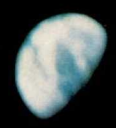
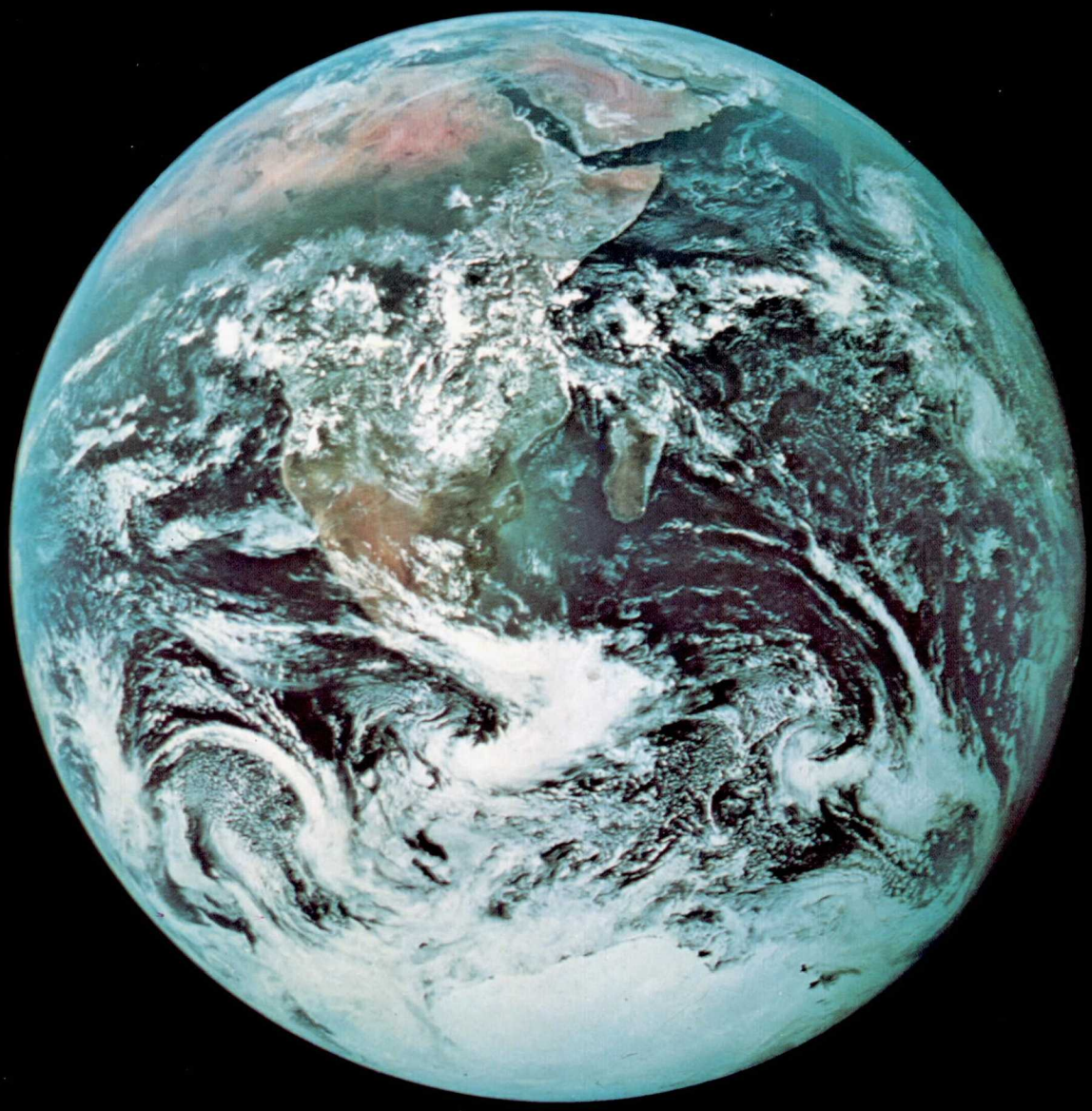


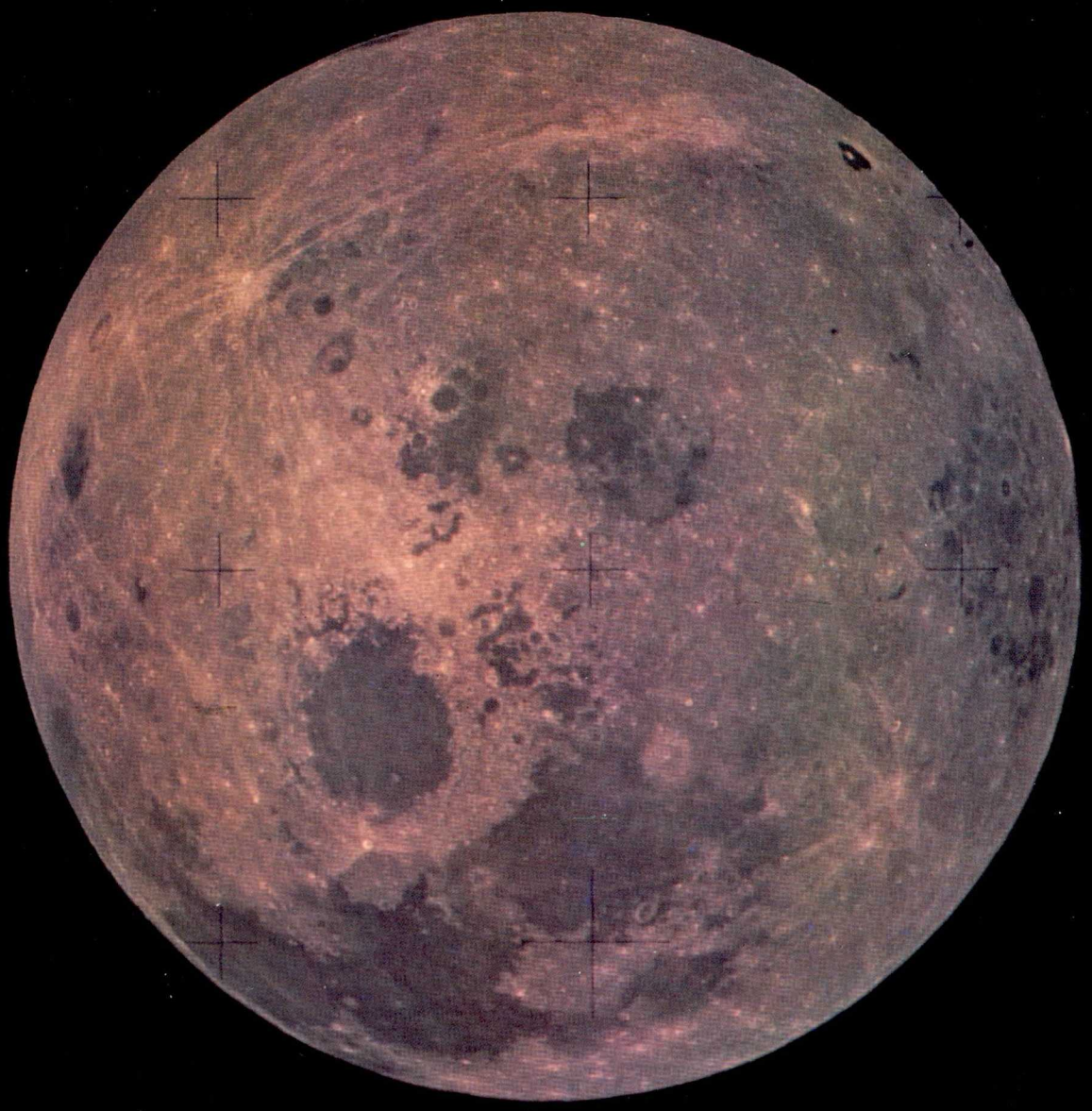
Apollo



cover photo: *Eugene A. Cernan, commander of Apollo 17, adjusts United States flag set up on Moon.*

Africa, Arabian Peninsula, and island republic of Malagasy are clearly visible from Apollo 17.

Apollo

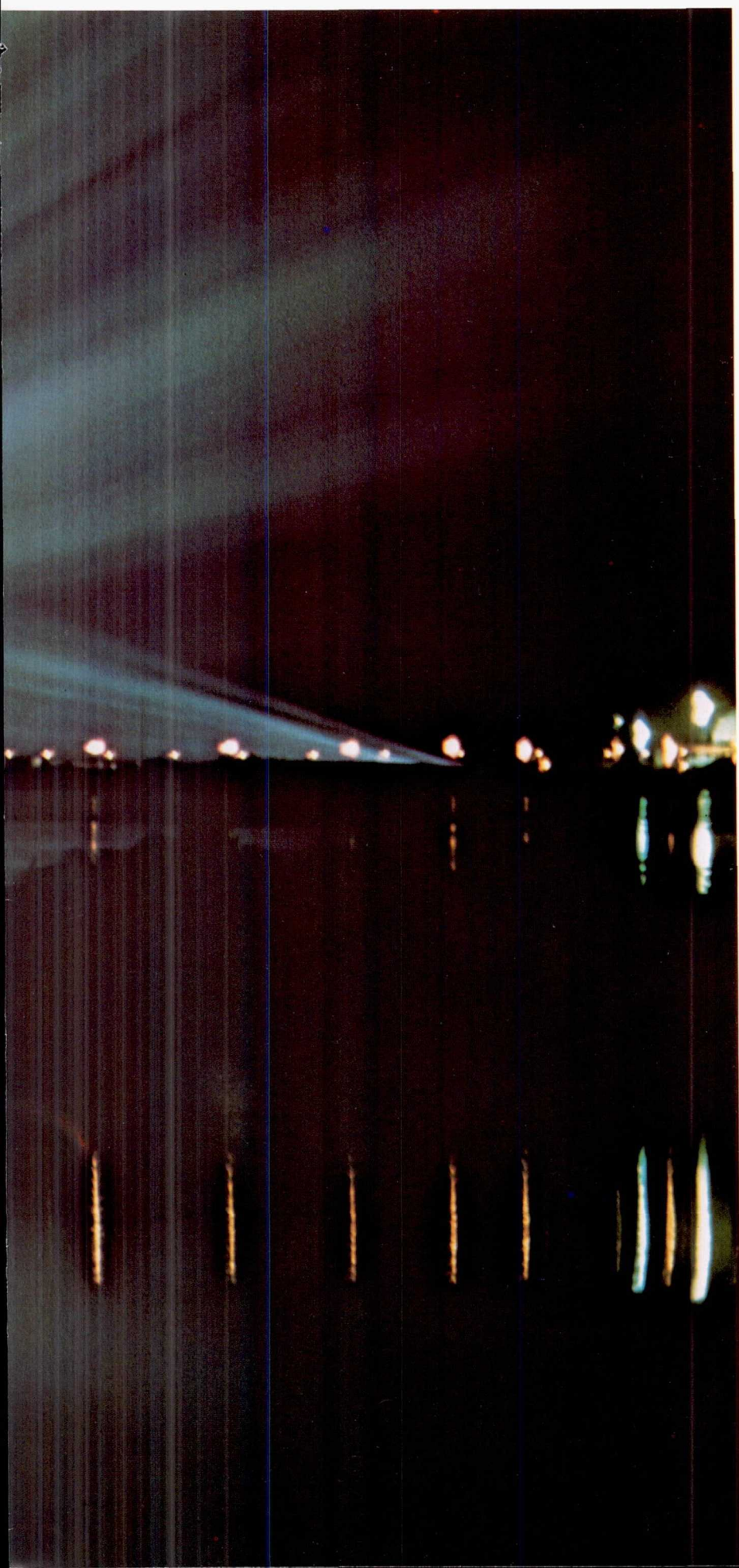


View of Moon from Apollo 13 as spacecraft was returning to Earth.

Apollo 10 lift-off as viewed by fish-eyed camera.

Apollo

Text by Russell E. Chappell



Contents

In play of searchlights, Apollo 11 gleams on pad like a giant star sapphire.

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Introduction

It was as if man, experimenting at the verge of the River Euphrates, had just learned that a hollowed-out log would float and had tested it timidly on a voyage near the shore. And his chieftain declared, "Before the end of this millenium we shall build a much larger boat, sail it to the end of the great Western Sea, and return safely."

That was where man stood, in a sense, in 1961. He had recently learned how an object no larger than a basketball could be rocketed into orbit around the Earth. Only one mortal had yet traveled such an orbital path. And the President of the United States set forth the task: "... This nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth."

The decade is over and the task is done; Project Apollo has been achieved.

How to measure the accomplishment? As a triumph of exploration that landed 12 brave men on the Moon? As a supreme test of technology that marshaled the brain and muscle of half a million people to create the world's greatest machine? As a monumental scientific inquiry that delivered billions of bits of data to investigators on Earth and yielded new insight on the origin of the universe?

Certainly Apollo accomplished all of these things and did them superbly well. Consider the machine, the propellant-loaded Saturn V rocket. All 2.7 million kilograms (6 million pounds) of it in three giant stages towered 28 stories above the launch pad at Cape Kennedy, its 11 engines ready at ignition to develop the power to send 43,000 kilograms (95,000 pounds) racing Moonward. It performed without flaw on nine missions to the Moon.

Regard the men, the dozen who walked on the lifeless surface of the Moon and the 15 others who flew into the grasp of its one-sixth gravity. The astronauts demonstrated that, however sophisticated the machines—Ranger, Lunar Orbiter or Surveyor—that got there before him, man's intelligence was essential to exploration.

Remember Apollo 17, the final mission, and Astronaut Harrison (Jack) Schmitt, the first geologist on the Moon? On the rim of Van Serg Crater, he and Astronaut Gene Cernan got orders from Earth to depart "... immediately if not sooner."

"We can't . . . we can't leave this," Schmitt insisted. "This may be the youngest mantle over whatever was thrown out of the craters," and, when Cernan too insisted on staying longer, Mission Control deferred to the judgment of man on the scene. Cernan and Schmitt brought back a sample of the Moon that a machine, on command from Earth, would have obediently abandoned.

Then there was Apollo 13, when for the only time during the project the Apollo spacecraft failed, and the men in the black emptiness of space used their skill and intelligence to fight for—and win—their lives. They were more than 320,000 kilometers (200,000 miles) from Earth on the outward voyage and moving 3,400 kilometers, (2,100 miles) closer to the Moon with each hour when an explosion in its Service Module crippled the command ship. Astronauts James Lovell Jr., Fred W. Haise Jr., and John L. Swigert Jr. took to what they called their life raft, the Lunar Module Aquarius, rode it around the Moon, and back to Earth, reboarding the cold and waterless Command Module Odyssey for their successful reentry and splashdown. Swigert was a last-minute replacement for Astronaut Thomas K. Mattingly II who had been exposed to German measles during launch preparations.

"We do not realize what we have on Earth until we leave it," said Lovell, who, while on the long way home, called Earth "a grand oasis in the vastness of space."

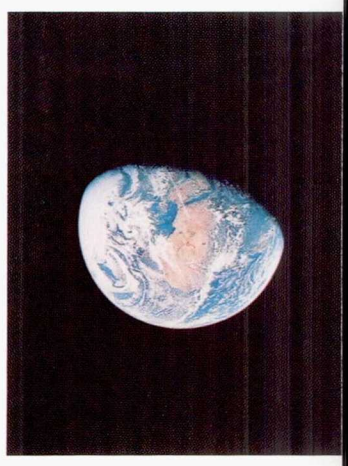
It was a theme voiced repeatedly by the men who had penetrated the void, had ventured far enough beyond the Earth to see it from the cold and airless emptiness around us as the frail and beautiful place it is in the inimical surroundings of the solar system. Astronaut Frank Borman, who commanded Apollo 8, the first mission to encircle the Moon, borrowed the eloquence of the Old Testament to express his awe at the glory of Earthrise as seen from above the bleak lunarscape.

". . . And God saw that it was good," he concluded his reading of the Story of Creation in the first 10 verses of Genesis, and then he added in his own words, "God bless all of you—all of you on the *good* Earth."

Astronaut Neil Armstrong, who put the first human footprint on the Moon, will forever be known for his remark on that historic occasion, "That's one small step for a man, one giant leap for mankind." But Armstrong also had something to say about what Earth means to those who have ventured away from it: "We were sorry to see the Moon go," he said, commenting on the liftoff of Lunar Module Eagle from the Moon, "but we were certainly glad to see that Earth return."

Even as the men in space looked on the Earth and saw that it was good and, compared with the dark void in which it orbited, was small and limited, the people on Earth were discovering how they had fouled the waters and paved over the green land and wasted the resources from a restricted supply. Pictures that the astronauts took from space, showing the Earth fragile and blue and vivid in the dark, told all who would look that three billion of us ride a spacecraft in a deady vacuum with a life-support system as vital to us all as the backpack to an astronaut on the lifeless Moon.

What the men in space could tell us about our plight, fortunately for the Earth and its people, was not all they had to tell. Their eyes and cameras and sensitive instruments could pinpoint the ravished spots on the planet. Their discoveries about the composition and possible origin of the Moon, too, tell us more about the beginnings of our Earth and what may be done to take care of it and its precious life-support system.



In terms of man's history on Earth the Space Age is a mere blink of the eye. Yet in this blink of the eye the dimensions of man's capabilities in science and engineering have burst all shackles at a wildly accelerating rate. The limits to what man can do and where he may go are vanishing.

Is there any reason why we cannot, as did the crew of Apollo 13, call on our vast technology, our science, our own wit and courage to save ourselves from the void? The Earth, we all know now, is a spacecraft that must be saved to save ourselves.

Man Dares to Orbit

To comprehend how the future could be squeezed into so small a piece of the present, it helps to know where technology stood on Oct. 4, 1957, when the beep of Earth-orbiting Sputnik announced the dawn of the Space Age. That only 12 years later men could land on the Moon and return seems breathtakingly quick.

But the state of the art, as the engineers say, was such that the means for exploring space were close to hand in 1957. The Soviet Union, partly because of its remote geography, had decided to develop a long-range rocket as early as 1947 and, six weeks before Sputnik flew, announced that the job was done. American scientists and engineers, building on the German experience with the V-2, which in turn was based on the work of American Robert Goddard, had been working on rocketry for all three branches of the military.

Nineteen fifty-seven, moreover, was the International Geophysical Year, a world-wide scientific effort scheduled to run on, oddly enough, for 18 months and expire at the end of 1958. Sometime during those 18 months, the United States had promised, a scientific satellite would be lofted into orbit. When the bird, the 3.6 kilogram (8 pound) Vanguard, finally flew on March 17, 1958, it was a month and a half after the Army's Explorer I became the first American satellite.

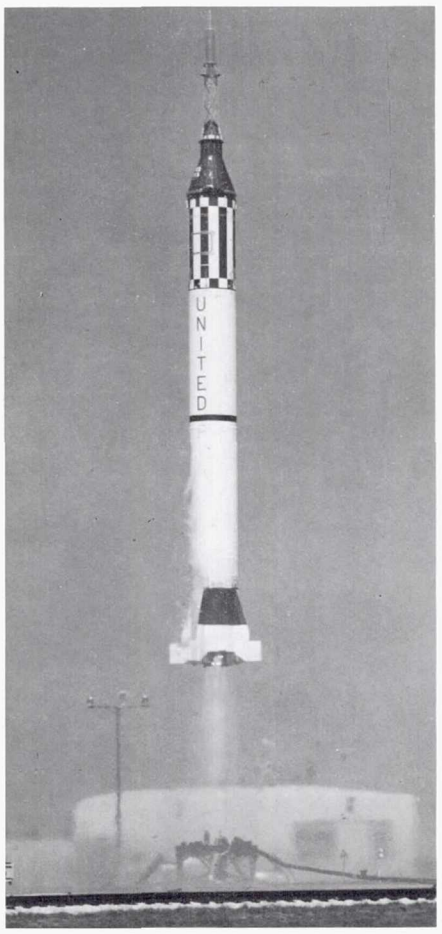
So when the National Aeronautics and Space Administration, created by Congress to explore space, opened for business on Oct. 1, 1958, the new agency could draw upon programs in being, could absorb the very people who were doing the work and the places where they were doing it. From the first week of its existence NASA was able to consider the proposal to put a man in orbit around the Earth, measure his reactions in space flight, and get him safely home.

"Let's get on with it."

With those words, T. Keith Glennan, the first NASA administrator, launched Project Mercury. It got under way in 1961 with suborbital flights by Astronauts Alan B. Shepard Jr. and Virgil I. (Gus) Grissom, went on to send John H. Glenn and then M. Scott Carpenter on three-orbit missions and the six-orbit mission of Walter M. Schirra Jr. in 1962 and ended with the 22 orbits by L. Gordon Cooper in 1963.

It was only 20 days after Shepard's 15-minute parabola down range from what was then called Cape Canaveral that President John F. Kennedy went before Congress and called for a national effort to send men to the Moon and back. "I believe we possess all the resources and talents necessary," he said, "but . . . we have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment."

The first seven astronauts, from left: M.Scott Carpenter; L.Gordon Cooper, Jr.; John H.Glenn,Jr.; Virgil I.Grissom; Walter M.Schirra,Jr.; Alan B.Shepard, Jr.; Donald K.Slayton.



Redstone launches Grissom on second manned suborbital flight.

Glenn enters Mercury spacecraft preparatory to America's first manned Earth orbital flight.

Shepard is lifted aboard helicopter after completing first U. S. manned suborbital mission, May 5, 1961.

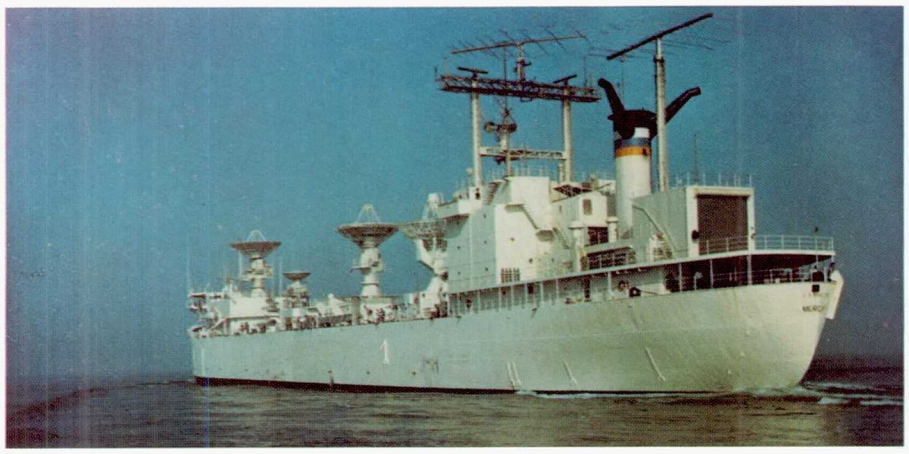
And then he established the timetable—"before this decade is out."

