challenger's in good shape. I don't see anything hanging down. . . ." "She's in excellent shape," Cernan answered, and added, ". . . you look pretty."

Then slowly, slowly the two vehicles closed the distance between them, Evans maneuvering to line up the spacecraft for the docking maneuver. "Okay, coming in nice and slow . . . no problems." "You're looking good . . . looking good . . . looking good . . . must be a couple of feet away . . . about two or three feet is all."

The first touching placed the two spacecraft in soft lock, without final latching and locking accomplished. There were some minutes of maneuvering, backing off, recapture and then Challenger spoke: "Okay . . . here he comes. Bang, two good old barber poles! . . . Okay, Houston, we're hard docked."

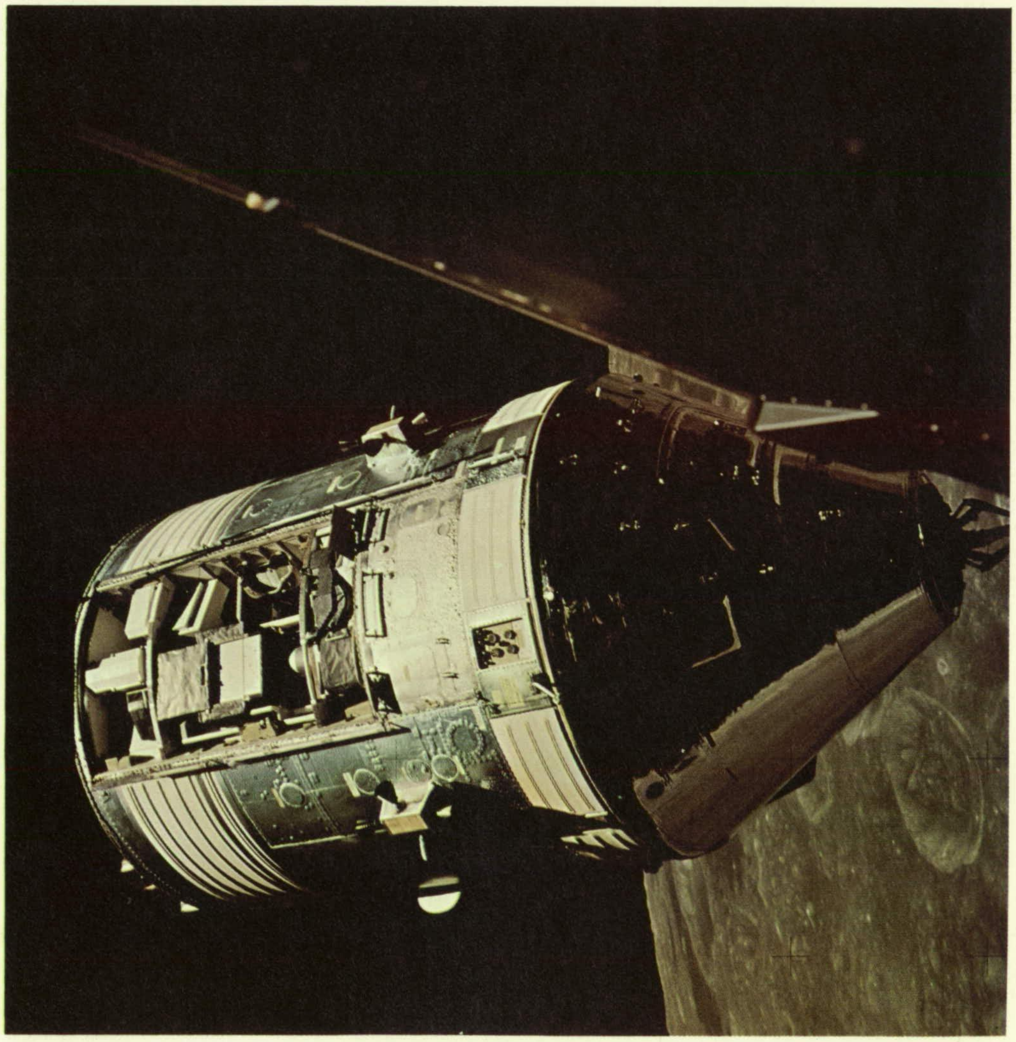
The barber poles, indicators on the command panels of Challenger, showed the latching. Challenger and America once again were a single spacecraft in lunar orbit.

Evans removed the probe and drogue assemblies and passed them through the airlock to Cernan and Schmitt, along with a vacuum cleaner and a list of the items that needed to be transferred from Challenger to the command module. Emptied, Challenger's ascent stage was sealed off from the command module and the three astronauts were back together in the command module for another day of work in lunar orbit before the start of the long voyage homeward.

"Don't let us bother you, Ron," said one of the returning astronauts. "You just go about and do whatever you want to do. We'll just get clean for the next three days."

Then the Challenger ascent stage was separated and, behind the Moon, nudged into a trajectory that would take it down to do its last job: crash on the Moon to get one more set of data points on the seismic instrumentation.

A good view of the Scientific Instrument Module bay is seen as the command/service module America maneuvers near Challenger's ascent stage prior to docking.