Up to then the space agency had been thinking about a Moon voyage as something that might take place at some vaguely future date in the 1970s. NASA planning was based on the development of ever-stronger boosters. The strongest of the vehicles then being developed, the Saturn I, had eight engines and 6.6 million newtons (1.5 million pounds) of thrust. It had just passed a tied-down firing test.

For a manned mission to the Moon, Project Apollo would need a monster called Saturn V; each of the five engines in its first stage alone would be more powerful than all eight of Saturn I's. (The little rocket on Apollo's escape tower, as it came about, had more boost than the Redstone that lifted off Alan Shepard.) And Saturn V would have to be ready and thoroughly tested *before* 1970.

Saturn V was just one item on the long shopping list that NASA's next administrator James E. Webb took to the industrial marketplace, where 95 per cent of NASA funds were to go. Cape Canaveral, soon to be renamed Cape Kennedy, needed a building 525 feet tall where the Saturn V, the Apollo spacecraft, and the Moon landing ship could be put together atop a tracked carrier as big as a baseball diamond.

The NASA Marshall Space Flight Center in Huntsville, Ala. needed test stands big enough to hold down Saturn V during static tests. As the command center for Apollo missions, the NASA Manned Spacecraft Center was to be built at Houston, Texas. To track the spacecraft and collect information from them, the network directed from the NASA Goddard Space Flight Center in Greenbelt, Md. had to have new land bases around the world and ships specially

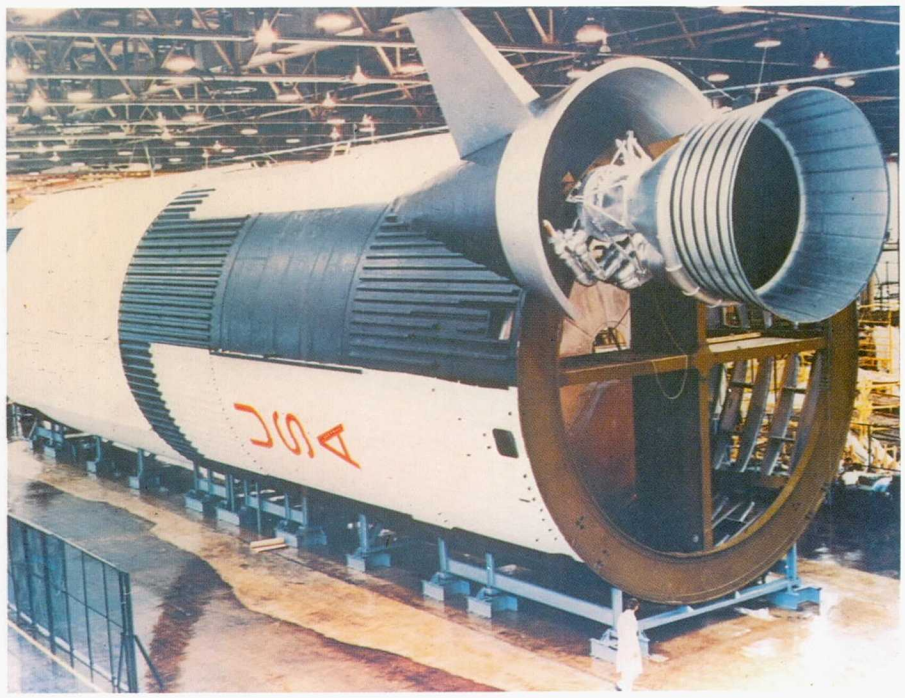


USNS Mercury, used for tracking when Apollo spacecraft were in Earth orbit.

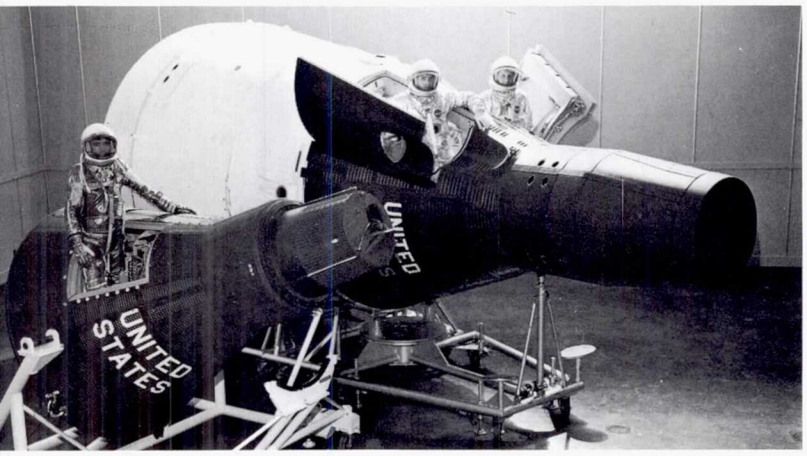
Above right: Test firing of Saturn V second stage.

Saturn V test flight.

Transporter carries Apollo 10/Saturn V from Vehicle Assembly Building.



Saturn V (1st) stage at Michoud Assembly Facility, New Orleans, La.



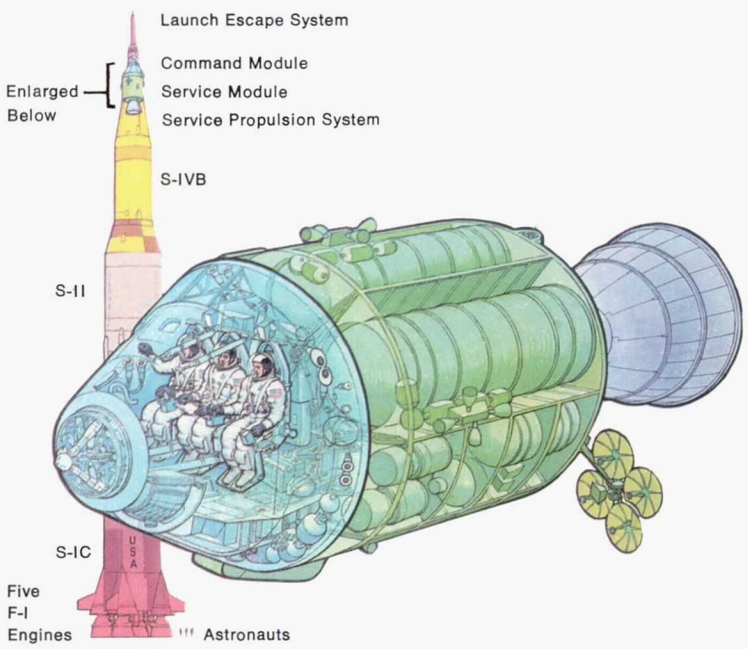
Mercury (foreground) and Gemini spacecraft at manufacturer's plant.

constructed and instrumented.

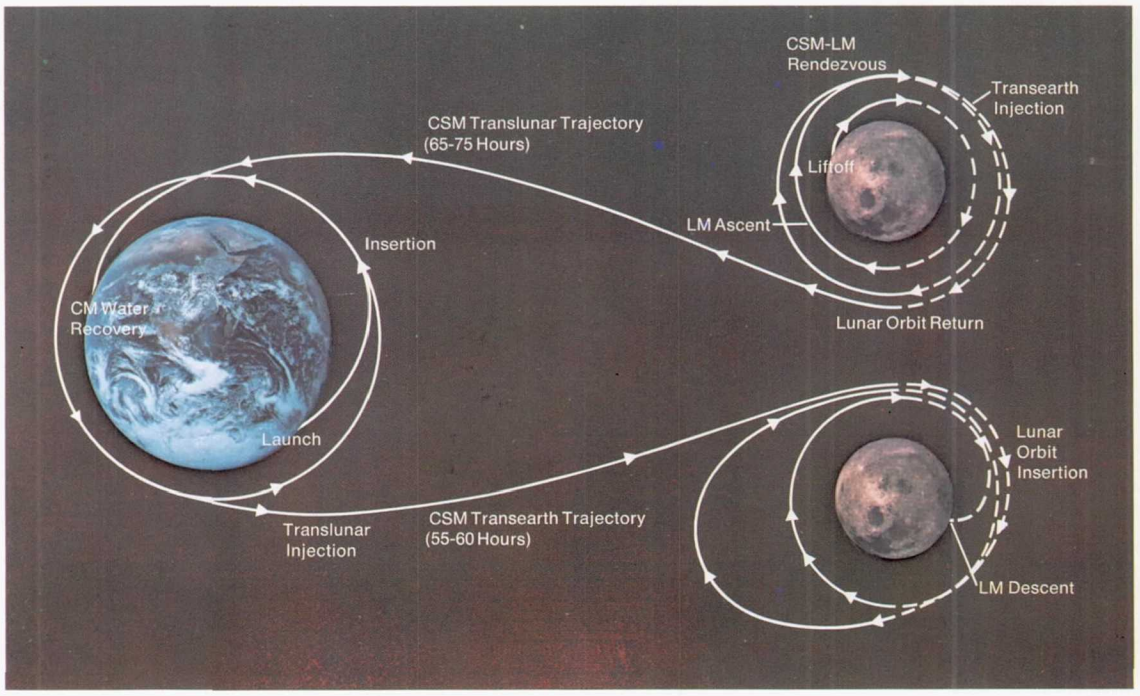
Before men put down on the Moon it would help, too, if more could be learned about the conditions there than could be seen through the most powerful of telescopes on Earth. There would, in fact, have to be unmanned spacecraft to fly to the Moon, take a close look, and report back to Earth.

Besides all that, and a great deal more, there would also have to be a preparatory series of space flights called Project Gemini. Mercury showed that men could live and work in space for as long as a day. To go to the Moon and back, though, men would have to be able to function in space for a week or more.

Under the lunar orbit rendezvous technique adopted by NASA in July 1962, astronauts would also have to learn whether they could maneuver two spacecraft so that they could rendezvous and dock with each other far from the Earth. That was required by the Moon flight plan: To launch three men and a Moon ship into Earth orbit, blast them out of orbit and off to the Moon, separate a landing craft with two men from a command ship, and finally, after the two had walked on the Moon, thrust them back into Moon orbit for rendezvous with the command ship and the third man for return to Earth.



Apollo Spacecraft and Saturn V Launch Vehicle



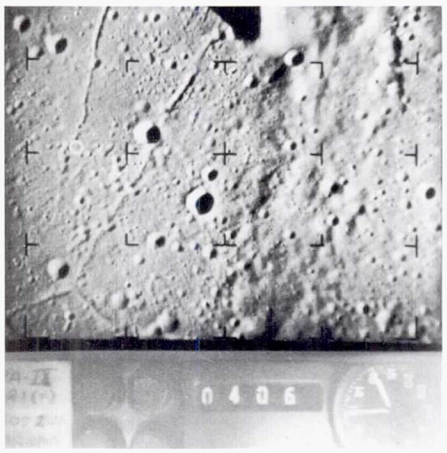
Apollo Lunar Landing Mission Profile

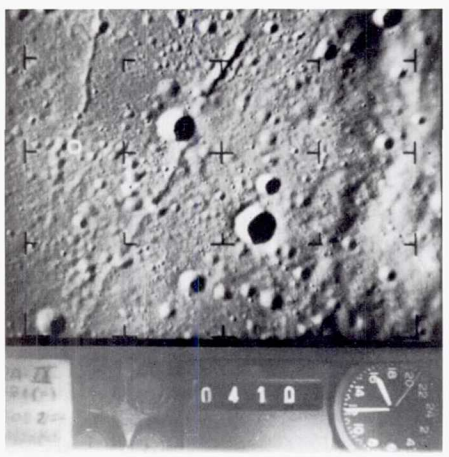
Locations of ground stations used in tracking, communicating with, and acquiring data from Apollo. Ships and aircraft also give support.

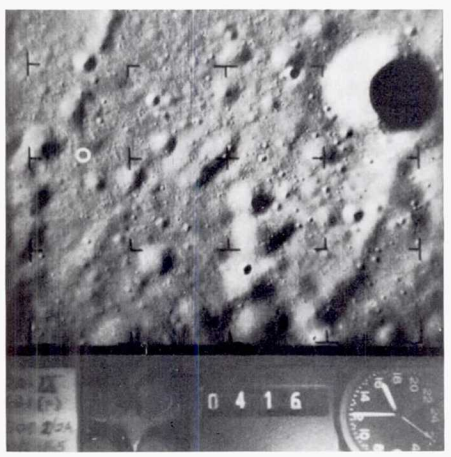
Apollo 9/Saturn V roll-out.

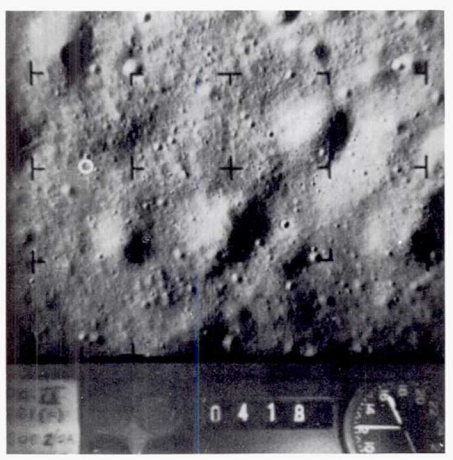
Taking the Moon's Measure

Sequence of pictures telecast by Ranger 9 as it hurtled into the Moon.







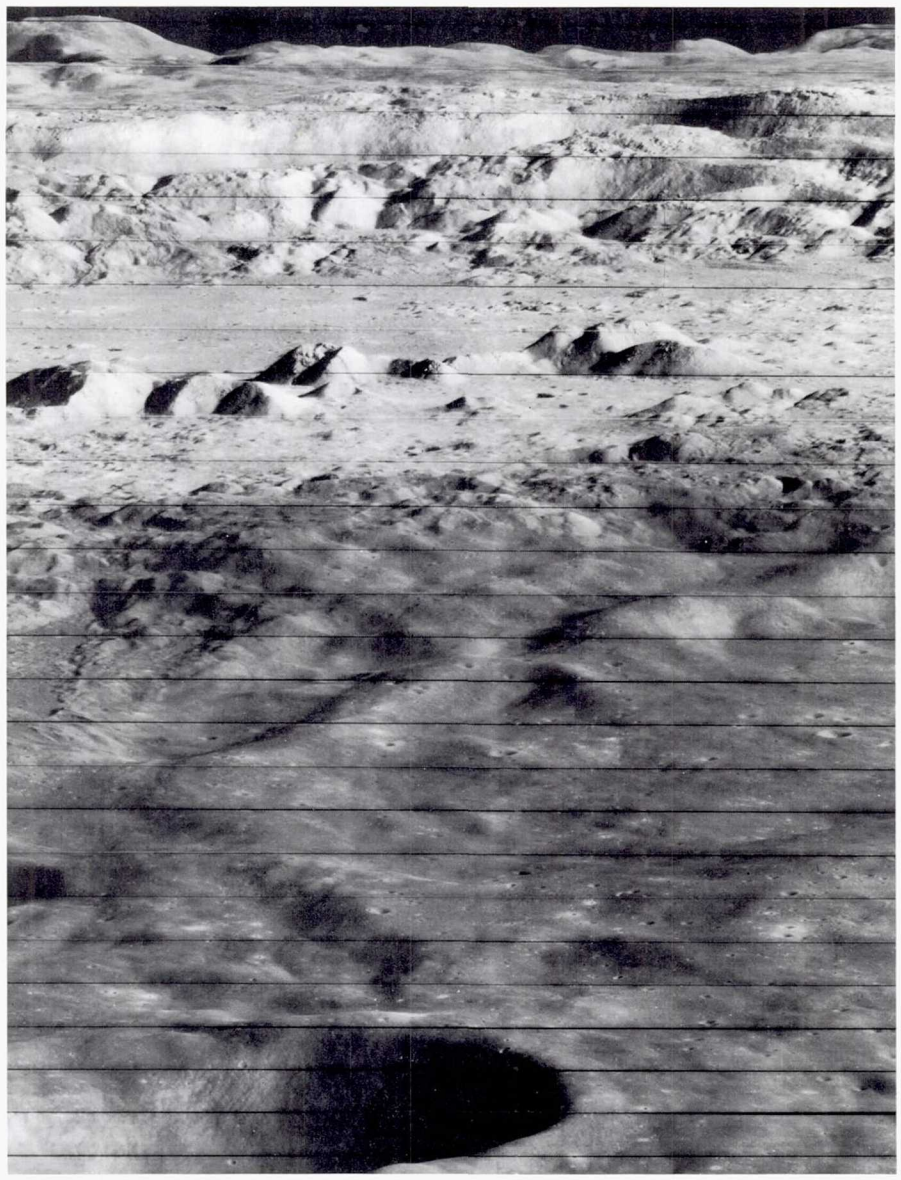


Even before Gemini began to test the skills and endurance of the astronauts, people on Earth got their first close-up views of the surface of the Moon. The automated Ranger 7 soared from the Cape July 28, 1964, and, before striking the Moon, sent back 4,316 photographs, the last one taken 480 meters (1500 feet) above the surface. Objects less than a meter (yard) wide were discernible.

Rangers 8 and 9, just as successful, confirmed that there were broad smooth stretches of Moonscape suitable for landings. The automated Surveyors, unlike crash-landing Rangers, were capable of touching down lightly and, in addition to sending back photos, could dig trenches and relay back to Earth important findings about the texture of the Moon.

Surveyor 3 went beyond science and engineering to pure serendipity. It bounced upon landing and shot a picture of one of its own footprints. It was plain: the Moon's surface was firm enough to support a walking man.

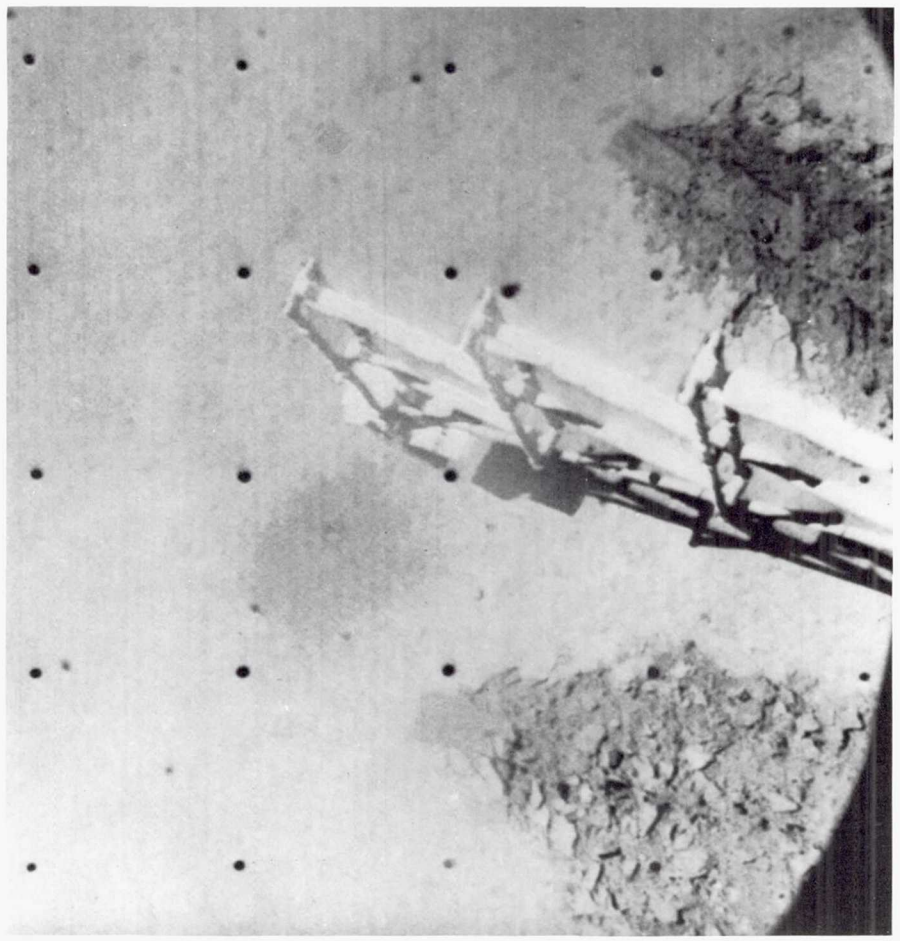
Lunar Orbiter's task was to take long photographic looks at proposed Apollo landing places, and the first three of the series carried it out. That done, the last three Lunar Orbiters



View across part of the vast Moon crater Corpernicus taken by the camera on Lunar Orbiter 2. From horizon to base of photograph is about 290 kilometers (180 miles).

Surveyor 3 and its surface sampler arm cast shadow on the Moon.

Surveyor surface sampler pauses between two trenches it dug in lunar material.



undertook nothing less than the job of mapping the Moon, and their photographs, 10 times as clear as anything possible from an observatory on Earth, covered more than 99 per cent of the Moon.

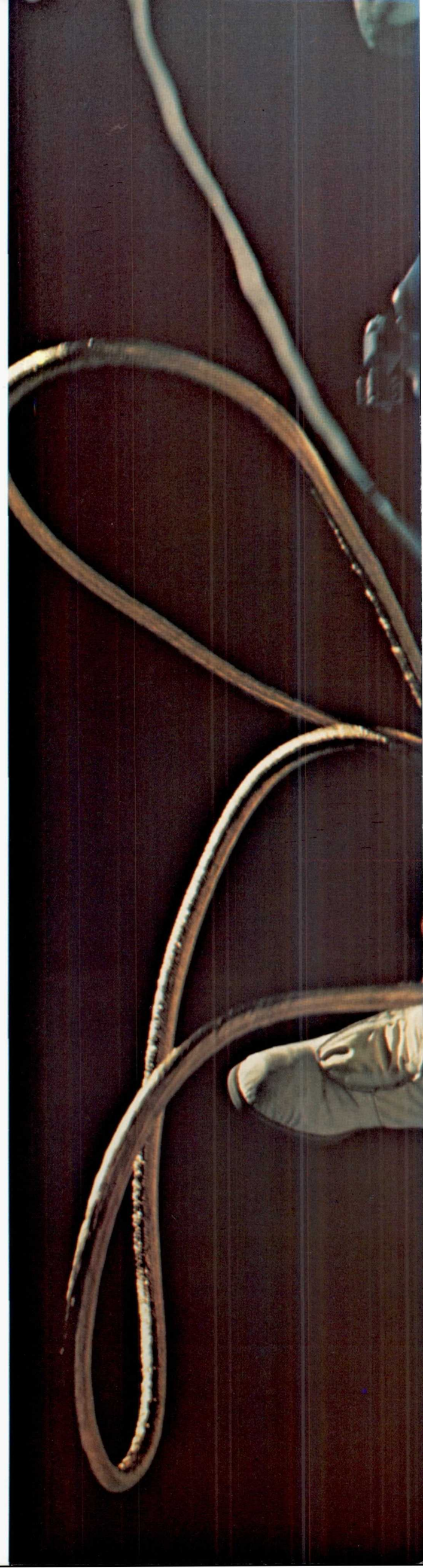
Project Gemini, meanwhile, was showing that astronauts could do all that was being asked of them. There were 10 manned Gemini flights, all of them sent into orbit by the 1.9 million newton (430,000 pound) thrust Titan II. On the first mission Astronauts Virgil Grissom and John W. Young steered their spacecraft through three changes of orbit. On the second Edward White clambered out of the spacecraft and "walked" about at the end of a golden tether.

Geminis 7 and 6, lifting off one after the other from the Cape, successfully rendezvoused in orbit, and maneuvered in close formation. Walter M. Schirra Jr., and Thomas P. Stafford then splashed down in 6, while Frank Borman and James A. Lovell went on to fly Gemini 7 for 206 orbits, almost two weeks in space, and returned to Earth in good fettle.

Docking in space was first accomplished by Neil A. Armstrong and David R. Scott using Gemini 8 with an Agena stage as target vehicle. A short circuit curtailed the mission and forced an emergency landing in the Pacific Ocean. Gemini 10, 11 and 12 dockings went without incident.

Now the men, both flight and ground crews, were trained and ready for the great voyage. They even had an inkling of what would await them on the Moon. All that was wanting was the rocket and the spacecraft to take them there.

Edward H. White II floats outside Gemini 4 spacecraft during the first walk in space by an American astronaut, June 3, 1965.



The Systems, the People are 'Go'

In the excitement over Mercury not many noticed that a Saturn I put a boiler-plate Apollo spacecraft, unmanned of course, into orbit in mid-1964. And with Gemini flying few *paid heed when the next year* the giant Saturn V began static test firings. The hardware, in short, was hard on the heels of the men.

At this point a shocking tragedy intervened. The three Astronauts assigned to the first Apollo mission perished when fire engulfed the interior of their spacecraft during a launch rehearsal. It was atop a Saturn IB, January 27, 1967 at Launch Complex 34. A stunned nation

Apollo 6/Saturn V lift-off, April 4, 1968. This flight qualified Saturn V for subsequent manned flights.
Three views of Apollo 6 launch taken by camera mounted on the 108-meter (360-foot) level of the umbilical tower.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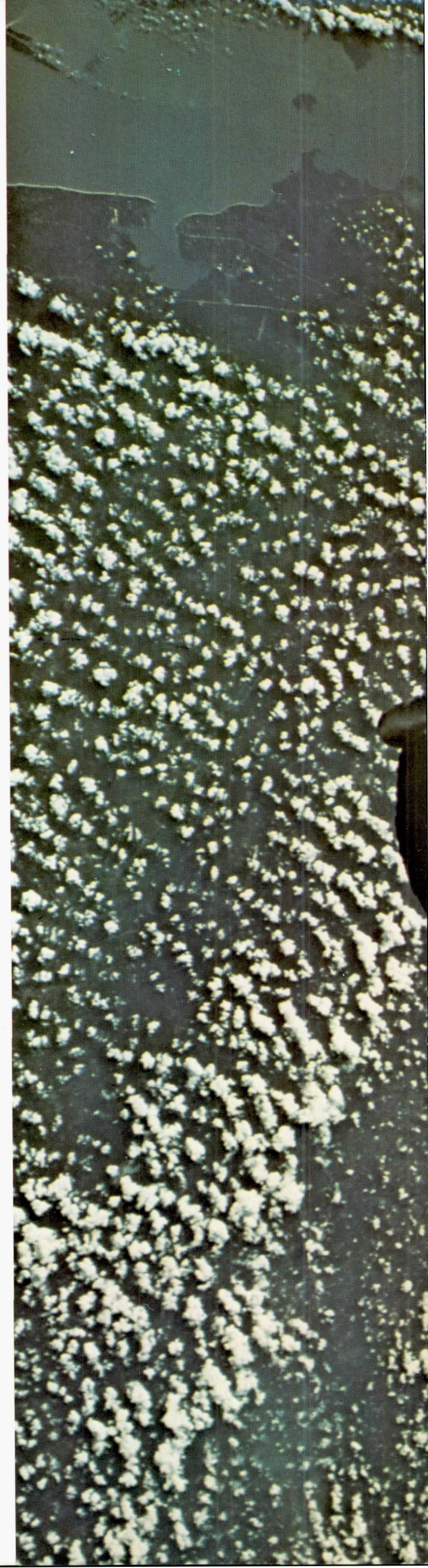


S-IV B (third stage) of Saturn V as seen by Apollo 7 crew.

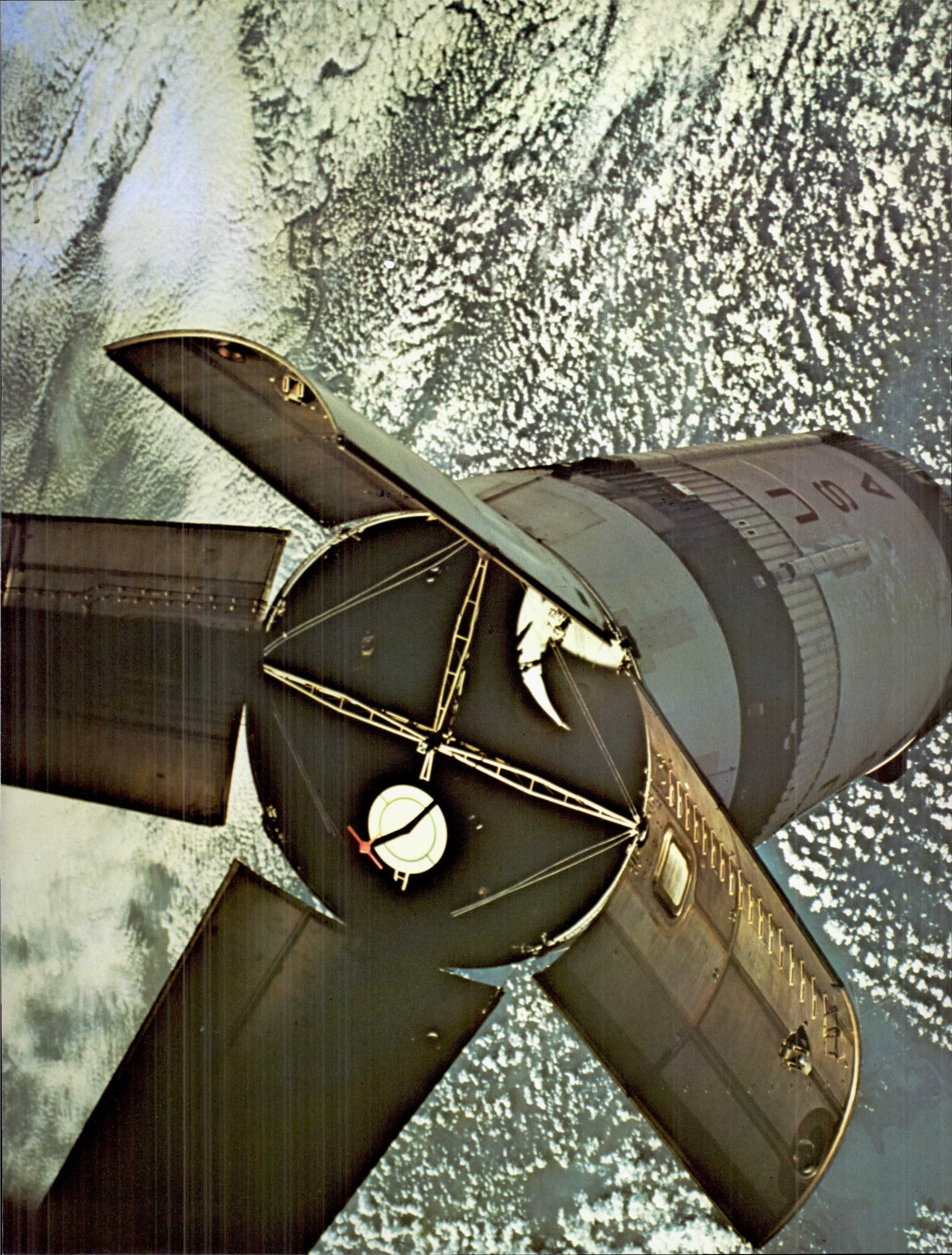
mourned Virgil I. Grissom, Edward H. White II and Roger B. Chaffee.

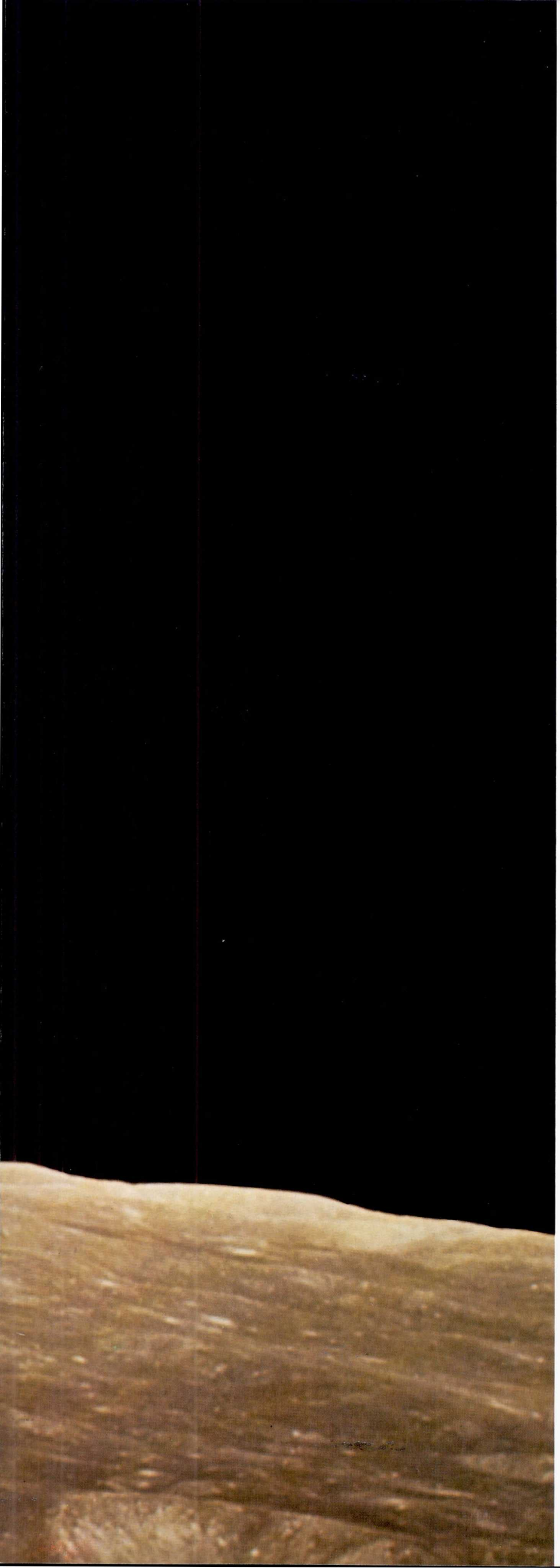
It would be months before the Apollo Program again was on a firm operating schedule. The first launch of a Saturn V was made in late 1967 and, in early 1968, an unmanned Lunar Module made its first flight. The LM's ascent and descent stage rocket motors were test fired in orbit.

Everything began falling into place on Oct. 11, 1968, when a Saturn IB pushed Apollo 7 into Earth orbit. Astronauts Schirra, Donn F. Eisele, and Walter Cunningham practiced rendezvous and simulated docking with the spent upper stage of the rocket. Millions saw their live TV pictures. When nearly 11 days and 163 orbits later they splashed down within a mile of their recovery ship, the Apollo command and service modules had been thoroughly tested —*near the Earth.*

Mission Control Center, Houston, Texas.

Apollo 7 crew, left to right: Don F.Eisele; Walter M.Schirra,Jr.; and Walter Cunningham

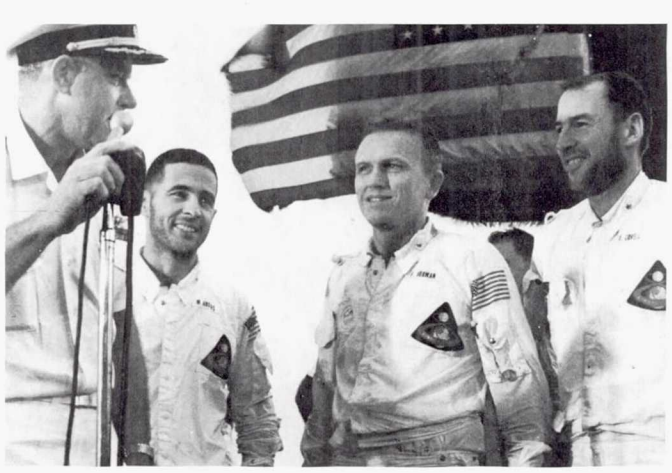




Earth-rise over the Moon as viewed by Apollo 8 crew.

Apollo 8 ventured across nearly a quarter of a million miles of space to circle within 112 kilometers (70 miles) of the Moon at Christmastime 1968. The Apollo 8 crew was the first to ride the thunder of Saturn V. Astronauts Borman, Lovell, and William A. Anders traveled farther, faster, and looked closer at another celestial body than any men before them.

Commanding officer (left) of the USS Yorktown recovery ship introduces, left to right, Anders, Borman, and Lovell to his crew.



Well-wisher waves flag as he views Apollo 8 lift-off through binoculars.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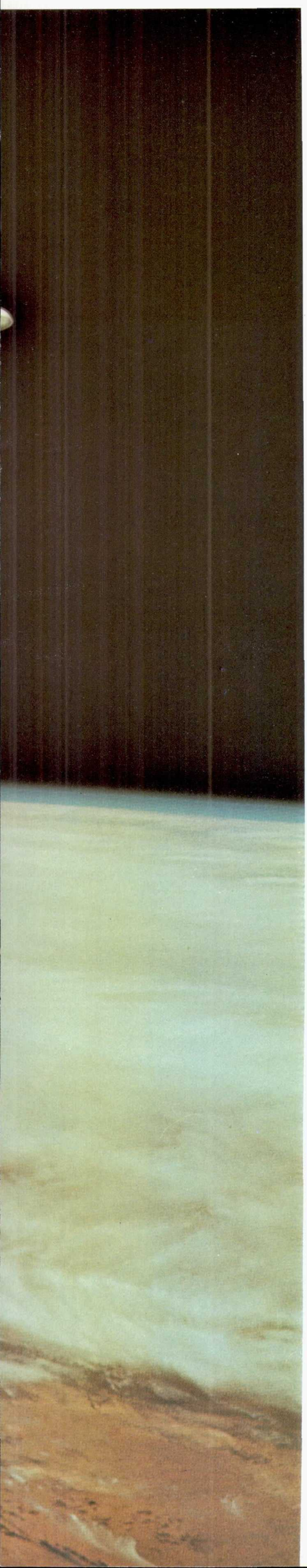


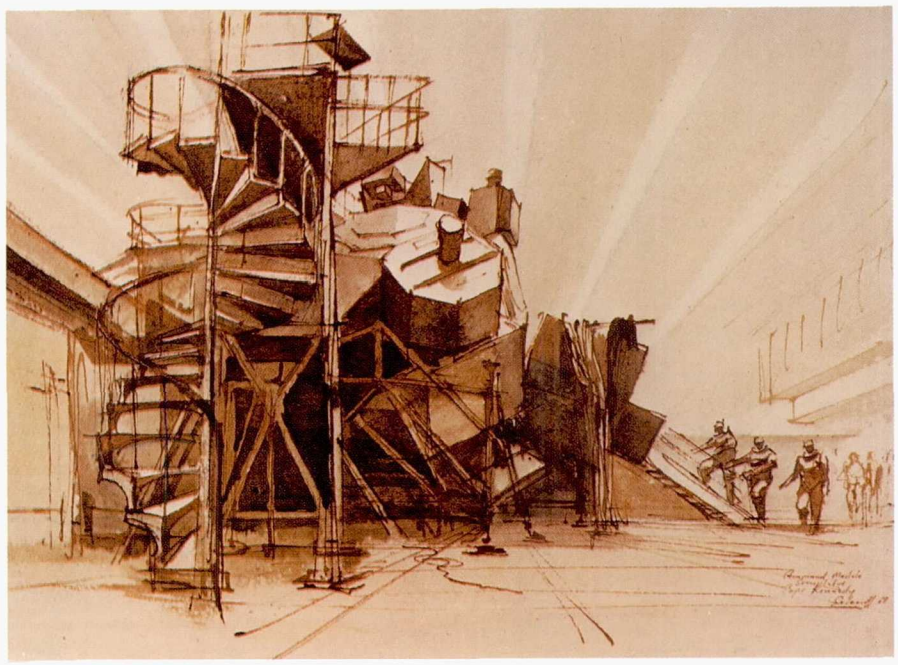
Lunar module gets first manned flight test.

Apollo 9 was the first manned operation in space of the strange craft that would actually land men on the Moon, the gangling Lunar Module (LM) which the crew christened Spider. Apollo 9 lifted off March 3, 1969, and five days later Astronauts James McDivitt and Russell Schweickart took Spider off for a test flight. On their return to the mother ship its pilot, David R. Scott, said, "You're the biggest, friendliest, funniest-looking Spider I've ever seen."

Spider's hollow drogue fitted delicately onto the other craft's docking probe, and a buzzer signaled that two such ships could indeed be rejoined in space.

"Wow!" McDivitt cried. "I haven't heard a sound that good for a long time."

Apollo 9 crew, left to right: Russell L.Schweickart, David R.Scott, and James A.McDivitt



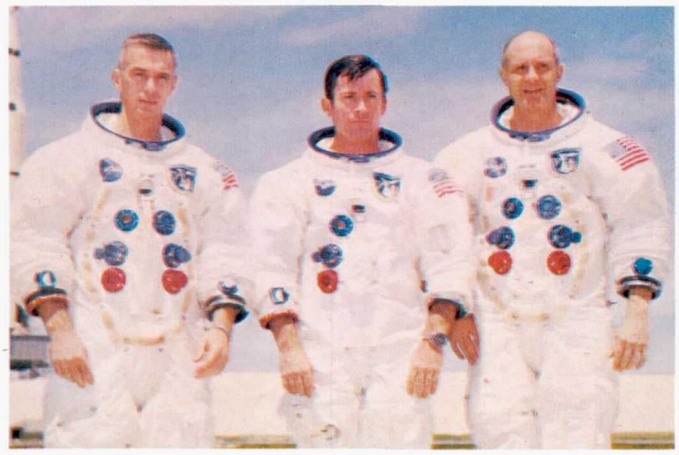
Apollo Command Module simulator at Kennedy Space Center, Fla., as depicted by artist Nicholas Solovioff.

Apollo 10 Lunar Module orbits Moon.

The decade had not quite nine months to run and there still remained the dress rehearsal, the eight-day flight of Apollo 10, which was to carry out every step except the landing upon the Moon itself. This time the millions could follow it all on color television; they saw Apollo 10 lift off on May 18 and saw the Earth from space for the first time almost as vividly as the astronauts had seen it.

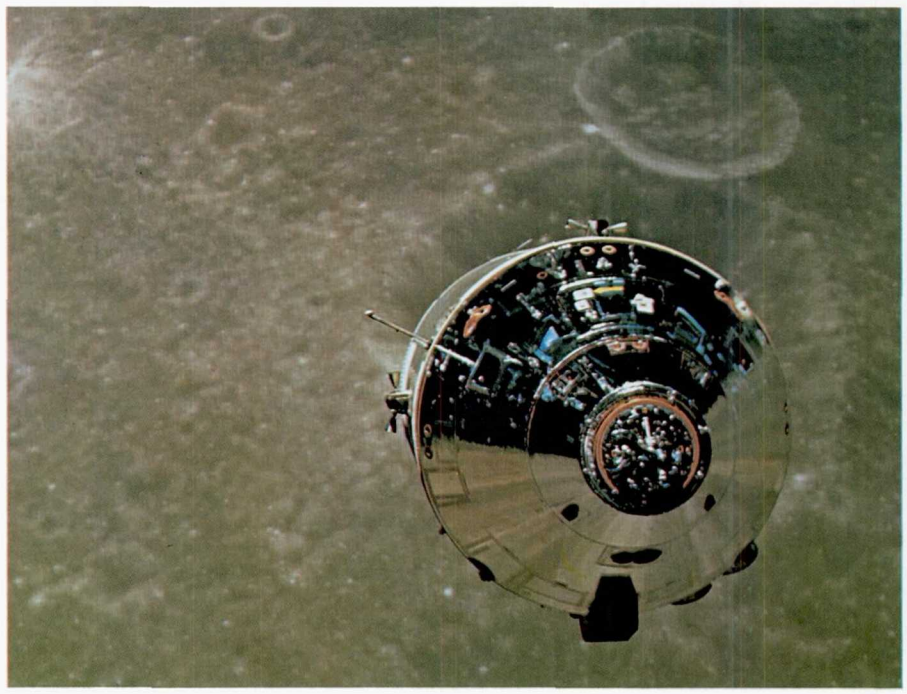
"We're right there," Astronaut Eugene A. Cernan, at the controls of the LM, called out four days later. "We're right over it." He and Stafford, leaving John W. Young in orbit, flew the LM down to within 15,000 meters (50,000 feet) of the Moon's Sea of Tranquility, the place chosen for the first landing.