Turning Toward The Planet Earth

"Bob, that's the most beautiful crescent Earth I've ever seen," radioed one of the astronauts just before the end of their 67th revolution around the Moon.

They were nearing the end of the long exploratory work that had begun with their first visual sightings of the lunar surface, expanded through the work on the surface by Cernan and Schmitt, and continued with visual observations of the Moon during the orbits after ascent and rendezvous.

That phase was to continue for only eight more turns around the Moon, and then the trans-Earth injection burn would be done, in the shadow of the Moon, after the 75th revolution. As they emerged from behind the Moon, they would be headed back toward Earth and splashdown in the Pacific.

Now the last data were sent to update computers for the burn. "Okay, Jack, here's the numbers you've been waiting for," said Capcom. "TEI rev 75 SPS/G&N 36 372 plus 063 plus 086. Noun 33 is 236 42 08 35 plus 30398 minus 01850. . . ."

The signals went on in lengthy procession, and soon after, the spacecraft moved behind the Moon and signal was lost.

The times of signal loss always make for tension. The success or failure of operations done behind the Moon never is known until the spacecraft returns to the near side and radio contact can be re-established.

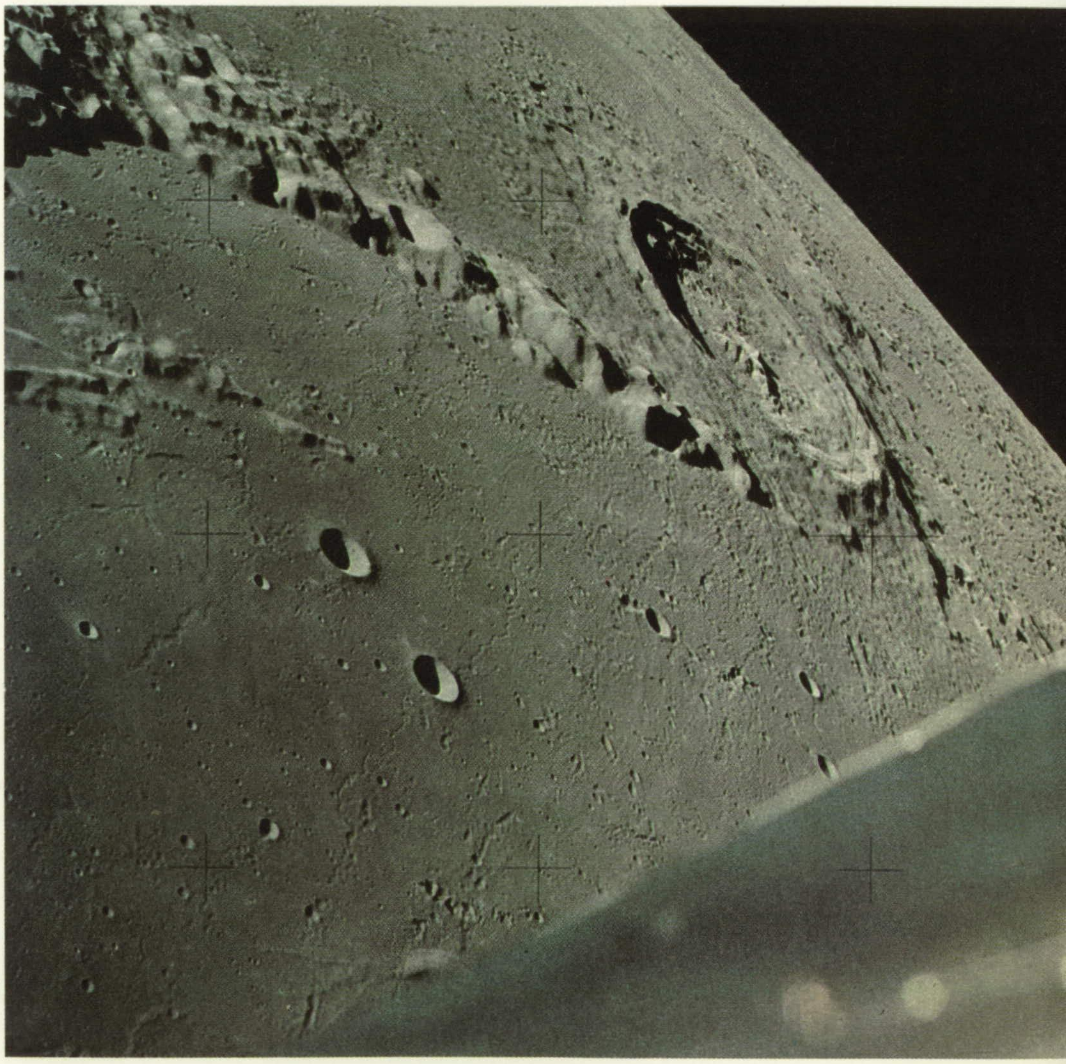
There was an expected dividend on this flight; it was to be only the second time that television from an Apollo spacecraft could show pictures of the far side of the Moon. The reason was that the burn on the far side would propel the spacecraft into a higher altitude, enabling contact with the Earth to be established earlier than usual. Then the on-board television camera could transmit pictures of portions of the far side.