Moments later, preparing to fly back to the mother ship, Stafford took the controls when the LM suddenly began to gyrate. He straightened it out, flew back into Moon orbit to dock with the Command and Service Module and so started their safe return to Earth.

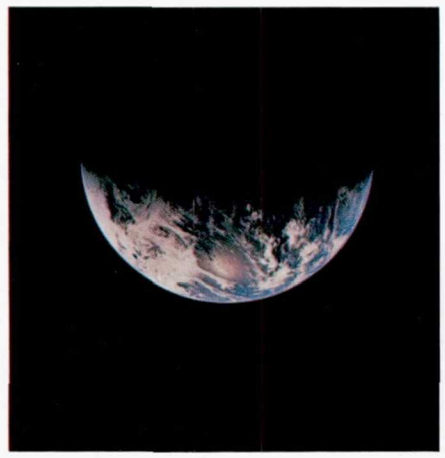


Apollo 10 crew, left to right: Eugene A. Cernan, John W.Young, and Thomas P.Stafford

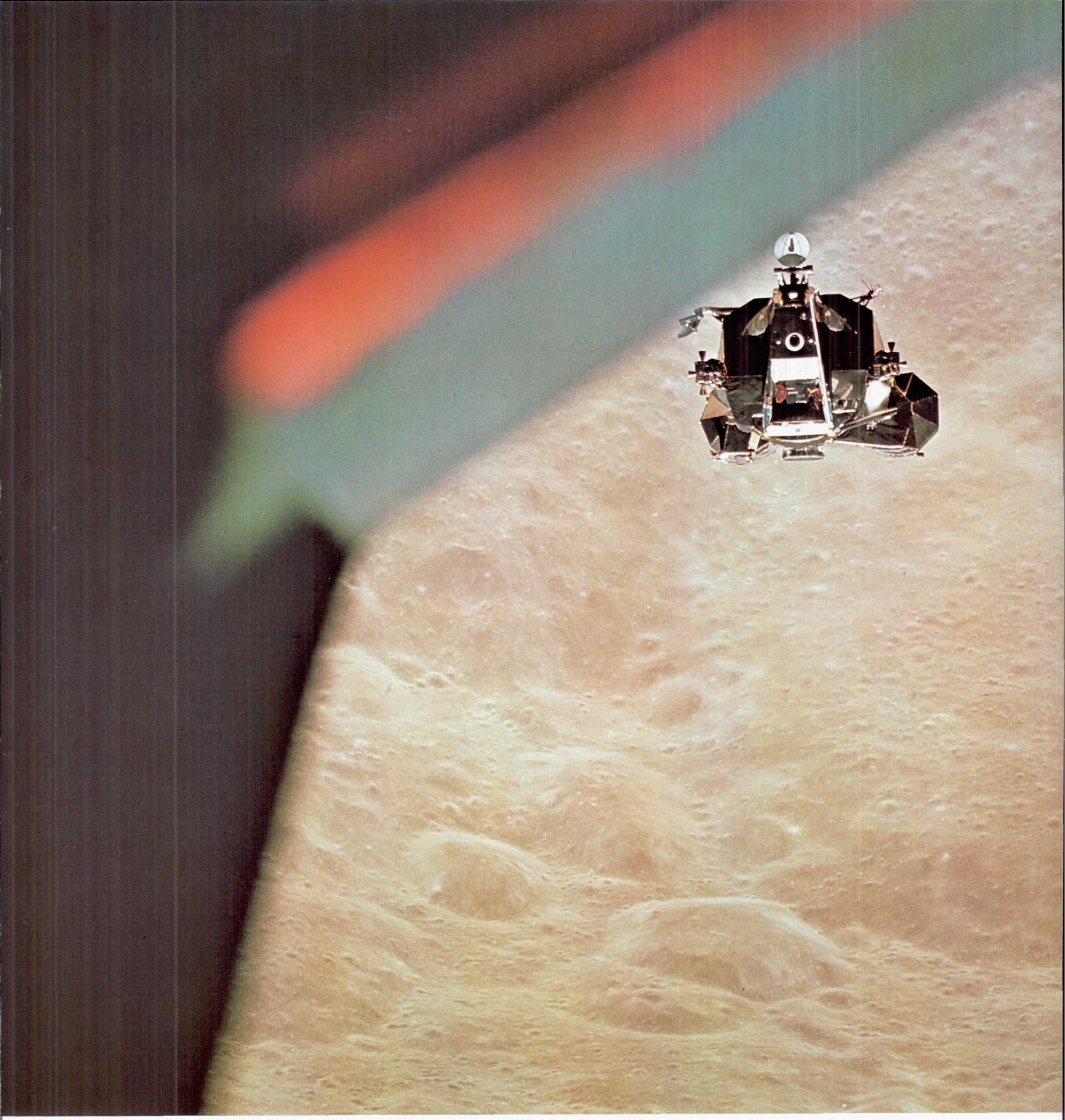
Apollo 10 Command/Service Module over the Moon.



Crescent Earth captured on Apollo 10 film.



Half Moon as seen by Apollo 10.



July 20, 1969 — A Dream Achieved

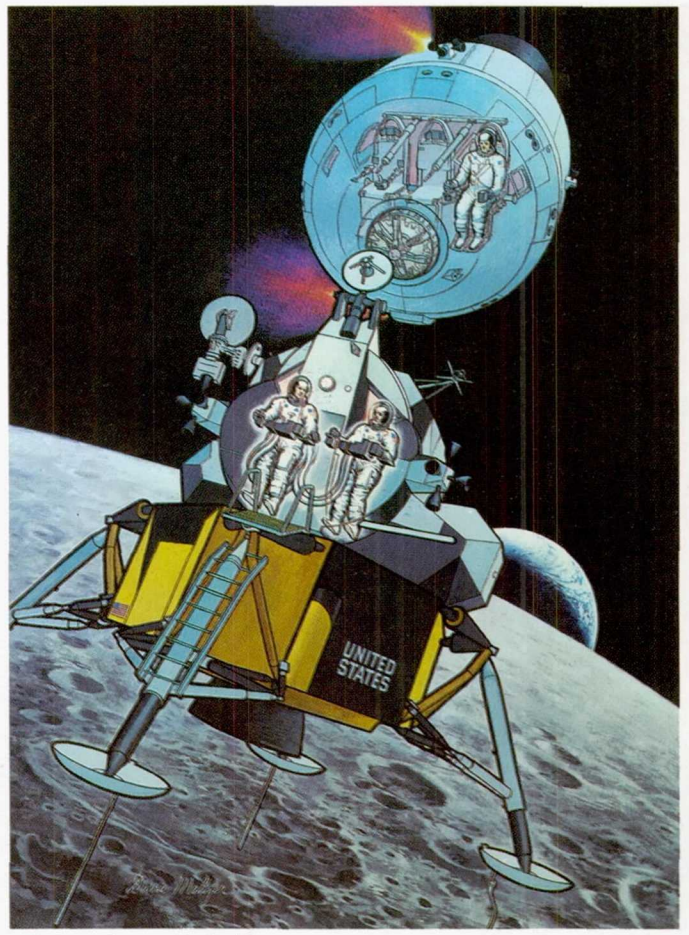
Sketch shows spidery-legged Lunar Module with Armstrong and Aldrin separating from the Command Module and Collins.

The man destined to put the first footprint on the Moon was Neil A. Armstrong, a civilian who had, in a sense, been preparing himself for the role since his birth in 1930 in Wapakoneta, Ohio. As a Navy pilot, he flew combat in Korea, and later, as a NASA test pilot, flew the rocket-propelled X-15 at record speed into the fringes of space.

Armstrong had a degree in aeronautical engineering and, like the two Air Force officers he would command in Apollo 11, had experience in space in Gemini. Edwin E. (Buzz) Aldrin Jr., who would be the second man on the Moon, had a doctor of science degree in astronautics. Michael Collins, with a bachelor of science degree, was to fly the Apollo command ship in parking orbit around the Moon while his fellow crewmen explored below.

Perhaps a million Americans came to Cape Kennedy to see them off. So did 3,000 newsmen from 56 countries, half of the U.S. Congress, and the Vice President of the United States. Millions more watched the launch on world-wide television. President Richard Nixon prepared to go aboard the carrier Hornet in the Pacific to welcome the crew back to Earth.

Michael Collins, Command Module pilot



Edwin E.Aldrin,Jr., Lunar Module Pilot

Neil A.Armstrong, Commander

Armstrong and Aldrin practice Moon landing in Lunar Module Simulator.

Launch of Apollo 11, July 16, 1969.

July 16, 1969, dawned fair and hot over the palmetto scrub on Merritt Island and the Cape. The temperature was in the mid-30's Celsius (mid-90s Fahrenheit), the clouds at 4,600 meters (15,000 feet), the breeze out of the southeast at 18 kilometers per hour (10 knots). The decade had not quite half a year to run.

The Apollo moonship, capped by the escape tower and its small rocket, sat atop the Saturn V. The whole assembly rose 111 meters (363 feet) above the pad and its sleek majesty masked an intricacy of more than nine million parts.

Countdown started 28 hours ahead of launch and could find flaws in only two of the many parts, a leaky valve and a faulty signal light. Both were corrected while the three astronauts, who rose at 4:15 a.m., were on their way to the pad in their air-conditioned van.

Armstrong went aboard at 6:54 and took position in the Apollo's lefthand couch. Five minutes later Collins joined him on the right and Aldrin in the center. The swing arm that they had walked across withdrew at 9:27. Five minutes to liftoff and still counting. . . .

Neither words nor pictures, even motion pictures, can tell truly the thunder and lightning of Saturn V's five great engines. The first engine fired eight and nine-tenths seconds before launch and then as the others roared into life that first brilliant orange-red glow became a huge fireball that grew into a tower of flame, thrusting against the Earth with 33 million newtons (7.6 million pounds) of fiery muscle. Not until the great rocket had risen past the service tower did the tidal wave of throaty thunder sweep over the awed thousands.

Apollo 11 took off at 9:32, within a fraction of a second of schedule. "Good luck and Godspeed," Launch Control radioed. "Thank you very much," Armstrong replied. "We know this will be a good flight."

The great voyage to the Moon was under way.

From orbit of the Earth to orbit of the Moon is a three-way trip. It began for Apollo 11 at 12:22 p.m. on its second circuit of the Earth. The first two stages of Saturn V having been jettisoned, the third stage fired and hurtled the space ship out of orbit and onto a path to the Moon at 38,700 kilometers per hour (24,200 mph).

Now it was time to take LM Eagle out of its shipping crate, an enclosed compartment atop the launch rocket, and fit Eagle to the nose of the mother ship, Columbia. The astronauts exploded the bolts that held Columbia to the crate and blew off the four panels that sheltered Eagle during the ride through the Earth's atmosphere.

Columbia moved off 30 meters (100 feet), turned around, came back and docked head to head with Eagle. Now the third stage of Saturn V, consuming the splash of fuel left in it, could be fired off into a long orbit of the Sun, getting it out of their path to the Moon.

Next day, the 17th, the astronauts made their only course correction of the voyage out, a three-second burn that not only sharpened up their heading but also tested the service module engine that would have to get them into and out of orbit of the Moon. That day, too, and again on the 18th the crew sent color telecasts of themselves back to Earth. In the long hours between they amused themselves by listening to music on a small tape recorder and once, to the temporary mystification of Mission Control, relieved the tedium by broadcasting recorded whistles and bells.

Life aboard Apollo 11 quickened on the 19th along with the speed of the spacecraft as it departed the reduced Earth gravity and felt the pull of the Moon. Armstrong reported, "The view of the Moon . . . is really spectacular. It fills about three-quarters of the hatch window and, of course, we can see the entire circumference even though part of it is in complete shadow and part of it's in earthshine."

The growing size of the Moon signaled that soon Apollo 11 must be thrust into lunar orbit, a maneuver known to the astronauts as lunar orbit insertion (LOI). At 12:58 p.m. Eastern Standard Time Mission Control gave the word:

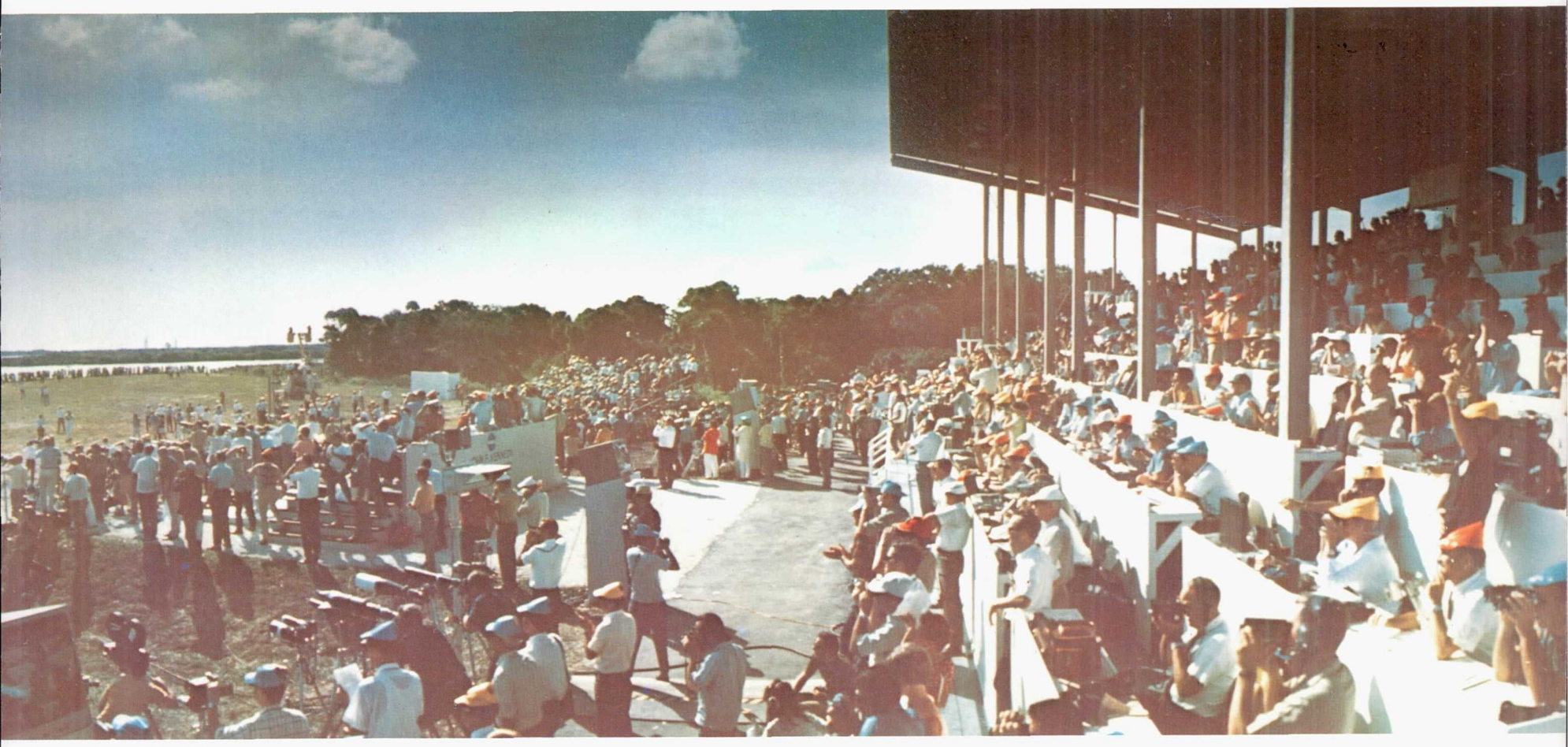
"You are go for LOI."

"Roger," Aldrin replied. "Go for LOI."

Columbia's main engine thrust with 90,200 newtons (20,500 pounds)

Ex-President Lyndon B. Johnson and Mrs. Johnson follow Apollo 11 liftoff. Mr. Johnson was an ardent supporter of the space program.

Reporters and photographers from throughout the world witness Apollo 11 lift-off.



Firing Room at Kennedy Launch Control Center.

Astronaut's bootprint made in lunar soil during Apollo 11 mission.

for six minutes, slowing the spacecraft so that it could be snared by the Moon's gravity. A 17-second burn a little later fixed the course at 100 to 122 kilometers (54 to 66 nautical miles) above the Moon and, orbiting every two hours, the astronauts settled down to sleep.

Next afternoon, after separating and test-flying Eagle near Columbia, Armstrong and Aldrin began their descent in the radio silence behind the Moon. Not until Collins, orbiting in Columbia, emerged from behind the Moon did Mission Control hear of their departure.

"Everything's going just swimmingly," Collins said. "Beautiful!"

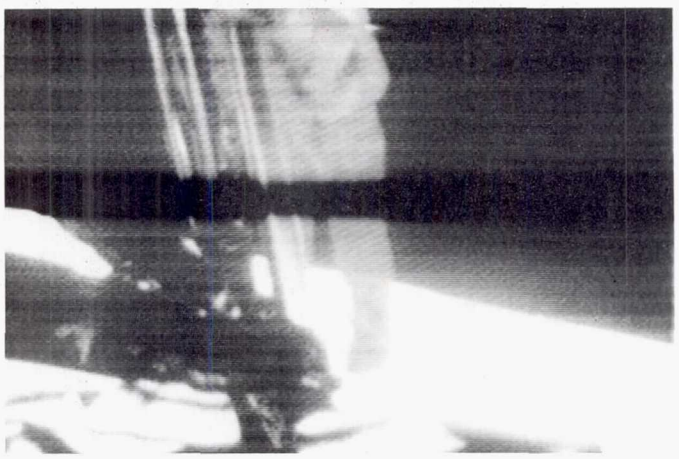
Four hundred feet above the Moon, though, Armstrong and Aldrin looked down and saw that Eagle was bound for a touchdown among boulders 3 meters (10 feet) across. Armstrong took manual control from the onboard computer. His heartbeat, monitored on Earth as are the vital signs of all men in space, surged from a normal 77 to 156. He flew Eagle beyond the boulders, beyond a 24-meter (80-foot) crater, seeking a smoother spot.

Aldrin's voice could be heard calling out the altitude readings: "Seventy-five feet. Things looking good. Lights on. Picking up some dust. Thirty feet. Two and a half down. Faint shadow. Four forward. Four forward, drifting to the right a little. Contact light. Okay, engine stop."

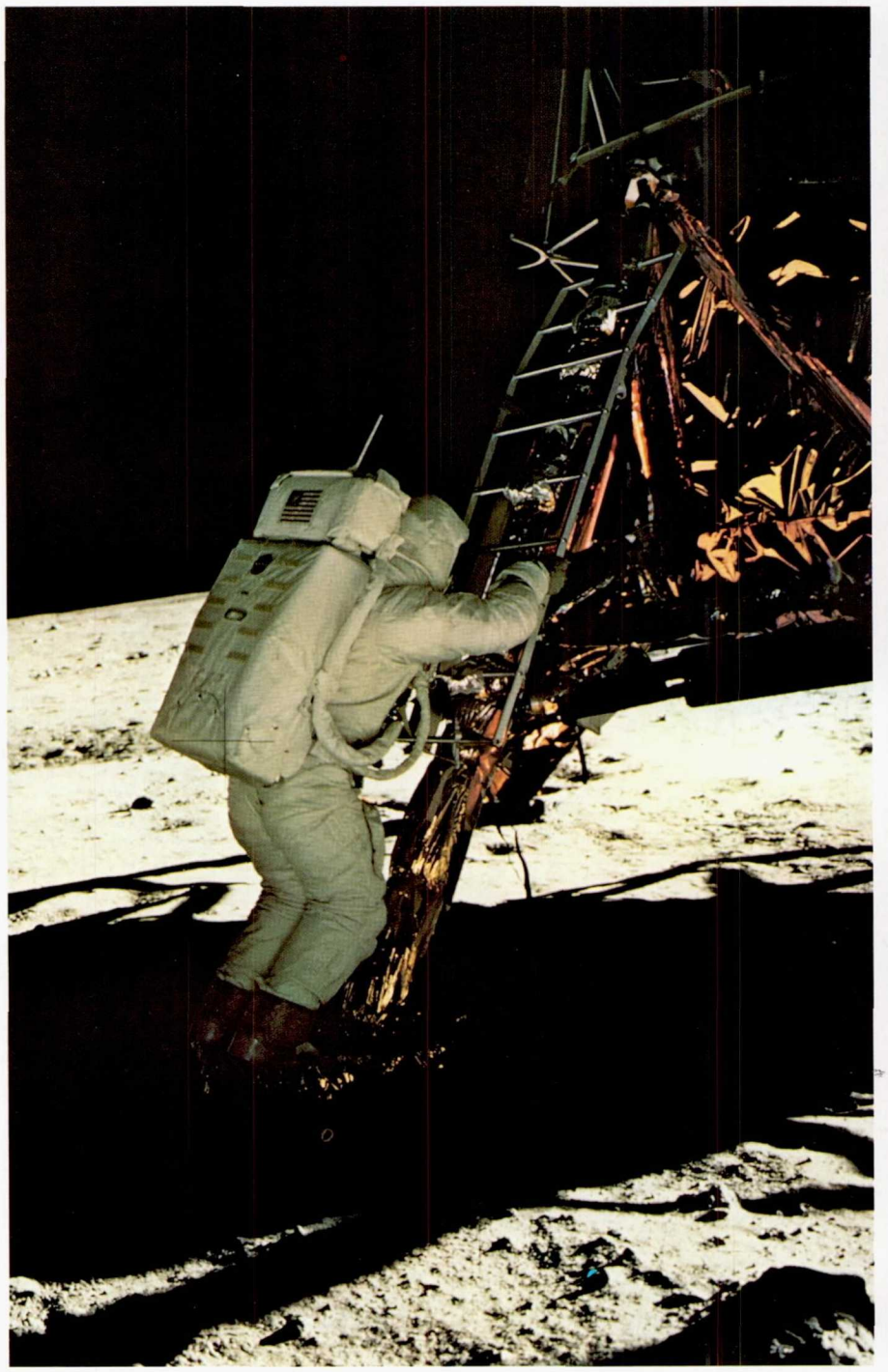
"The Eagle has landed," Armstrong informed Houston at 4:18 p.m.

Not many people in America got a full night's sleep. Armstrong opened the Eagle's hatch at 10:39 p.m. and, while climbing down the 3-meter (10-foot), nine-step ladder to the Moon, deployed a television camera so that all on Earth could watch him.

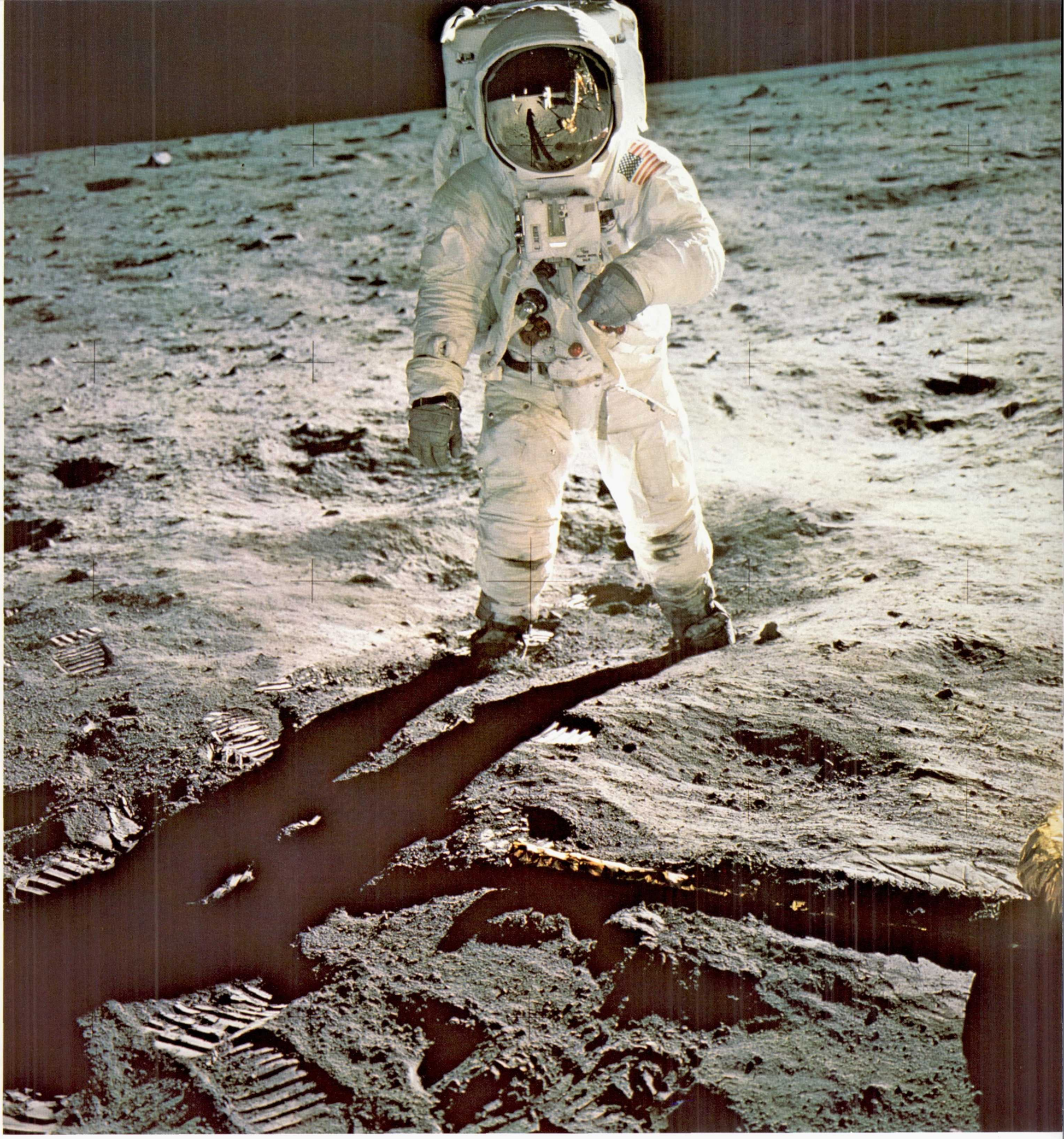
"I'm at the foot of the ladder," he reported and at 10:56 planted his left boot on the Moon. Aldrin followed him out at 11:11 and for two hours



Armstrong descends ladder on Lunar Module prior to becoming first human being to set foot upon the Moon. Black bar is TV anomaly.



Aldrin steps down to lunar surface.



Aldrin on the Moon. Face-plate reflects the scene he sees.

and 47 minutes they worked and investigated where no man had walked before.

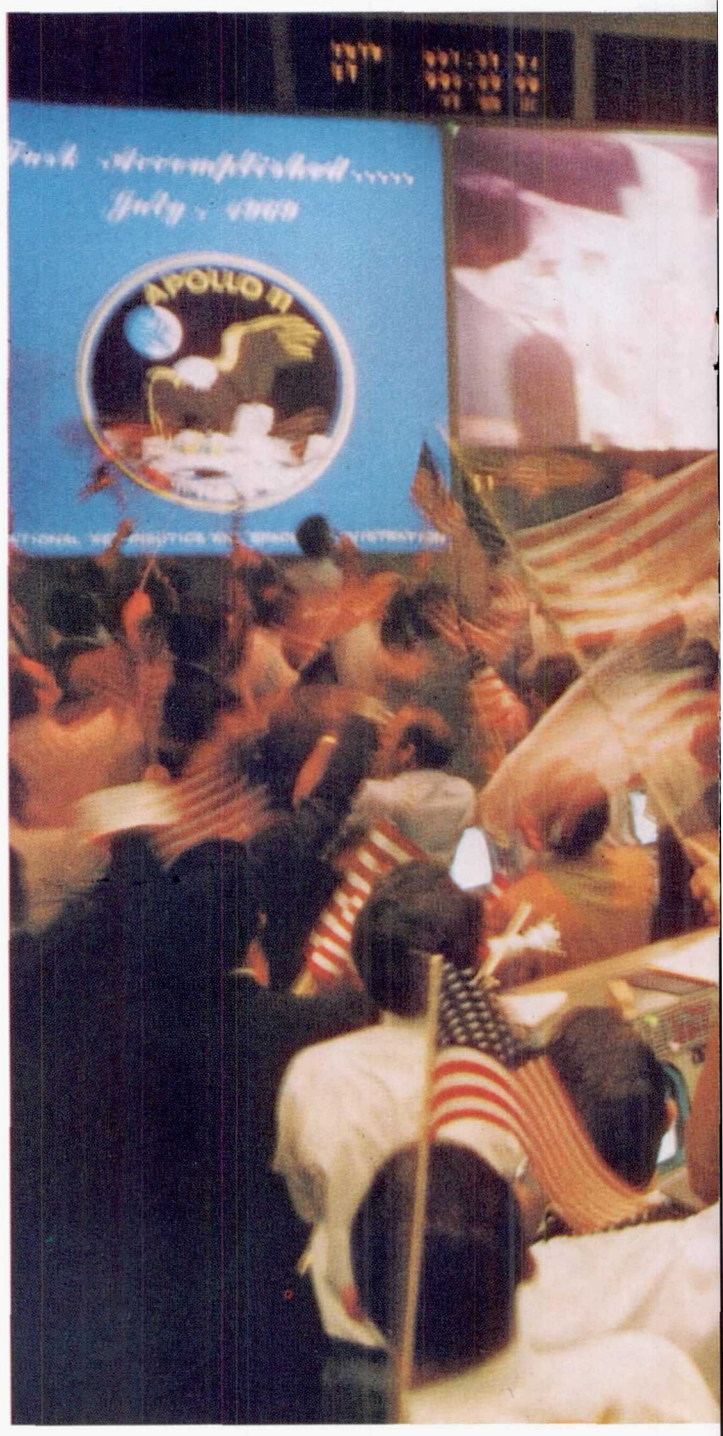
They erected and saluted an American flag, set out three scientific instruments, collected 21 kilograms (46 pounds) of rocks and soil, talked to President Nixon in his Oval Office at the White House, and came to enjoy the sensation of loping about in one-sixth gravity. "We felt very comfortable," Armstrong later said. "It was preferable both to weightlessness and to the Earth's gravity."

It was well past midnight in the Eastern United States when the men on the Moon closed the hatch on Eagle and after 4 in the morning when they settled down to sleep. Not long after noon the next day, the 21st, the astronauts fired the ascent engine and launched Eagle on the first leg of what was to be a triumphant return to Earth.

Surrounded by their historic boot marks, the flag, and the experiment packages at Tranquility Base, still stood the four spidery legs of the Eagle. On one of them a small stainless steel plaque recorded:

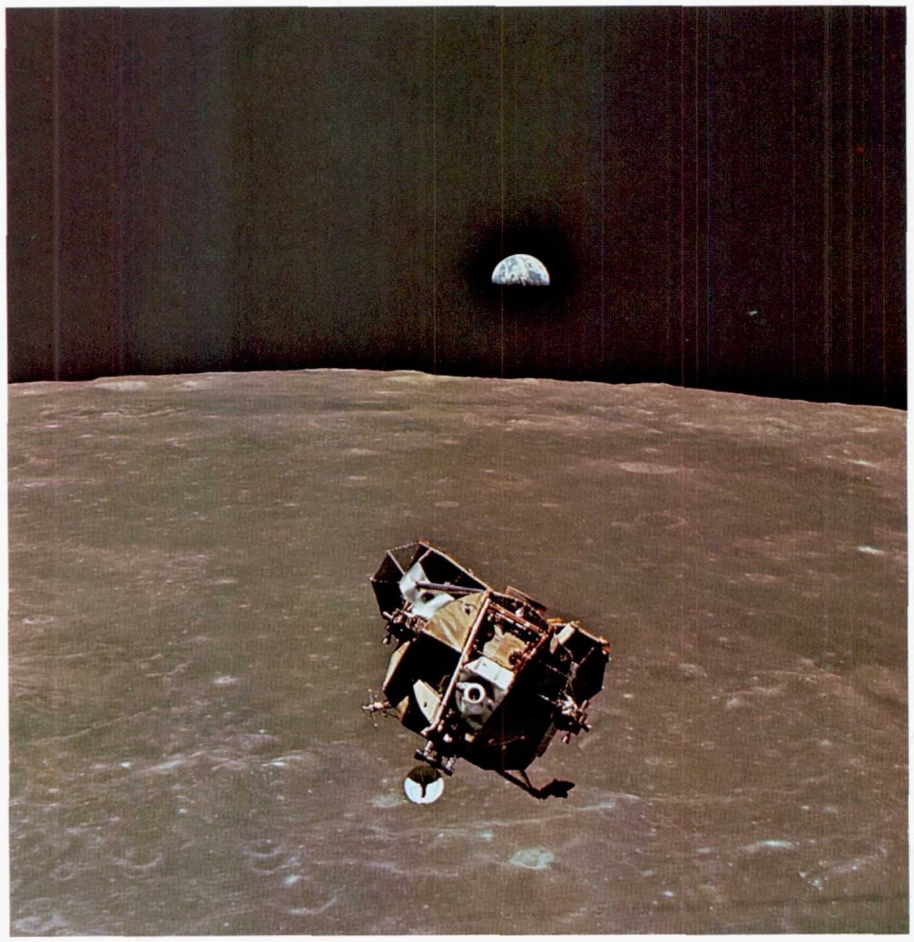
"Here men from the planet Earth first set foot upon the Moon. July 1969 A.D. We came in peace for all mankind."

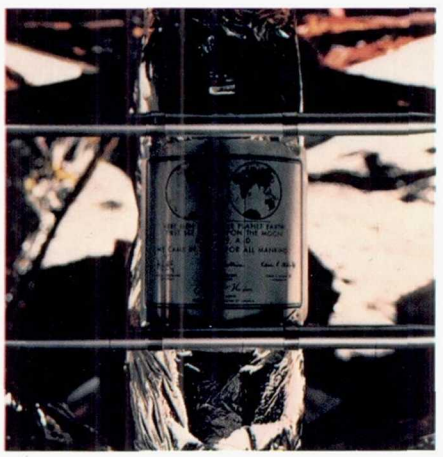
As the astronauts are shown stepping from their helicopter to the carrier's deck, Mission Control flashes "Task Accomplished" on the big board and proud flight controllers, technicians and officials spring to their feet, waving flags and shouting.



Back inside Lunar Module after walking on Moon, Armstrong removes helmet.

Eagle approaches Columbia for rendezvous and docking after lift-off from Moon.





Commemorative plaque on Lunar Module leg says: "Here men from the planet Earth first set foot upon the Moon. July 1969, A.D. We came in peace for all mankind." The plaque is signed by the Apollo 11 crew and President Richard M. Nixon.

Left to right, Armstrong, Collins, and Aldrin smile through window of Mobile Quarantine Facility aboard USS Hornet after recovery.

Items left on the Moon. *A silicon disc carrying statements from Presidents Nixon, Johnson, Kennedy, and Eisenhower and from leaders of 73 other nations; a gold replica of an olive branch, traditional symbol of peace; and the emblem of what was scheduled to be the first manned Apollo flight. Astronauts Virgil I.Grissom, Edward H.White II, and Roger B.Chaffee died in a fire in their spacecraft on the ground while practicing for their mission.*

Adventure and Discovery

Even before the decade had run its course, Project Apollo soared beyond adventure seasoned with science to science spiced with adventure. Apollo 12's Charles (Pete) Conrad, Alan L. Bean, and Richard Gordon weathered a Nov. 14 launch during which a bolt of lightning briefly bewildered the ship's guidance system and for the first time set off on a trajectory that, unlike earlier routes, would not loop them around the Moon and safely home if their engines failed.

They had to set that kind of course to reach their landing site in the Ocean of Storms where they were to deploy six experiments, including a seismometer and a small nuclear power station to operate them. Conrad, as Armstrong had before him, seized control of the LM Intrepid from the on-board computer and put himself and Bean down within 183 meters (600 feet) of the target, Surveyor 3, the unmanned spacecraft that took a lucky bounce 31 months earlier.

Apollo 11's astronauts had urged that future explorations start with a short period to get familiar with movement on the Moon. Bean and Conrad, who later likened his progress to a giraffe in slow motion, entered into this exercise with whoops of delight.

"Boy, you sure lean forward," Bean remarked.

". . . Don't think you're going to steam around here quite as fast as you thought you were," Conrad replied.

Jubilant enthusiasm marked all their activities: setting out the experiments, finding Surveyor 3 and snipping off bits of it for examination on Earth, collecting 34 kilograms (75 pounds) of rock samples so different from Apollo 11's as to show that the Moon had a complex geology indeed. What they fetched home so pleased scientists that one of them, W. T. Pecora, director of the U.S. Geological Survey, described Apollo 11's bag as "a geological hors d'oeuvre" and Apollo 12's as "a veritable feast."

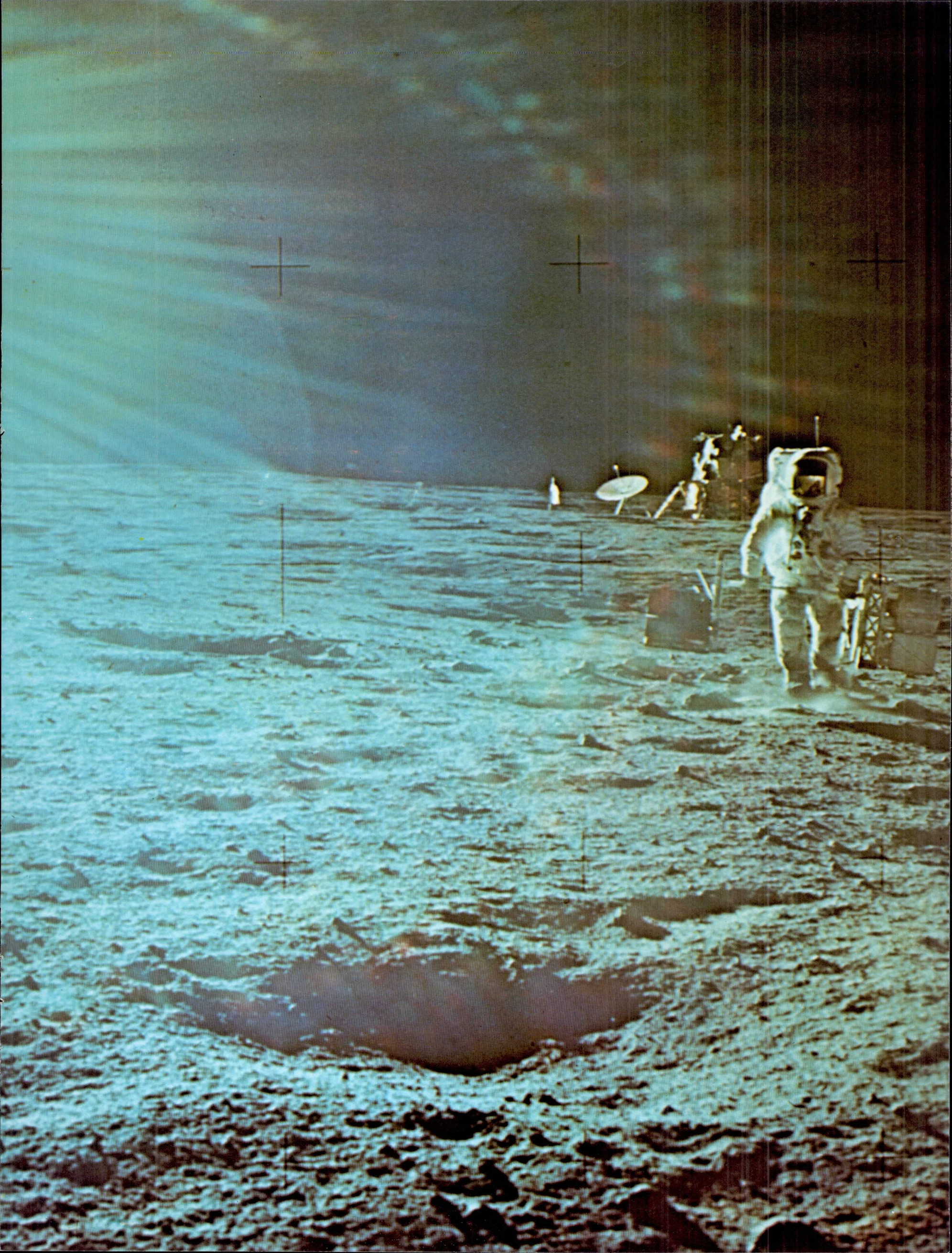
Apollo 12 further intrigued the scientists with the first bang registered by their seismometer. After rejoining the orbiting command craft Yankee Clipper, the astronauts sent Intrepid hurtling into the Moon at 8,000 kilometers per hour (5000 mph). On Earth that force might have created a slight two-minute tremor, but the seismometer on the Moon detected shock waves for 55 minutes.

Geophysicists now eagerly awaited Apollo 13, which was to crash the

Apollo 12 crew, left to right: Charles Conrad,Jr.; Richard F.Gordon, and Alan L.Bean.

Astronaut Bean examines the unmanned Surveyor 3 that landed on Moon April 19, 1967. Apollo 12 Lunar Module is on horizon.

Apollo 12 operations on Moon in glare of Sun.



Astronauts and flight controllers anxiously monitor consoles during Apollo 13 mission.

larger Saturn V third stage on the Moon. In the end that was the only scientific chore that Apollo 13 did accomplish. Three days out from the Cape on April 13, 1970, Astronauts Lovell and Haise had just finished checking out the LM Aquarius and Lovell was in the tunnel halfway back to the command ship Odyssey, where Swigert had the controls. Suddenly, they heard "a pretty large bang."

At first Lovell and Swigert thought Haise, as planned, had merely released a valve in Aquarius. But Haise, returning to Odyssey, scanned the instruments and saw that a main electrical system was decaying. Swigert alerted Mission Control:

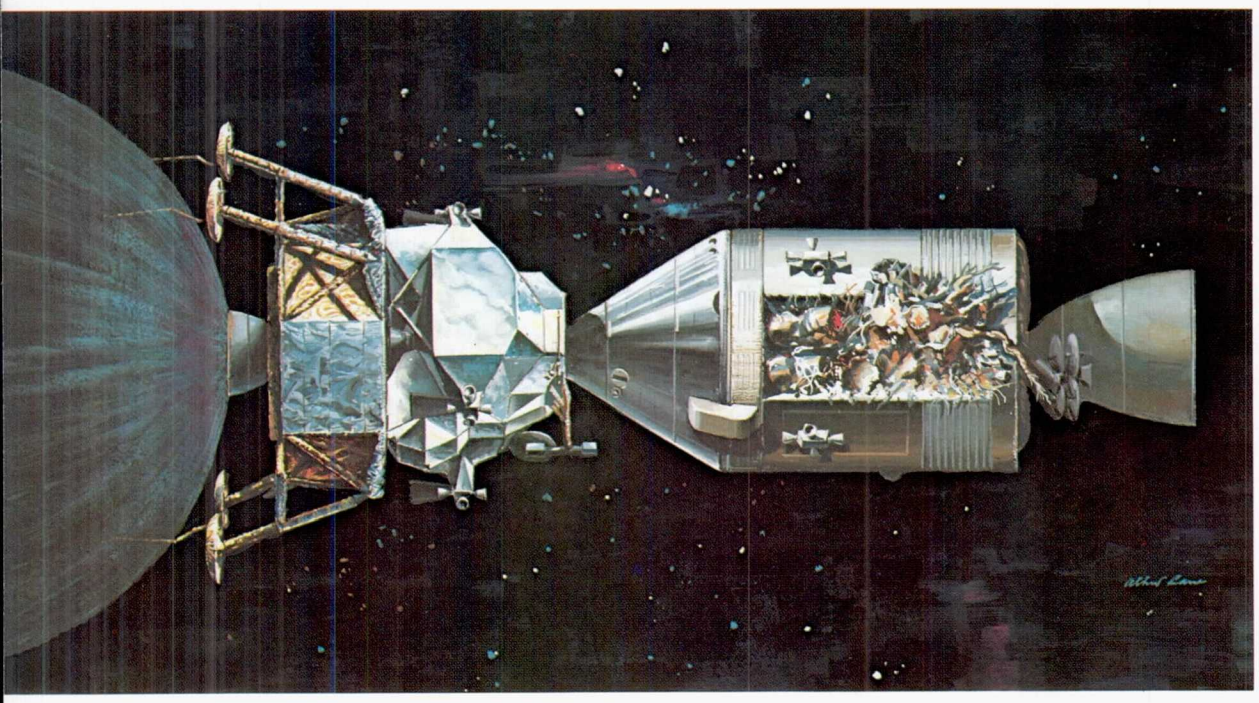
"Hey, we've got a problem here."