The first signals from the returning America came via the 64-meter (210-foot) diameter antenna at Goldstone, California, and they were followed almost immediately by pictures of the far side, showing the crater Tsiolkovski. "Houston, do you read America?" queried the spacecraft, and, after Houston affirmed it, Commander Cernan said, "America has found some fair winds and following seas, and we're on our way home."

But even on that leg of the trip the work continued, with visual observations of the Moon. Schmitt reviewed some of the results:

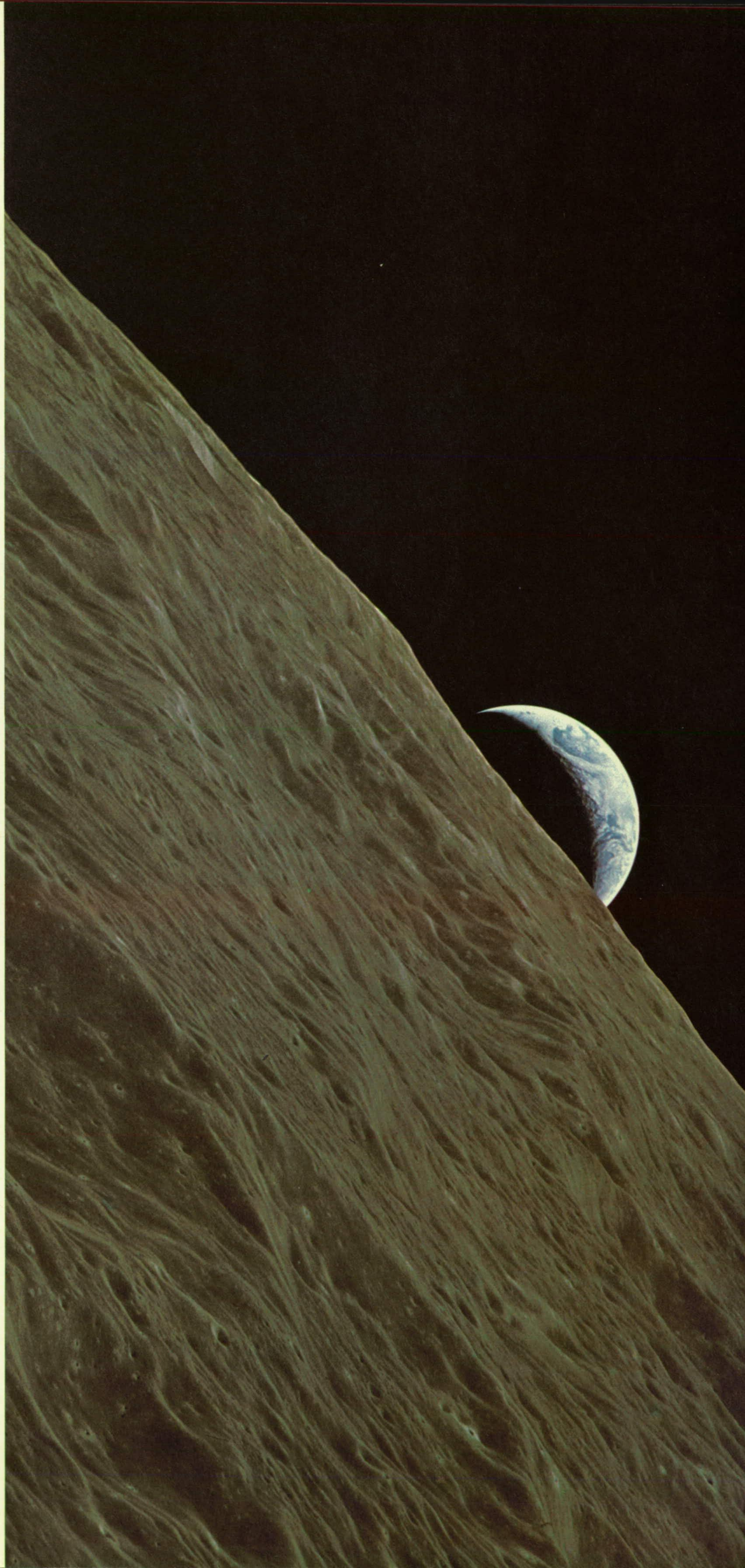
". . . we have pretty good evidence as a result of the Apollo program that . . . basalt flows . . . some three to four billion years ago erupted on the Moon and filled many of the lower areas that existed at the time. Not an awful lot has happened to the Moon—except for the impact craters, some of the younger ones—since three billion years ago, which is one of the reasons it becomes so interesting to man. . . . The Moon's frozen in a period of history three billion years and older, which is a period of history we cannot recognize very readily on Earth because of the dynamic processes of mountain building and oceans and weathering that are taking place even at the present time. Understanding that early history of the Moon may mean an understanding of the early history of the Earth. And I think we're well on our way to a first-order understanding of that history as a result of the program."

The Eratosthenes Crater and the southern tip of the Apennine range are seen below the lunar module.



A crescent Earth rises over the Moon in this photograph taken from lunar orbit by Astronaut Ron Evans.

Astronauts Cernan and Evans weightlessly drift into camera range aboard America.



Return, Re-entry And Recovery

The trip home was as routine as any trip back from the Moon could be. There was the excitement of Astronaut Ron Evans' excursion outside the command module to retrieve the film cassettes from the instrument bay in the service module, and his euphoric comments during that spectacular space walk. He got the film and returned it, and he commented on the view, the external condition of the spacecraft, spoke to his two children, sang, and generally behaved as others have who personally encounter space, freed of the shackles of a confining spacecraft.

The final test of the spacecraft and its systems came during the last minutes of the flight and the blazing re-entry through the Earth's atmosphere. The command and service modules separated, and Cernan maneuvered the command module to position it for the re-entry, its heat shield facing into the direction of flight. And about 304 hours after the spacecraft had lifted off the pad at Cape Kennedy, it slammed into the Earth's atmosphere, in a streaming, flaming dive toward the surface. Behind it trailed the tongues of flame from the instant combustion and ionization of the heat-shield material.

Then there was loss of radio contact, as the spacecraft plunged into the blackout zone, where the ionization from the burning heat shield hides all radio transmission. After a long and agonizing three minutes, voice contact came through again and then the atmosphere began to slow the craft, the drag force pressing the astronauts into their contoured seats with more than six times their normal weight.

Then there was the welcome sudden deceleration as the three drogue parachutes streamed behind the spacecraft, slowing it further. And, less than a minute later, the three main braking parachutes streamed, and blossomed behind and then above the descending command module. Down it came, dropping slowly toward the calm blue Pacific, and splashed down into the pattern of three-foot waves within sight of the recovery ship.

Cernan, Evans and Schmitt were back home, back home on Earth, back home on a small blue world in a dark corner of the galaxy.

Ron Evans retrieving exposed film and tape cassettes from the open bay in the side of the service module during a "spacewalk" on the return trip to Earth.

Recovery helicopter uses its rescue sling to lift the astronauts from the life raft next to the floating Apollo command module. USS Ticonderoga, the recovery carrier, lies in the background.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Science Results

The flight phase of the Apollo program now is over; but the scientific analysis of its data has hardly begun. For months and years to come, the measurements from Apollo 17 and its predecessor missions will continue to provide bases for understanding and argument about the Moon, the Earth, and their very ancient histories.

For science moves deliberately—some might say slowly—to analyze data taken during experiments. The sheer volume of data—already measured in the tens of billions of data points—precludes any rapid results. Further, some of the experiments that were emplaced on the Moon are designed for long-term exposure and are intended to return raw data for several years.

But there are preliminary results from some of the tests. The lunar seismic profiling experiment, for example, which uses explosive charges to explore the interior of the Moon, already has noted the impulse of the lunar module ascent engine firing, and the impact of the spent module after it impacted back on the Moon. The small explosive charges left on the surface were detonated after the astronauts had returned to lunar orbit, and showed that the sub-surface structure of the Apollo 17 site was definitely different from that of either Apollo 15 or 16.

That lunar module impact, plus the much earlier impact of the spent Saturn S-IVB stage, registered on the passive seismology experiment previously deployed on the Moon. And these two shocks, which doubled the amount of previous data, have shown the possibility that the Moon's crust is considerably thinner than the 60 kilometers (37.2 miles) earlier postulated. It's possible, said one scientist, that the thickness is only 25 kilometers. But there was prompt disagreement from another scientist, and the final results are yet to come.

The heat flow from the lunar crust appears to confirm the results of Apollo 15, which surprised the scientists with its high value. What this means is that the interior of the Moon may be warmer than expected, and this in turn hints at large quantities of radioactive materials in the lunar structure. There appears to be a much higher concentration of those materials on the Moon than there is on the Earth, leading to further arguments against the theory that the Moon was torn from the mass of the Earth.

First results from the lunar traverse gravimeter show that there is a high-density material filling the valley between the North and South Massifs, with greater thickness than expected. The implication, then, is that the valley originally was a very deep one, prior to its flooding from the Mare Serenitatis.

Geologically, there was a feeling that everything planned had been accomplished. The surface samples, the detailed documentation and observation of large boulders and surface features, and the visual descriptions of the surface by the astronauts during their EVA and orbital times, added immeasurably to man's knowledge of the Moon.

The orbital science experiments, oriented toward geophysics in contrast to earlier missions that concentrated on geochemistry, worked to near-perfection.

Five continuous revolutions' worth of data were obtained by the laser altimeter, which added to altitude profile data, and the continuity of the data will help recover gravity information as well. The panoramic and mapping cameras, which recorded the lunar surface on several miles of film, should produce the best series of maps yet developed for the Moon.

The lunar sounder, designed to probe the depths of the Moon with electromagnetic signals, acquired that data along a 49,000-kilometer (38,000-mile) track and returned more than 500 million soundings. All of that data was recorded on film, and will have to be processed and analyzed after the return to Earth.