Hundreds of technicians in Mission Control and three men in space coolly assessed the damage. Within minutes, analyzing data from ground and space, thousands of experts at universities and NASA contractor plants put the problem to a vast network of computers:

How to rescue Apollo 13?

Something more than an hour later, an anxious world heard Mission Control relay the answer to Apollo 13: ". . . We are now looking toward an alternate mission, swinging around the Moon and using the LM power systems . . ."

And that's what the astronauts did. Lovell and Haise powered up Aquarius while Swigert battened down Odyssey. Early in the morning of April 14 the Aquarius engine fired the crippled expedition onto a course that would send it around the Moon and back toward Earth. For more than 90 hours three men rode a spacecraft built to accommodate two men for 60 hours.



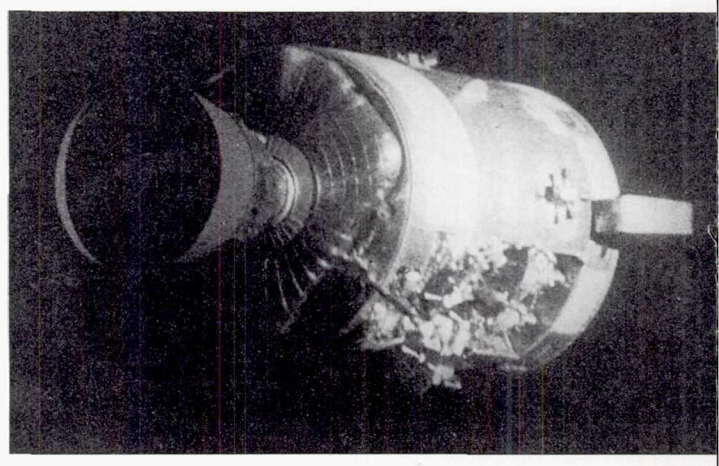
Artist portrays particles from damaged spacecraft accompanying Aquarius and the ruptured Odyssey as Apollo 13 fires engine to alter course.

Apollo 13 crew, left to right: James A.Lovell,Jr.; John L.Swigert,Jr., and Fred W.Haise.

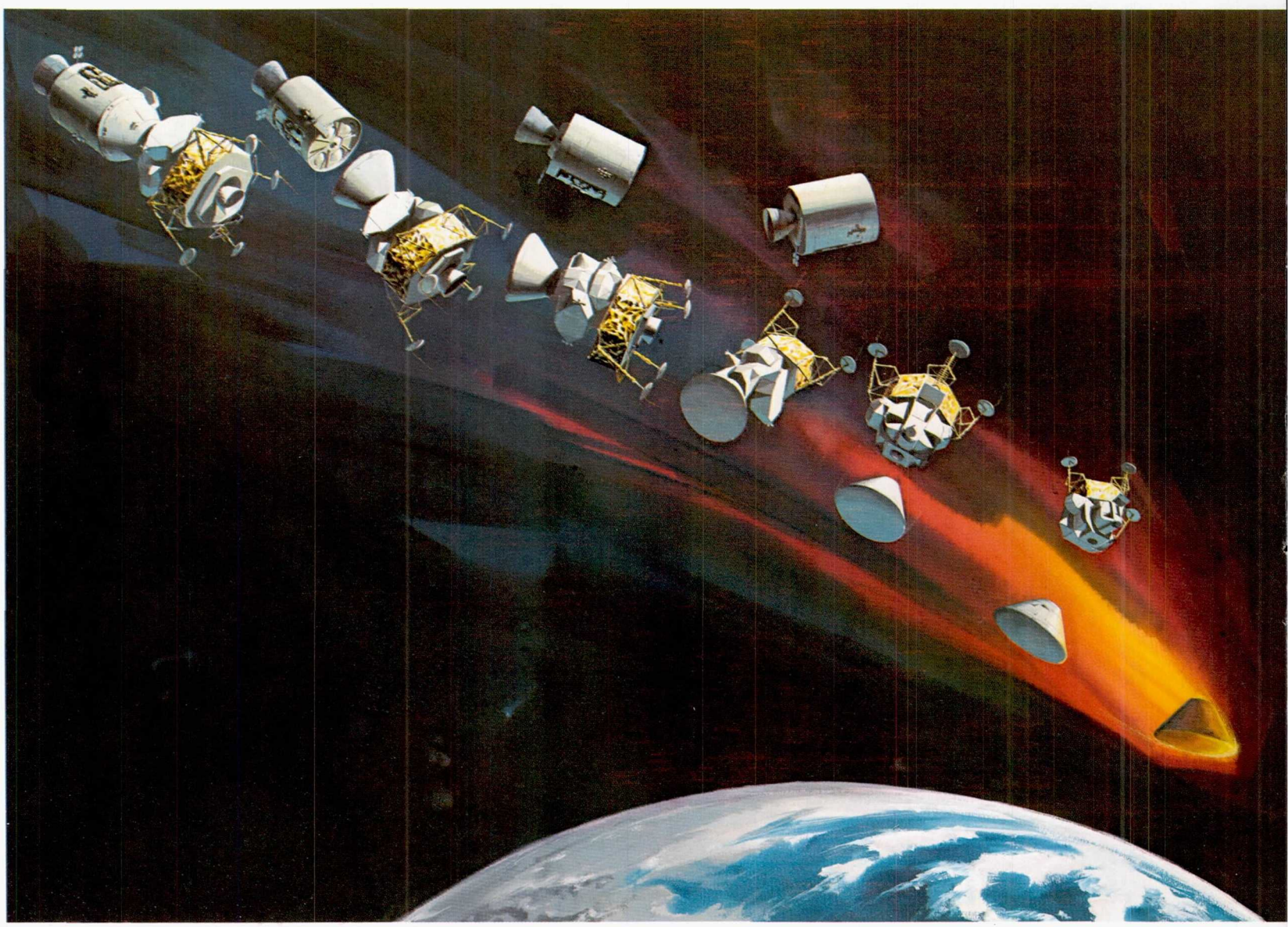
Approaching Earth, they fired the Aquarius engine again to thread themselves through the slender gateway out of space, shifted to the lifeless Odyssey, and cut loose the damaged Service Module and their lifeboat, the Aquarius. Carrier Iwo Jima, steaming on station in the Pacific Ocean, picked them up 45 minutes after splashdown, the fastest recovery ever.

For Apollo 14, originally scheduled to take Alan Shepard, Stuart A. Roosa, and Edgar D. Mitchell toward the Moon in October 1970, the mishap spelled a change of landing site and a delay until the following January

View of damaged Service Module.

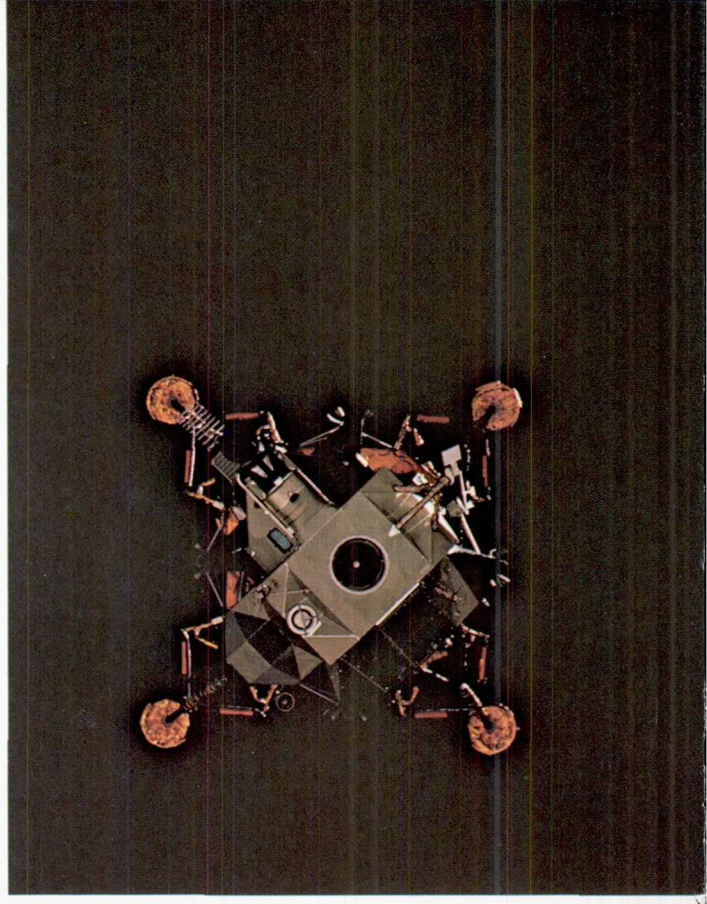


Separation sequence leading to re-entry of Command Module Odyssey.

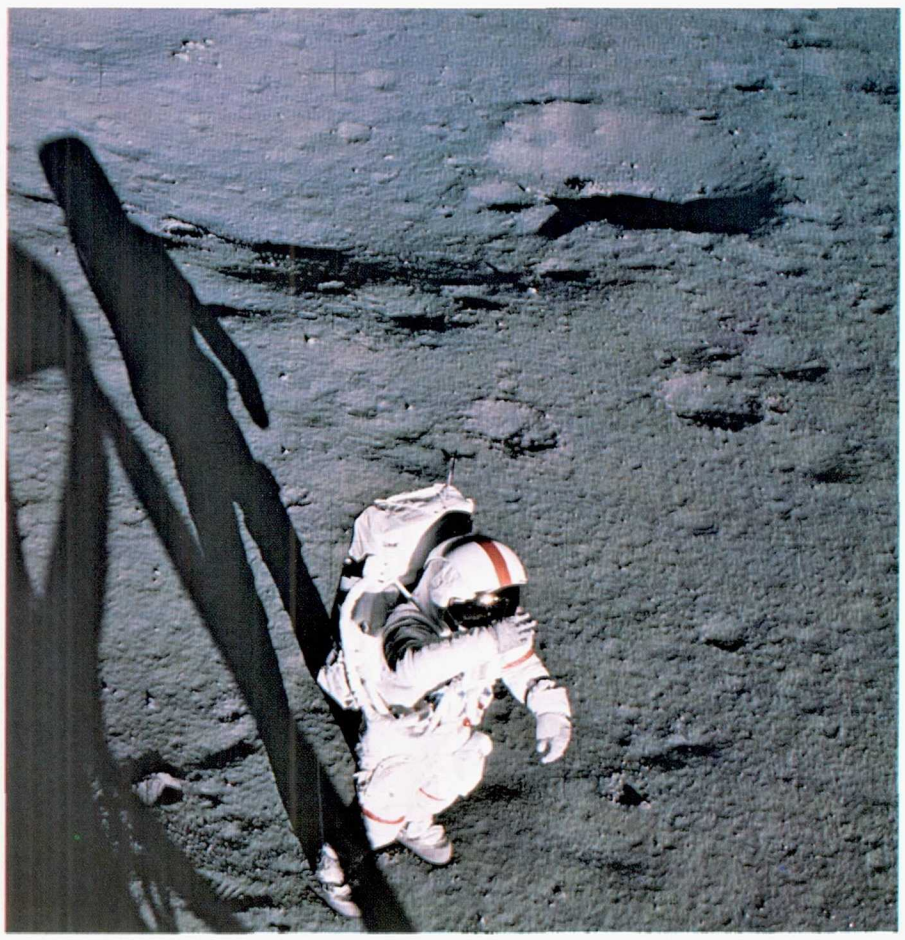


Elation in Mission Control Center after safe recovery of Apollo 13 crew.

Apollo 14 Lunar Module withdraws from Command Module.



Tracks of Modularized Equipment Transporter (MET) used on Apollo 14 mission lead away from Lunar Module on Moon.



Shepard shades his eyes against brilliant sunlight.

while the spacecraft was altered to prevent what had been pinpointed as an explosion in an oxygen tank.

Apollo 14 finally headed for what had been 13's destination, a landing in the foothills of the scientifically promising Fra Mauro region. Like Apollo 13, Apollo 14 also aimed its Saturn third stage at the Moon.

The first American in space and, at 47, the oldest to land on the Moon, Shepard was grounded by an ear infection all through Gemini. "It's been a long way," he all but sighed on climbing out of Antares, "but we're here."

Shepard and Mitchell set up an automated science laboratory that included another seismometer. When they later left the Moon and crashed their empty LM on the surface, scientists on Earth received two sets of radioed vibrations to study.

The two Moon walkers also introduced what NASA called MET (for

Alan B.Shepard,Jr.

Edgar D. Mitchell

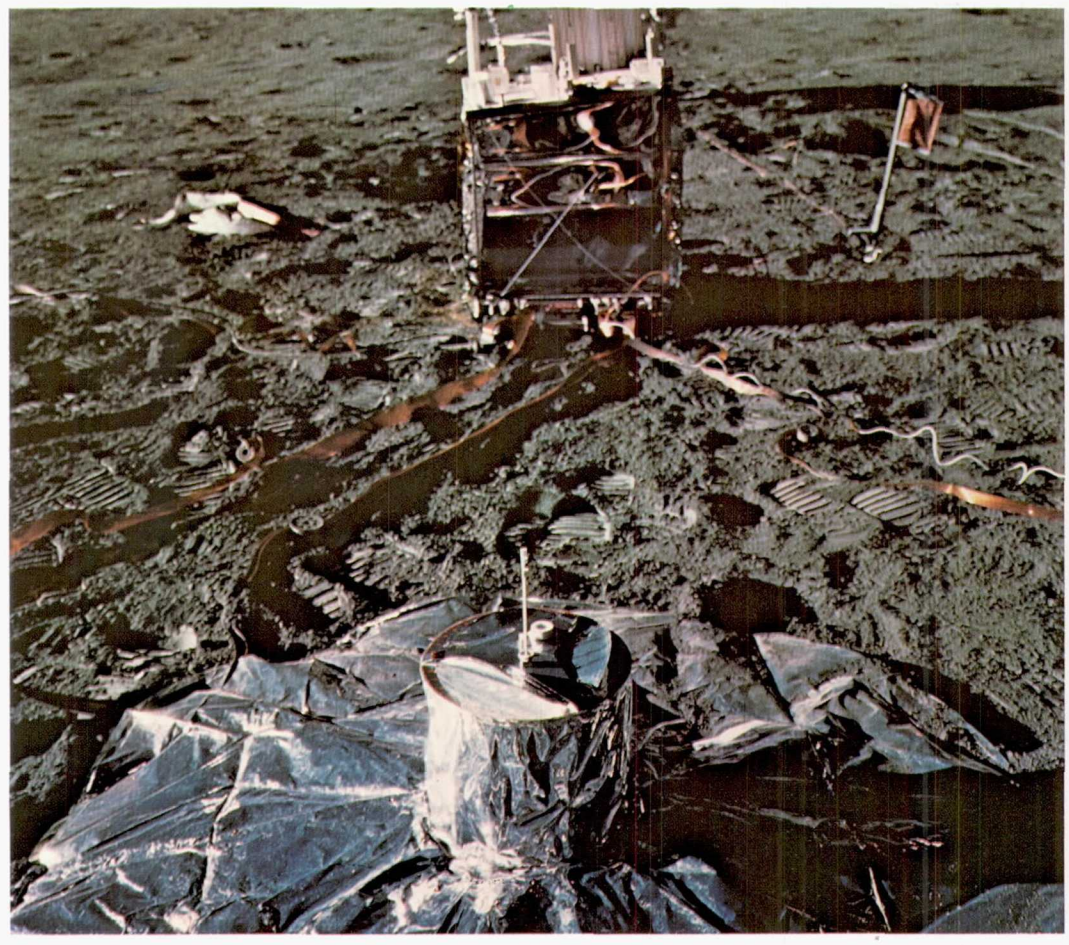
Stuart A.Roosa

modularized equipment transporter), a two-wheeler which they took turns pulling during two long explorations, one of them several disappointing yards short of an objective, Cone Crater. Altogether Shepard spent nearly nine and a half hours walking on the Moon, Mitchell a few minutes less.

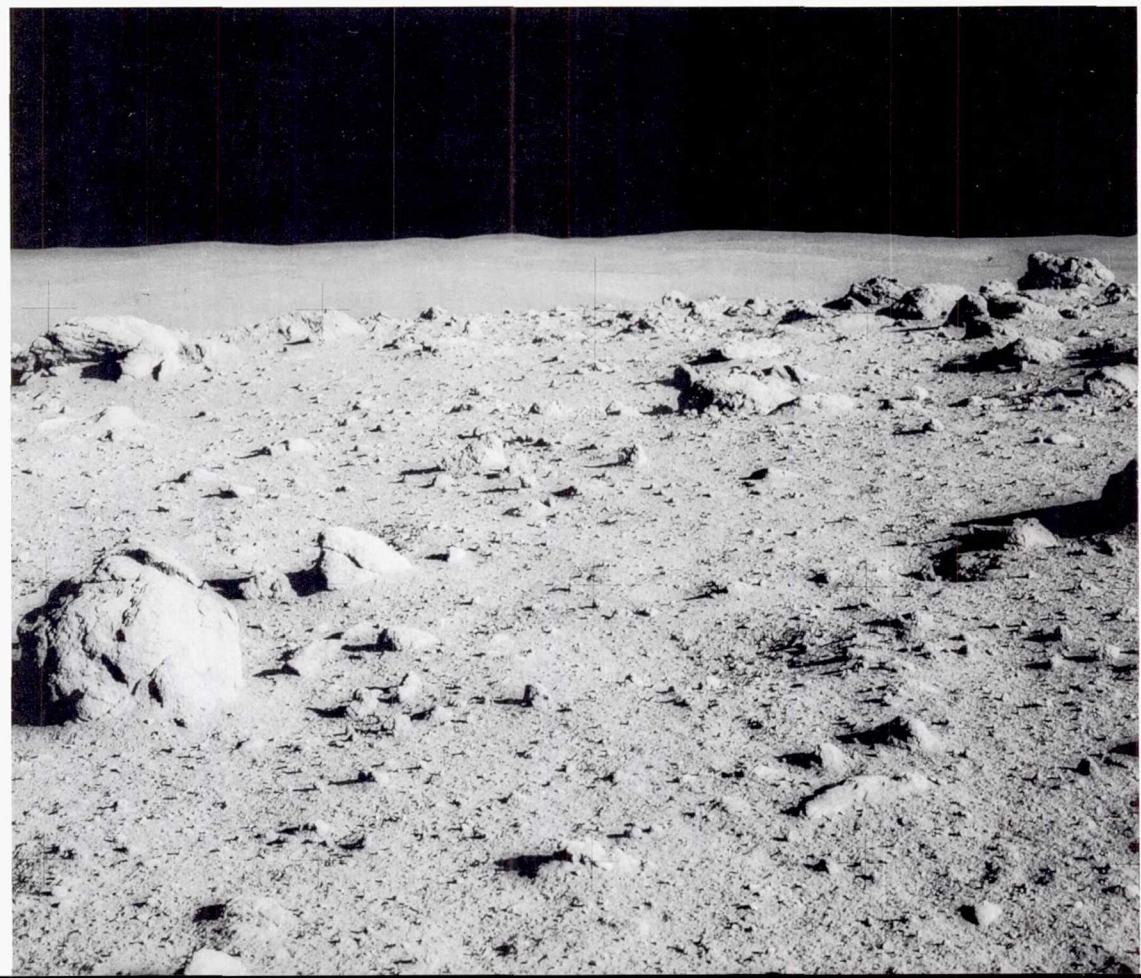
In light of Shepard's final act on the Moon the MET might better have been called a caddy cart. Just before reboarding Antares, he took two golf balls from his Moon suit and, after one whiffy, one-handedly drove them into the airless one-sixth gravity with the handle of a geological tool. "There it goes," he exulted. "Miles and miles."

Actually, Shepard estimated afterwards, the first went about 180 meters (200 yards) and the second 360 meters (400 yards).

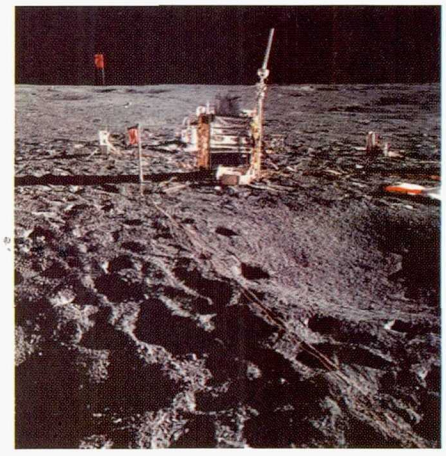
Passive Seismic Experiment Package (PSEP) for detecting meteorite impacts and Moonquakes is in foreground, central power station in rear.

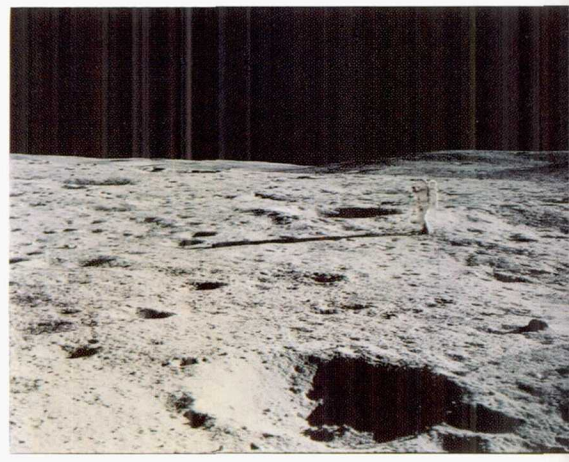


Near rim of Cone Crater, the Apollo 14 astronauts encountered rocks nearly as big as a meter (3 feet) in diameter.



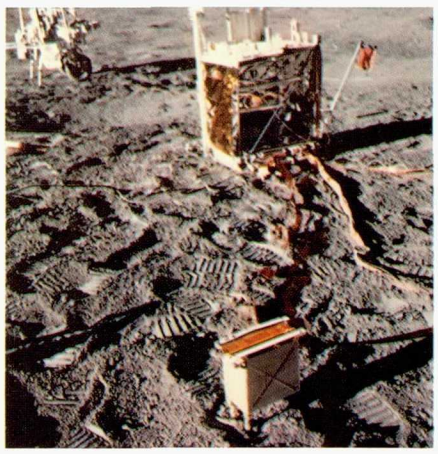
View of entire Apollo Lunar Surface Experiment Package array except nuclear power source.