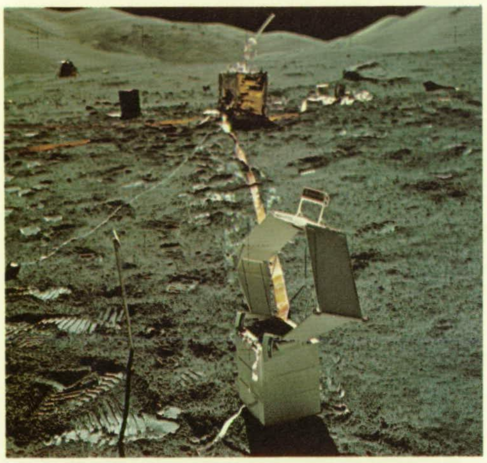
The infra-red scanning radiometer produced coverage of about one-third of the surface area of the Moon, and made about 100 million independent temperature measurements, during both day and night on the Moon. These points, which will produce thermal maps of the Moon, will lead to a new technique for exploration of planetary surfaces that lack an atmosphere.

The ultraviolet spectrometer experiment, whose prime function was to measure the lunar atmosphere, was unable to detect evidence of any major or even minor constituents of that atmosphere. In fact, all it recorded was one trace component of the lunar atmosphere. Said the principal investigator of that experiment, "What's behind us is the rather startling discovery that the Moon simply is not de-gassing; it has nothing left in terms of anything that would create an atmosphere."

A panoramic view of the ALSEP site taken during EVA 1. Seen are the gnomon and geophones in the left foreground, with the main science station further away. The North Massif is in the background.

Taken during EVA 3, this photograph shows the deployed ALSEP (Apollo Lunar Surface Experiment Package). The Lunar Surface Gravimeter is in the foreground and the Sculptured Hills are in the background.

Astronauts



Cernan, Evans and Schmitt, the crew of Apollo 17, were as typical or untypical as any other astronaut crew. In their late thirties, all three had long experience in their specialties. Cernan and Evans were from the Navy, and had been pilots; both had engineering degrees. Schmitt was the first professional scientist to go on a space mission, being a hard-rock geologist.

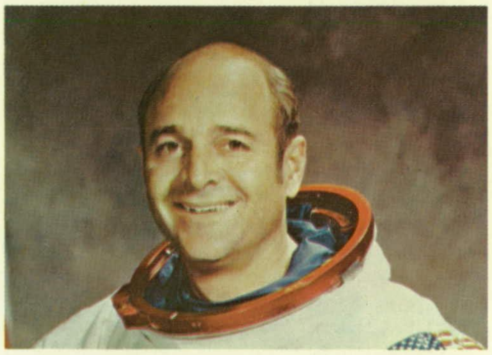
Eugene A. Cernan, born in Chicago in 1934, was an engineering graduate in Electrical Engineering from Purdue University, and holds a master of science degree in Aeronautical Engineering from the U.S. Naval Postgraduate School. He was commissioned in the Navy through the ROTC program at Purdue, entered flight training just after graduation, and has since logged more than 3,800 hours of flight time. He is a Navy Captain, and was one of the third group of astronauts, selected in October 1963.

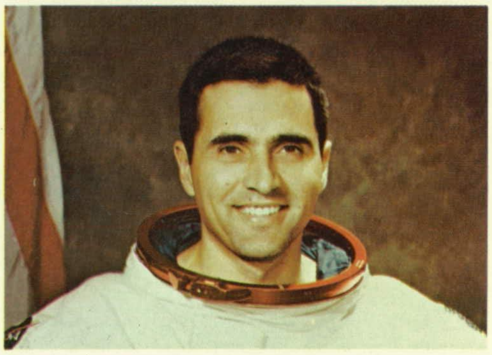
Space flight is not new to Cernan. He shared the Gemini 9 mission as co-pilot to command pilot Thomas P. Stafford, and completed a two-hour space walk outside that spacecraft. He was lunar module pilot for the Apollo 10 mission, the dress rehearsal for all that came after, and flew that spacecraft to within 14.8 kilometers (8 nautical miles) of the Moon's surface. On Apollo 17, he was crew commander.

Ronald E. Evans was born in St. Francis, Kansas, in 1933. His training included a bachelor of science degree in Electrical Engineering from the University of Kansas, and a master of science degree in Aeronautical Engineering from the U.S. Naval Postgraduate School. Commissioned after ROTC at the University of Kansas, he flew naval aircraft in tours of duty on carriers. When NASA notified him of his selection as an astronaut in April 1966, he was serving in the Pacific aboard the USS Ticonderoga, the same carrier that was to become the recovery ship for the astronauts of Apollo 17 more than six years later. This flight is his first into space; but he has been a backup and support crew member on earlier Apollo missions. He was Apollo 17 command module pilot.

Harrison H. Schmitt was born in Santa Rita, New Mexico, in 1935, the son of a mining geologist. His undergraduate work was done at California Institute of Technology, and after post-graduate studies at the University of Oslo in Norway, he received his doctorate in geology from Harvard University.

He was selected as an astronaut by NASA in June 1965 and went through more than a year of flight training to learn the piloting skills necessary to the mission. With more than 1665 hours flying time logged, Schmitt was selected as the lunar module pilot for the Apollo 17 trip.