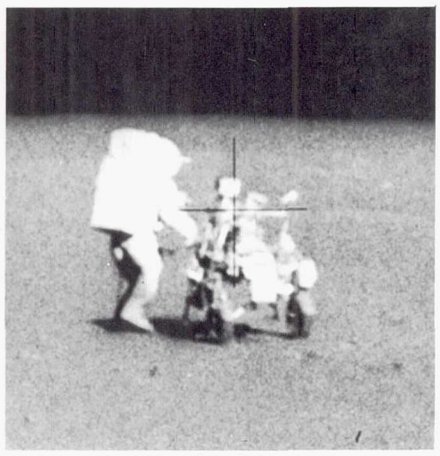
Mitchell operates TV camera.

Charged Particle Lunar Environment Experiment (CPLEE) in foreground detects atomic particles from space.



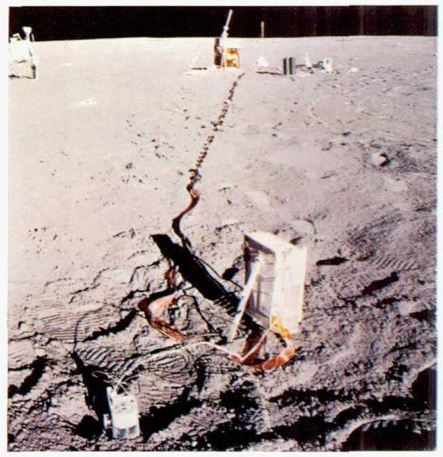
Suprathermal Ion Detector (SIDE) in foreground detects ions (atoms from which electrons have been stripped) in lunar environment.

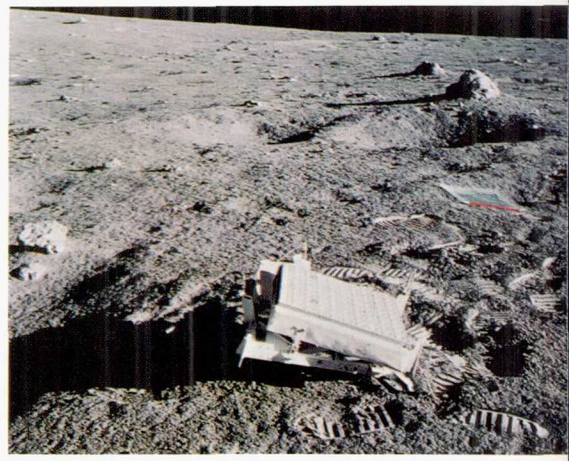
Laser reflector left on Moon by Apollo 14.

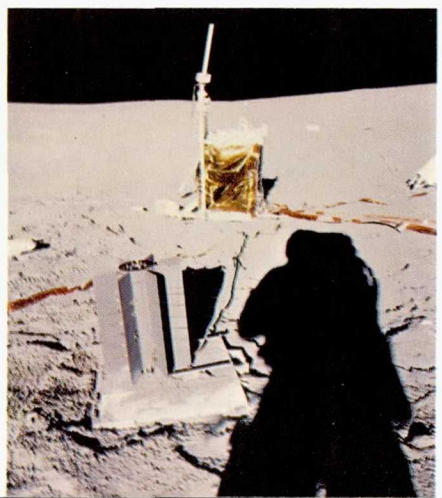


Mitchell takes handtool from MET.

Radioisotope Thermoelectric Generator for ALSEP in foreground, beside astronaut's shadow.



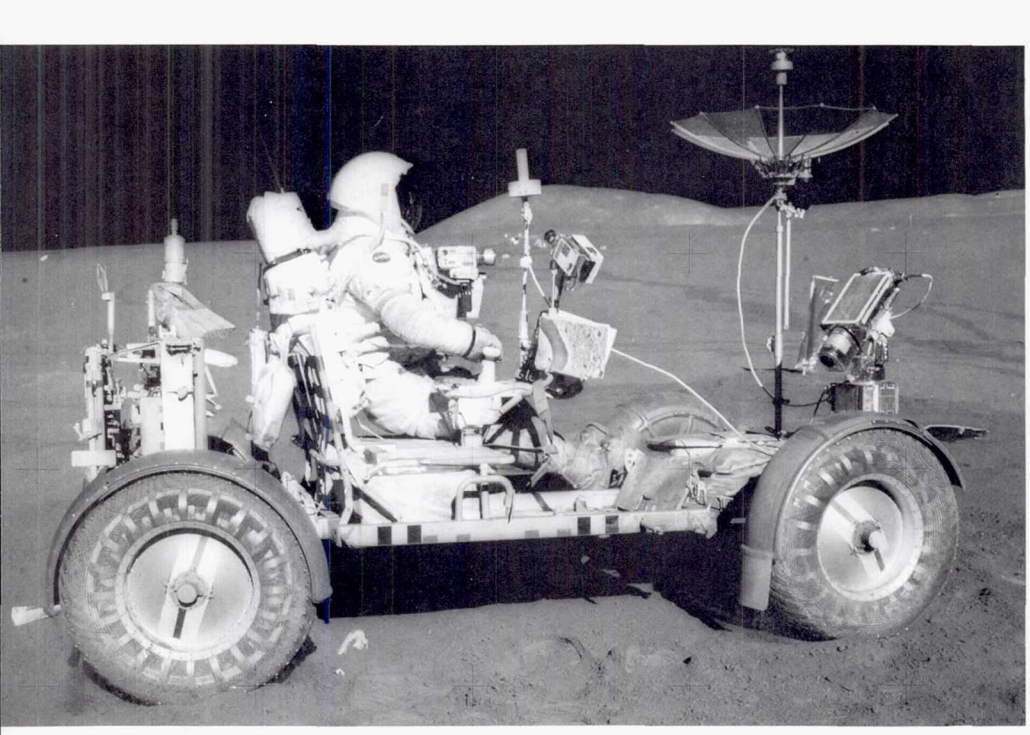




Travel grew easier for men on the Moon with Apollo 15. David R. Scott, 15's commander, boarded a battery-powered jeep-like vehicle on the Moon on July 31, 1971, and pronounced it "a reasonable fit."

"OK, Dave," said Mission Control. "And buckle up for safety."

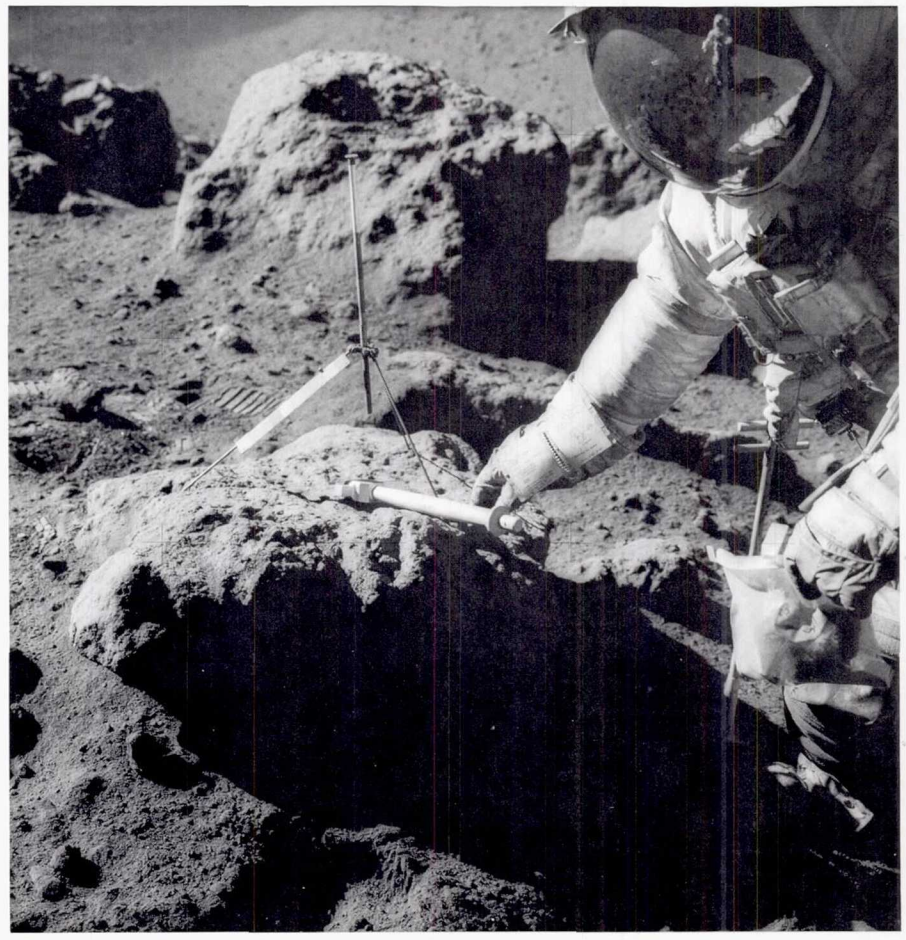
NASA called it LRV (for lunar roving vehicle) and the New York News called it "the merry moon-mobile. The astronauts came to call it the Rover and with its help Scott and James B. Irwin logged more than 18 hours of travel from the LM Falcon's base on the Marsh of Decay to the foothills of the 4,500-meter (15,000-foot) Apennine Mountains and the

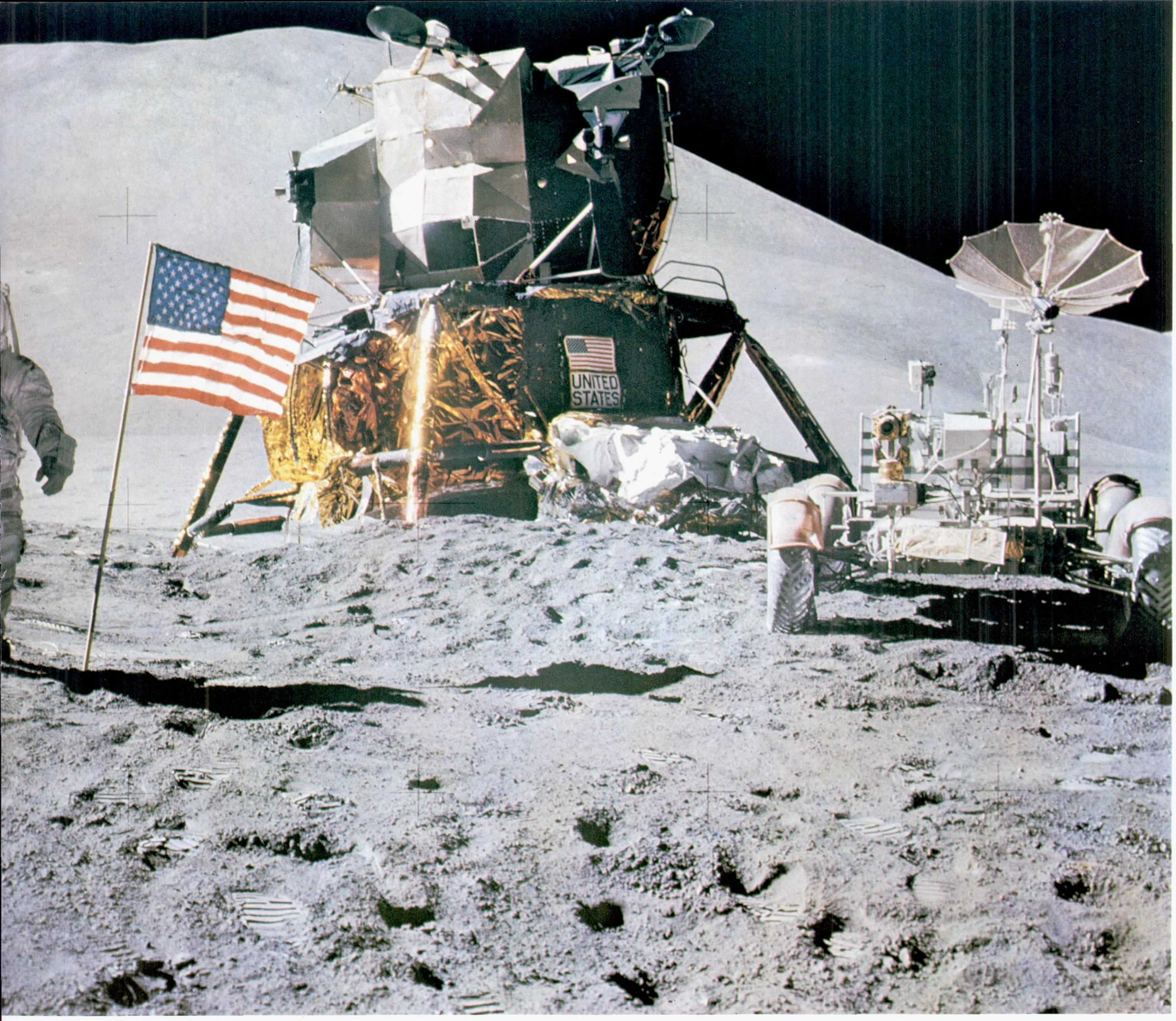


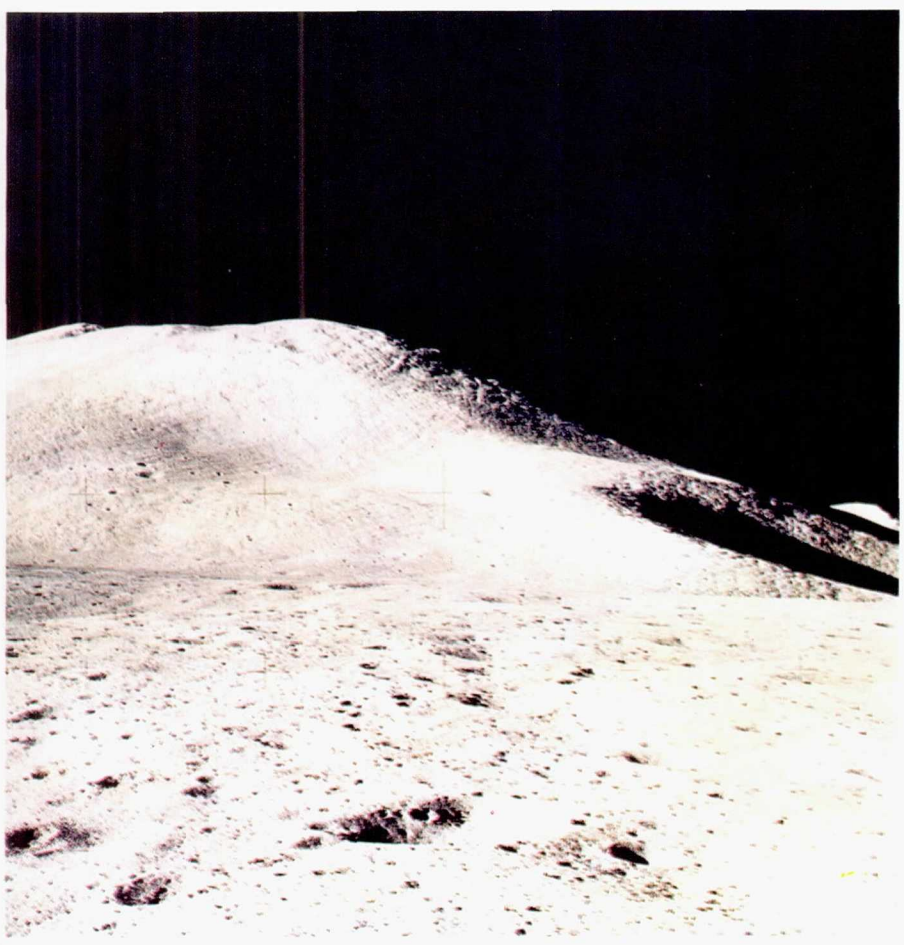
David R.Scott in lunar rover.

James B. Irwin salutes U.S. flag beside Lunar Module and lunar rover. Hadley Delta is in background.

Scott reaches for lunar rock sample.







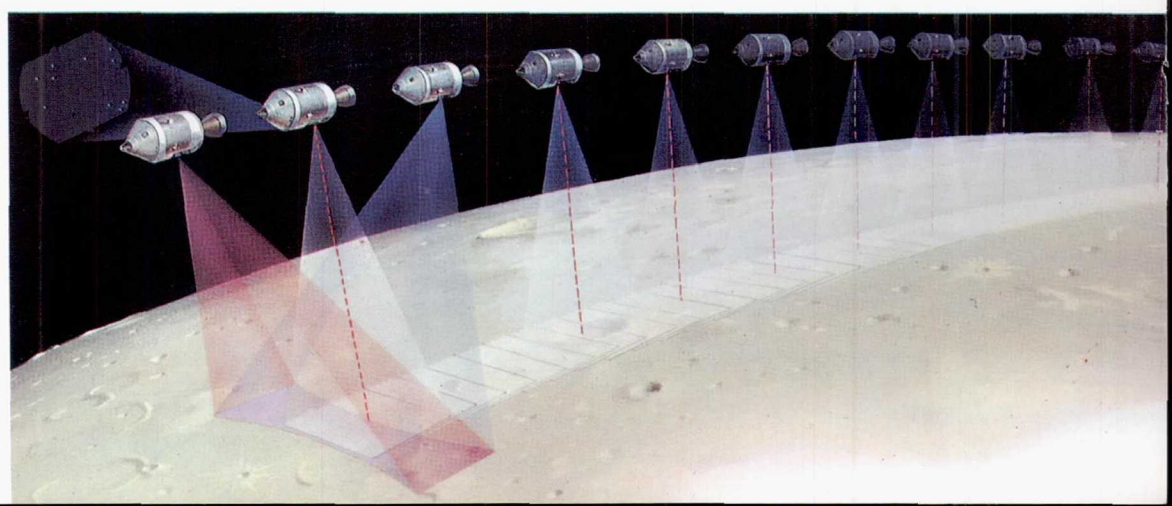
Hadley Delta (mountain) and St. George Crater.

Oblique view of Hadley-Apennine area, lower center, as photographed by camera in SIM bay of Apollo 15 Command Module in lunar orbit.

1.6 kilometer (mile)-wide 180 to 360-meter-deep (600 to 1,200-foot-deep) Hadley Rille.

When Scott and Irwin had finished their investigations, the television audience on Earth could see for the first time the liftoff of the LM to rejoin Alfred M. Worden in the Endeavour. The scene was picked up by the camera mounted on the abandoned Rover. On the way home Worden recorded a notable first: a walk in deep space, more than 317,000 kilometers (197,000 miles) from Earth, to retrieve film from cameras in the Service Module before it was discarded.

After splashdown, left to right: Scott, Irwin, and Worden.



Mapping camera shoots overlapping pictures (light squares) as laser altimeter (dashed lines) measures distance to Moon's surface and stellar camera simultaneously photographs star field to determine precise attitude of the Moon-orbiting Endeavour. Panoramic camera takes wider exposures (dark area).

With instruments of increasing sophistication, six Apollo landings on the Moon set up a network of miniature laboratories. Exceeding their life expectancies, most of the devices—here drawn to scale—still send torrents of data to Earth.