Eugene A. Cernan, Captain, U.S. Navy

Ronald E. Evans, Captain, U.S. Navy

Harrison H. Schmitt, PhD.

The Next Steps In Space

Apollo 17 has been called an end and a beginning. More accurately, it is an important way-point in the exploration of space by manned and unmanned spacecraft. Apollo 17 was the last of the manned Apollo missions; but it is far from being the last manned space flight effort.

At this moment, the first of the Skylab orbital workshops and its launch vehicle are standing assembled in the huge Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center. Due to be launched in mid 1973, the Skylabs will be used for a wide range of scientific and medical experiments, aimed primarily at understanding the requirements for long-term stays in space.

In Skylab, the first emphasis will be properly placed on a series of medical experiments to determine how well man can adapt to the conditions of long-term exposure to the peculiar characteristics of space. Additionally, a number of solar astronomy experiments will be performed, studying the Sun through the uncluttered distance between an on-board telescope and our primary star.

Potentially the most valuable of the Skylab experiments, in their possible applications to the problems of everyday life, are a series of Earth surveys that will be made. Observations of the Earth, from Skylab heights, will continue to yield more of the kind of information that can be useful at ground level.

Skylab draws on both the expertise and the hardware of the Apollo program. The Saturn V booster will place in orbit the workshop cluster, a structure consisting of the workshop itself, modified from a Saturn S-IVB stage, the Apollo telescope mount, an airlock and a docking adapter. This cluster—weighing 82,237 kilograms (181,300 pounds) and spanning 35.97 meters (118 feet)—will be orbited at a height of 435 kilometers (235 nautical miles) in a nearly-circular path inclined at 50 degrees to the Earth's polar axis.

About a day after the launch of the workshop cluster, the first manned flight—Skylab 2—will be launched. Lifted into orbit by a Saturn IB booster, the three-man crew will make the trip to their orbital home in a modified Apollo command/service module. They will rendezvous and dock, and enter the workshop for a time period of 28 days to conduct the planned programs of experimentation.

Their laboratory will give them considerably more room to move around than the Apollo astronauts enjoyed. The total work volume of the Skylab workshop cluster is 316.45 cubic meters (12,673 cubic feet) which is about the size of a four-bedroom house.

At the end of their 28-day stay, the crew will ready the workshop for a two-month dormant period. They will then enter the command/service module, separate from the cluster, and return to Earth.

After two months, the second crew will make its journey to the workshop, this time for a stay of 56 days. But, having studied most of the medical problems in the earlier stay, this time period will concentrate on the solar astronomy and Earth resources experiments.

Skylab 4, the last of the planned programmed launches, will go aloft about a month after the completion of the second mission, and will also stay in orbit for 56 days. Earth resources will receive the major share of the attention on this trip.

You can see the evolution of the space program by studying the progress made from the early days of the one-man Mercury flights. A program as daring as the introduction of man into space must, of necessity, start at the first step. And so the first Mercury flights lofted astronauts into ballistic trajectories above the Earth to check initial problems and reactions to manned space flight. Stay time was increased as the orbital trips were added. Two-man Gemini teams explored the concepts of working together to achieve longer stay times and to perform more useful tasks.

Then came Apollo, with its long-term Earth orbits with a three-man crew. Apollo 11, as the first lunar landing, proved that the trip could be made safely. Apollo 12 proved that lunar landings could be made precisely. Later Apollo missions proved the usefulness of man as an explorer and scientist in space as he was on Earth.

Then came Skylab, the logical next step, with its extended stay times in space and the opportunity to study Earth over extended periods. It's too early to predict, but the Skylab work may prove to be the most valuable space experiments ever undertaken, in terms of direct applications to everyday problems on Earth.

Beyond Skylab there are two programs of extreme interest. The first is the joint Apollo-Soyuz test program, to be the first international space effort. American astronauts, in an Apollo spacecraft, will rendezvous, dock, and visit an orbiting Soyuz. In turn, Soyuz crewmen will pass through the docking module and return the visit to the Apollo.

The target date for the launch is July 15, 1975.

There is a deep and serious purpose behind this first planned experiment with Apollo and Soyuz. The first flight will test the designs, the ability to work together, and the ability to communicate and control a joint program. Later spacecraft of both nations will be designed so that they can rendezvous and dock with each other and with their space stations in an extension of that first cooperative joining in space.

Finally, the real benefits of space appear to be achievable only if some economical means of getting to and from orbit can be established. It is, at the moment, costly to use a huge launch vehicle to loft one spacecraft into space only to soon be discarded in a flaming plunge back into the Earth's atmosphere.

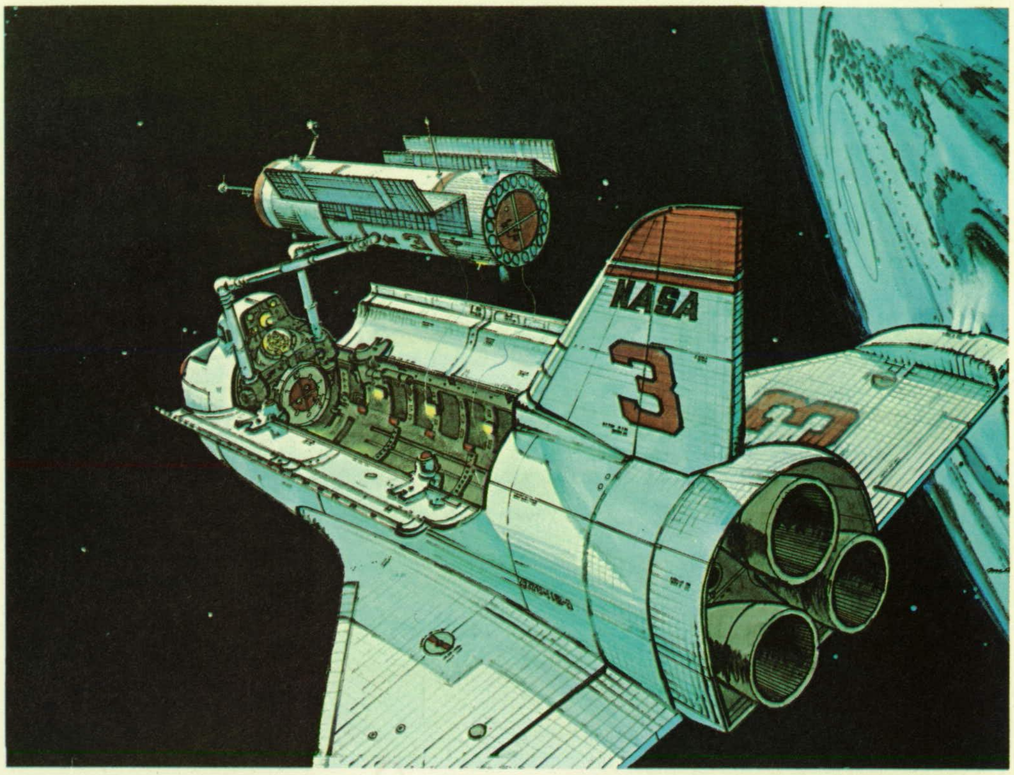
One answer is the space shuttle, an airplane-like orbiter roughly the size of a contemporary twin-jet airliner. Strap-on solid propellant rockets will launch the shuttle initially, and its own propulsion system will take over as the second stage.

The spacious design of the shuttle will provide an enormous amount of space—equivalent to the passenger cabin volume of today's four-engined jet air transports—in which payloads can be carried to and from space. Imagine the convenience of carrying a complete scientific satellite, plus the crew to maintain it, to an orbit where it can be parked and watched. Or the ability to retrieve an important satellite communication link, and replace some critical component whose life is limited by time.

The shuttle, after its trip into orbit, can literally fly back to Earth, making a conventional landing at an airstrip. Two weeks later it can be ready for another trip.

The payoff here lies in two areas: first, the convenience of the shuttle in getting to and from space easily and economically; second, in the economics

The space shuttle, a re-usable vehicle for travel from Earth to orbit and back again, promises to increase the benefits of space research while lowering the costs of operations.

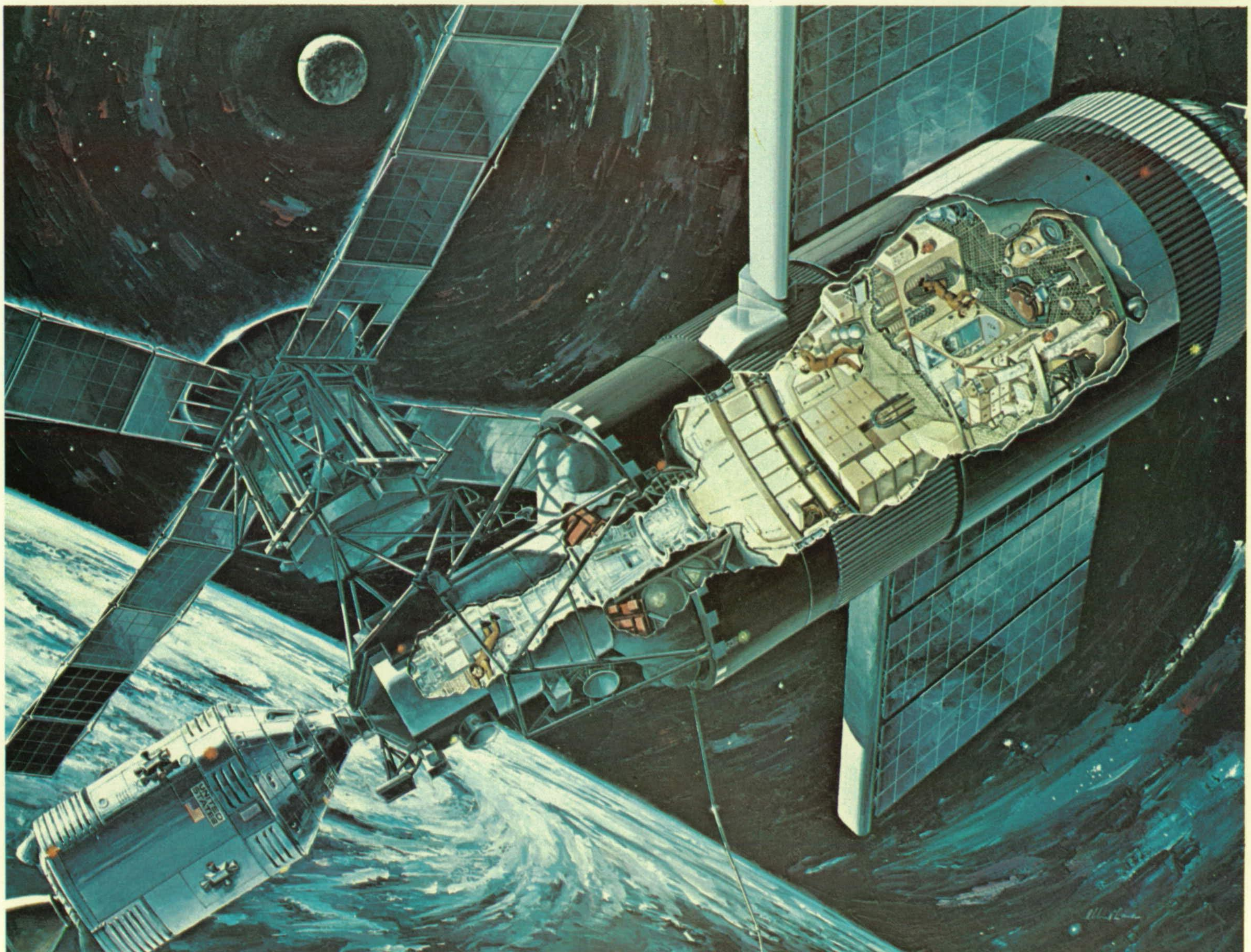


of the shuttle. To take a pound of weight to orbit now costs about $1,000 or more, depending on the vehicle used. The shuttle costs are expected to reduce that figure to something less than $200, perhaps as little as $160 per pound in orbit.

To put that into perspective, you can orbit the Earth once, right now—admittedly at a much lower altitude and via commercial airlines—for about $10 per pound of your weight.

The space shuttle economics may or may not ever permit fares like that. But one thing is certain: the space shuttle will provide the only way to make the benefits of space readily and cheaply available. As President Richard Nixon said early in 1972, the space shuttle "... will go a long way toward delivering the rich benefits of practical space utilization and the valuable spinoffs from space efforts into the daily lives of Americans and all people."

Skylab will conduct space science, medical, Earth resources and other experiments in an Earth-orbiting laboratory.



Apollo 17 1972 Time of major flight events

Launch at Kennedy Space Center	12:33 a.m., December 7
Spacecraft enters lunar orbit	2:48 p.m., December 10
Lunar module lands at Taurus-Littrow	1:55 p.m., December 11
Liftoff from Moon	5:55 p.m., December 14
Trans-Earth injection	6:35 p.m., December 16
Splashdown	2:24 p.m., December 17

Apollo 17 1972 EVA on Moon

	Start	Duration	Distance driven with LRV	Rocks collected
First EVA	6:55 p.m. Dec. 11	7 hr. 12 min.	4.4 km. (3 nmi.)	13 kg. (29 lb.)
Second EVA	6:17 p.m. Dec. 12	7 hr. 37 min.	20 km. (12 nmi.)	36 kg. (80 lb.)
Third EVA	5:23 p.m. Dec. 13	7 hr. 17 min.	11.6 km. (6 nmi.)	66 kg. (145 lb.)

Note: All times Eastern Standard.

Epilogue

". . . if ever there was a fragile-appearing piece of blue in space, it's the Earth right now."

When much else has been forgotten about the Apollo program, people will remember the astronauts' descriptions of their views of the Earth from space, a small, blue, lonesome sphere sailing through a dark galaxy. It was the manned spaceflight program that first gave people an awareness of just how small and finite and limited are the resources of spaceship Earth.

The problems were defined more clearly and more tellingly than ever before. Manned space flights awakened a worldwide consciousness that Earth, our home, was all we had to share among billions of people of all colors and all philosophies. It underlined the fragility of this tiny blue sphere, the pitifully small amounts of water and rainfall, snow in the mountains and blue seas, of green pampas, broad steppes, hillside farms and rice paddies.

But Apollo did more than define the problem. It began to suggest solutions. With men as trained observers in space, people could watch over their own spaceship, could see the fouling of its water and the loss of its green lands, and could begin to plan solutions. Sensitive instruments, cameras, spectrometers, human eyes could see what needed to be done, and send back the coordinates of trouble.

It has been said that you can't begin to understand a problem until you can look at it from a distance. The Apollo program, and the manned space flights that will surely follow, place mankind at that needed distance so that he can ponder solutions to his problems.

So it is interesting that scientists will better understand the origins of the Moon, and therefore, of the Earth.

But it is vital that man finally has seen his home from the depths of space, and has understood, after all, how frail an abode it really is.

Earth, the frail blue planet, as seen from the returning Apollo 17.

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