Subsatellite (1): *Deployed from the orbiting Command Module, this unmanned satellite radios data on solar wind, cosmic rays, the Moon's weak magnetic field, and its irregular gravitational field.*

Active Seismic Experiment (2): *After the Lunar Module departs, a mortar hurls grenadelike charges as far as 3,000 feet. Detonations send seismic signals to geophones, revealing subsurface differences.*

Heat-Flow Experiment (3): *Probe planted eight feet in the lunar soil holds sensors that measure heat flowing from the interior.*

Solar Wind Spectrometer (4): *This measures the number of electrons and protons streaming from the Sun, as well as their velocity, direction, and temperature.*

Suprathermal Ion Detector (5): *Registers the rate at which ions are created in the Moon's tenuous atmosphere and detects ions from space.*

Cold Cathode Ion Gauge (6): *Capturing particles of the Moon's thin atmosphere, the gauge monitors its constantly changing density.*

Lunar Surface Magnetometer (7): *Sensors at the ends of the three booms record the Moon's slight magnetic field.*

Charged Particle Lunar Environment (8): *This device records the flow of particles hurled outward by the Sun, including those that cause Earth auroras.*

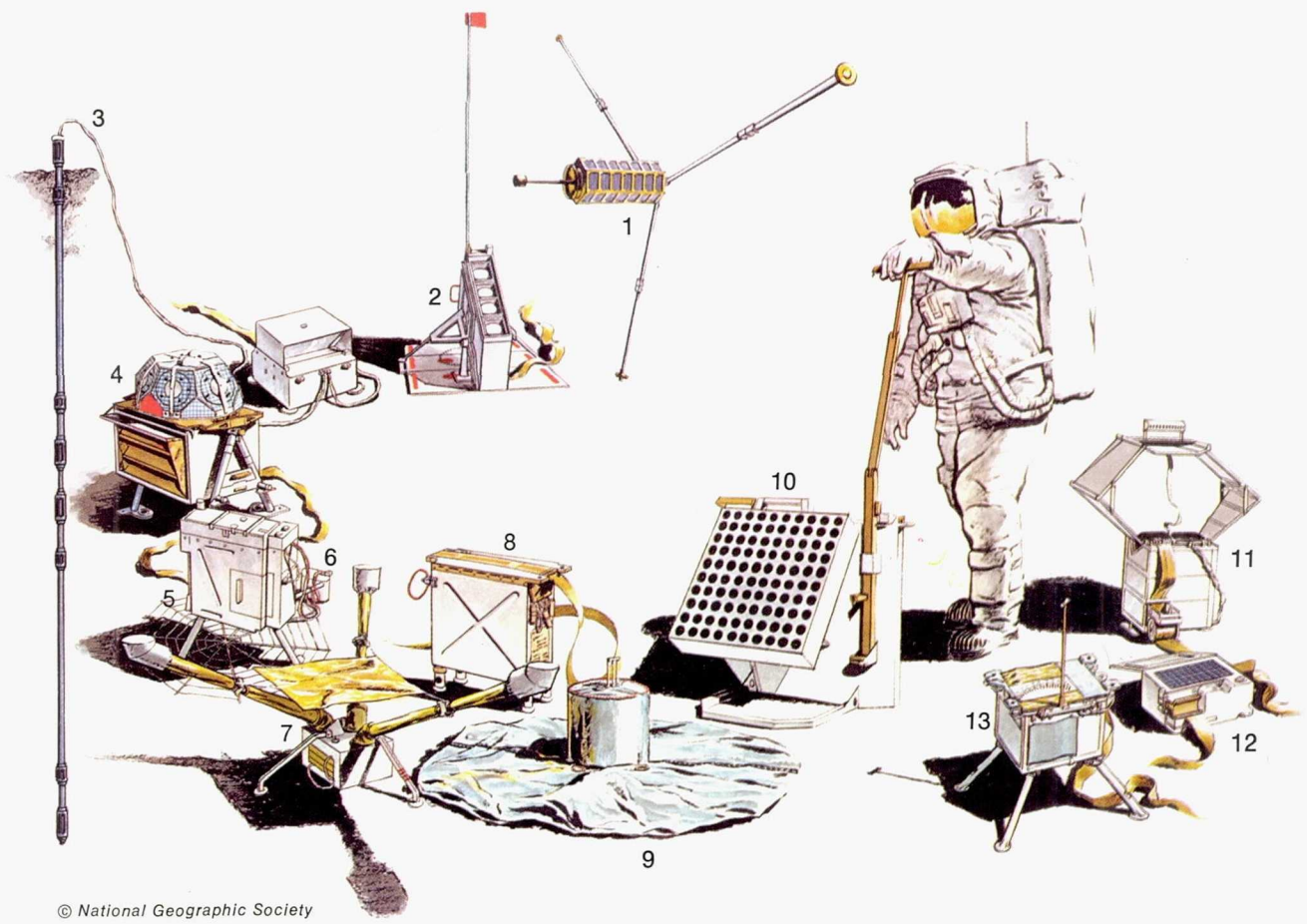
Passive Seismic Experiment (9): *Recording moonquakes and meteorite impacts, the seismometer enables scientists to draw profiles of the lunar interior.*

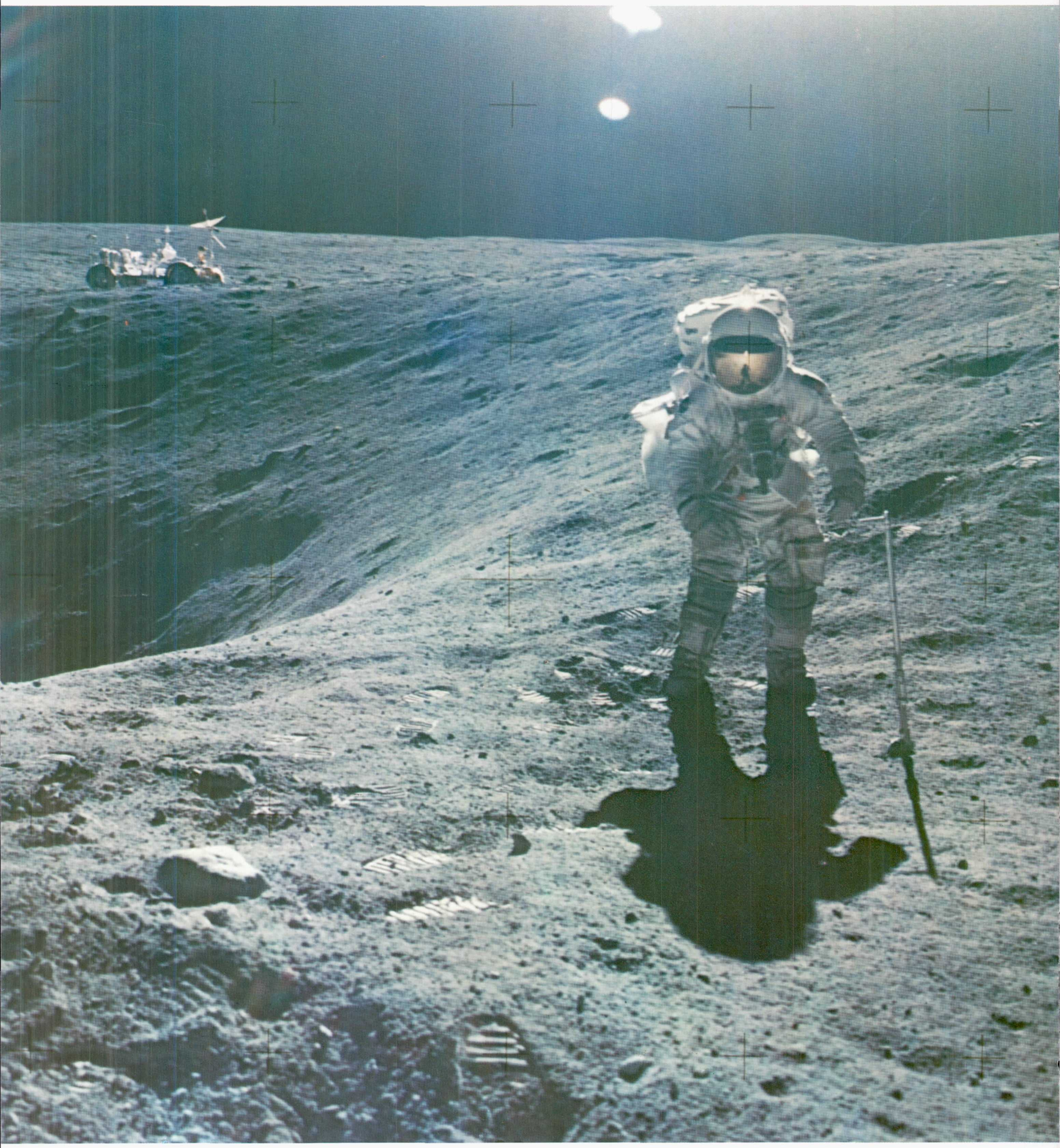
Laser Ranging Retroreflector (10): *Bouncing laser pulses back to Earth, the reflector measures Earth rotation, polar motion, and continental drift, as well as aspects of lunar physics. It gauges Earth- Moon distances to an accuracy of less than six inches.*

Lunar Surface Gravimeter (11): *Detecting changes as small as 1/10 billionth in the force of the Moon's gravity field, this experiment is searching for the gravitational waves predicted in Einstein's theory of relativity.*

Lunar Atmospheric Composition Experiment (12): *This sophisticated analyzer of lunar gases was carried only by Apollo 17, as were devices 11 and 13.*

Lunar Ejecta and Meteorites Experiment (13): *Impacting micrometeorites and the surface fragments they dislodge generate electrical signals that reveal the particles' speed, direction, and mass.*



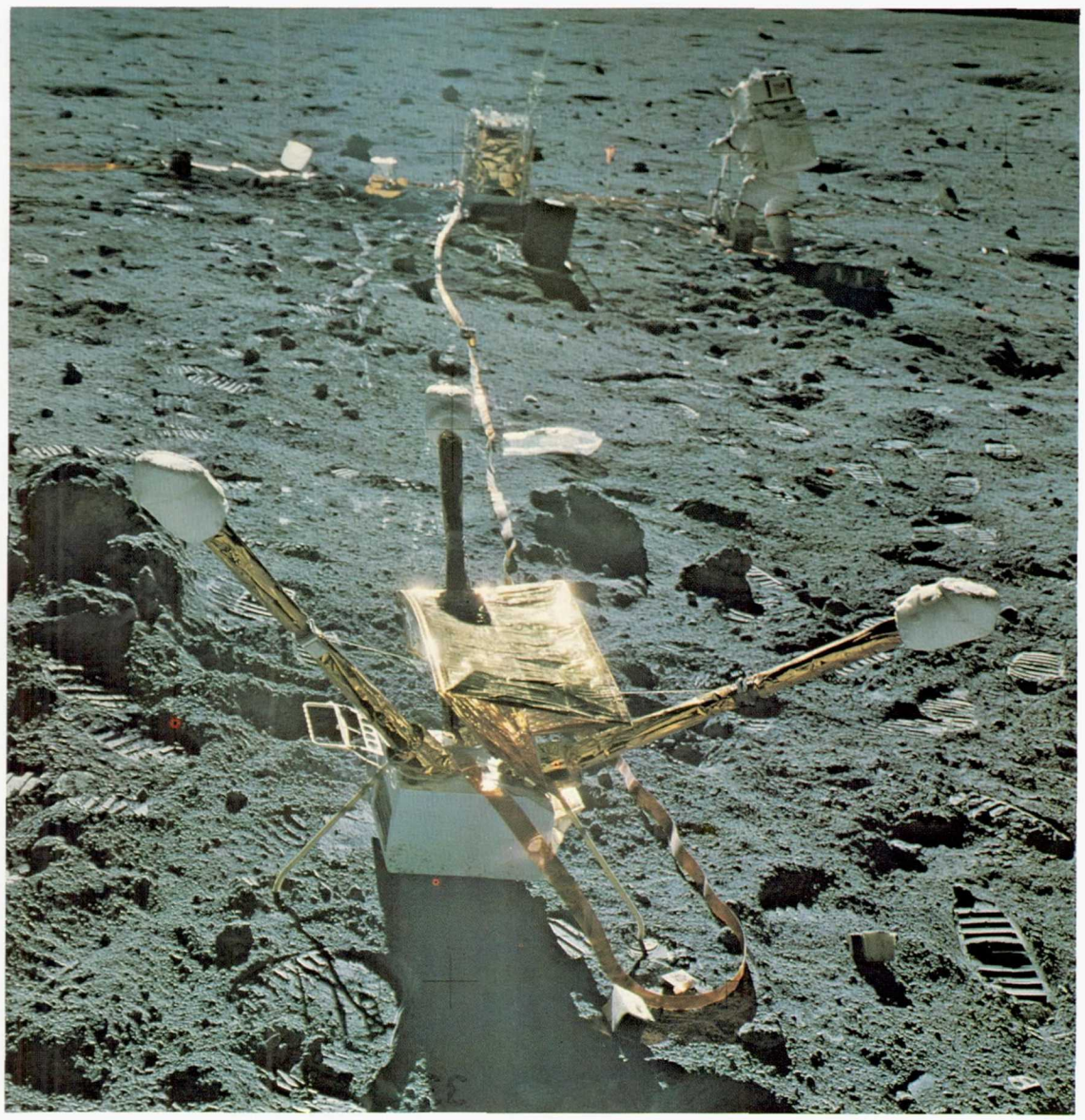


Apollo 16 astronaut Charles M.Duke, Jr., collects samples at rim of Plum Crater. Lunar rover is in background.

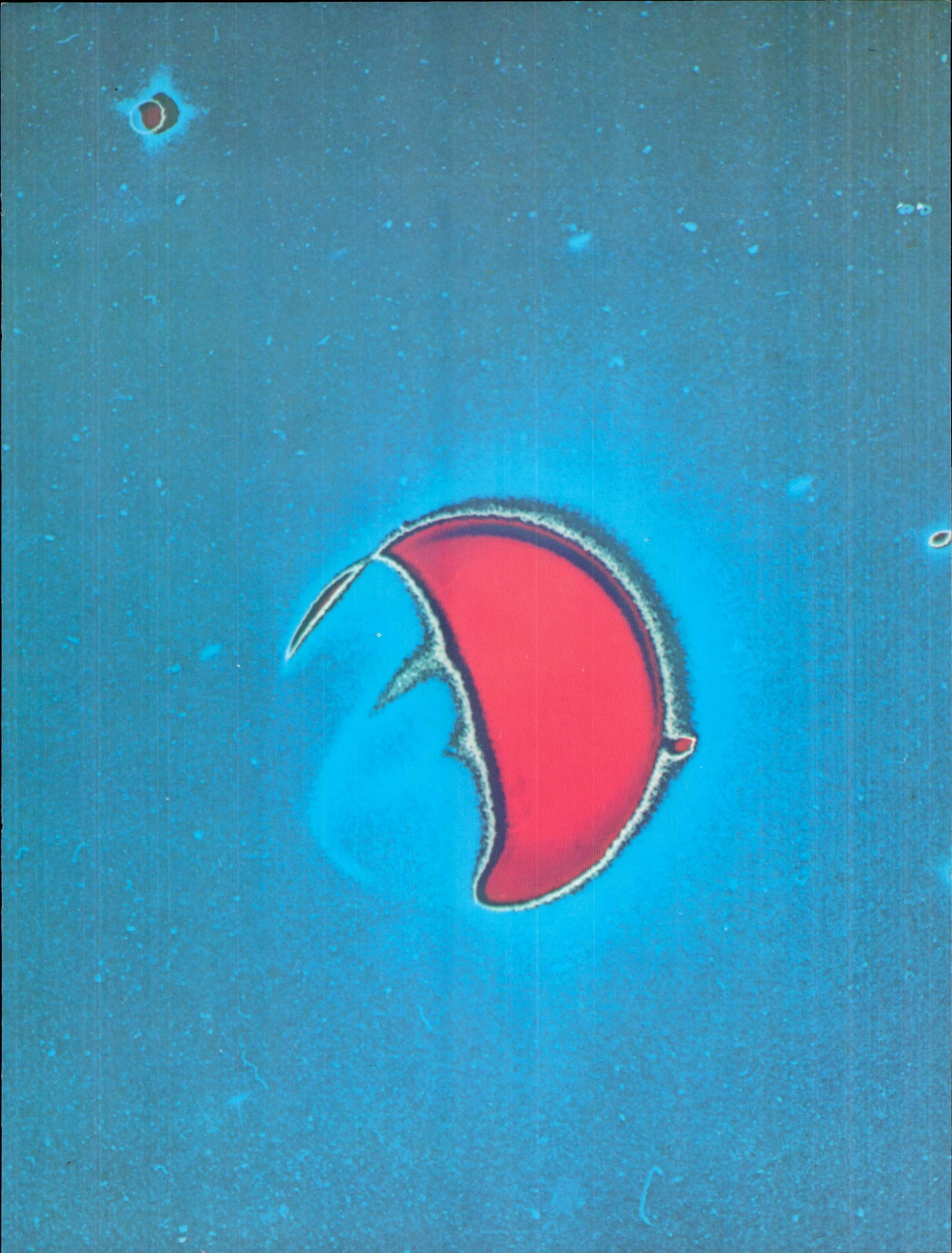
Edward I.Fendell, seated at console in Mission Control, remotely controlled TV camera that astronauts set up on Moon. Scenes were fed directly to television networks.

Like 15 before it and 17 yet to come, Apollo 16 used an advanced configuration of the spacecraft that got a load as big as a moving van to the Moon. Apollo 16 Commander John W. Young and LM Pilot Charles M. Duke Jr. also were the first astronauts to land in the Moon's highlands, putting down April 20, 1972, on the rock-strewn plains of the Descartes region.

But for six tense hours there was



Young stands amid ALSEP array he and Duke deployed on Moon.



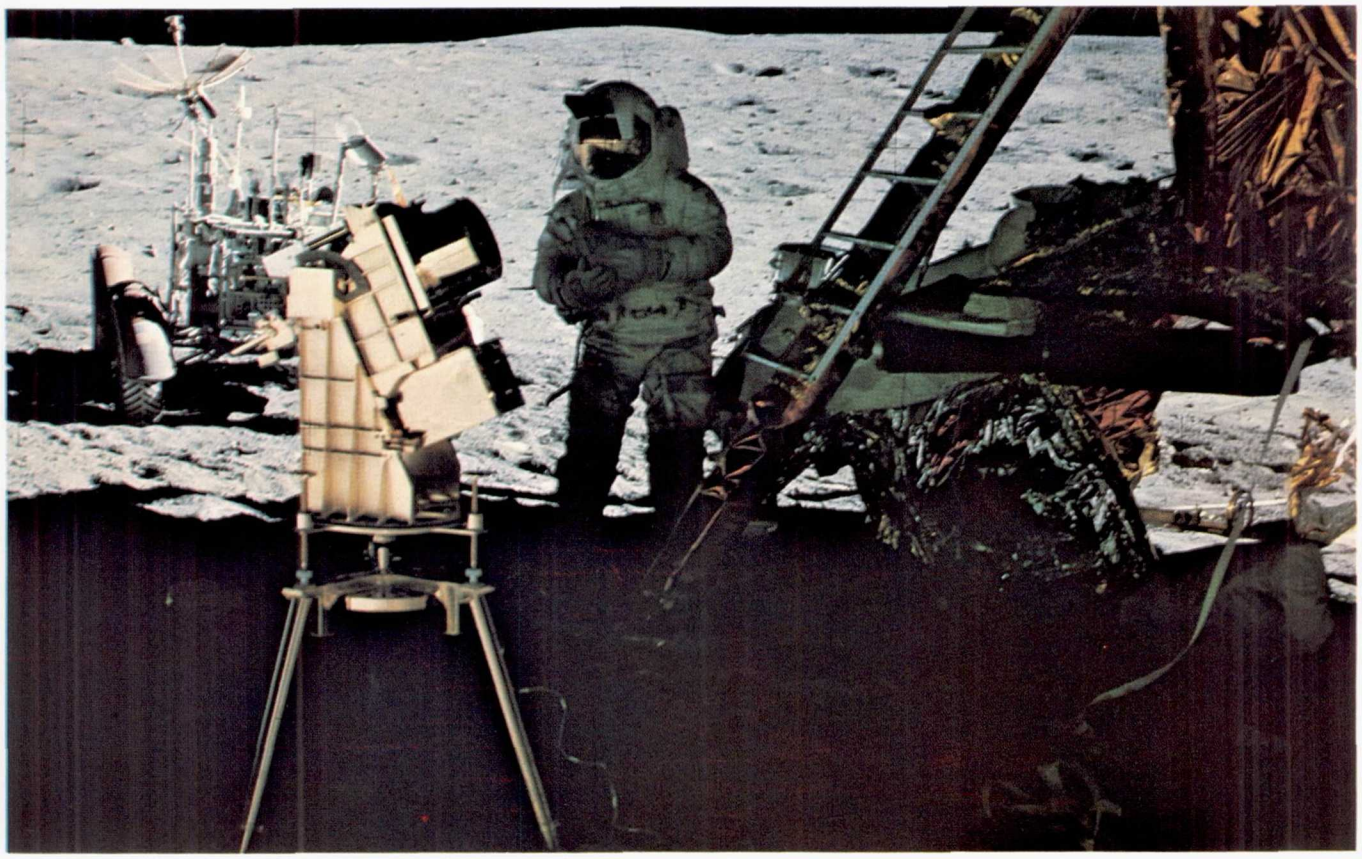
Color enhanced ultraviolet photograph of Earth taken on Moon by Apollo 16 shows regions of atomic oxygen and molecular nitrogen in Earth's atmosphere and airglow bands.

Apollo 16 Ultraviolet Camera/Spectrograph on Moon. It photographed ultraviolet light emitted by Earth and other celestial objects.

doubt that they would be able to land on the Moon at all. It happened just after their LM Orion separated from the command ship Casper and minutes before they were to descend.

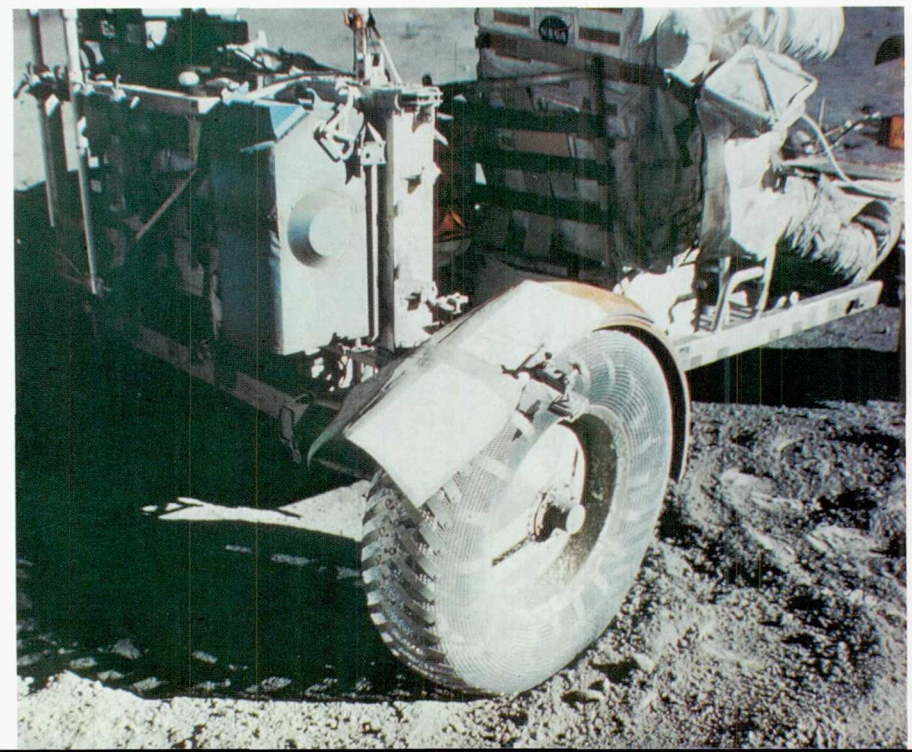
Casper's pilot Thomas K. Mattingly II found that his main engine vibrated while on secondary steering. While both ships continued in neighboring orbits, an actual engine test and two simulated tests by computer were conducted on Earth.

Finally Young and Duke were cleared to land and they ultimately spent a record 71 hours and two minutes on the Moon. They ventured forth three times and set up still another nuclear-powered laboratory, the fourth, on the Moon.



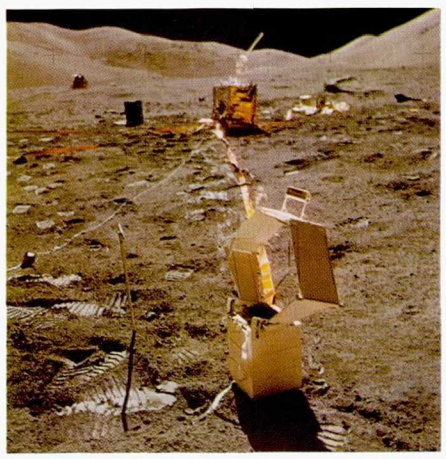
John W.Young, above, Charles M.Duke,Jr., far left, and Thomas K.Mattingly II

Photo from Lunar Module catches Command/Service Module, in distance, passing over Apollo 17 landing site.



Stiff plasticized maps are taped together to patch rover's broken fender.

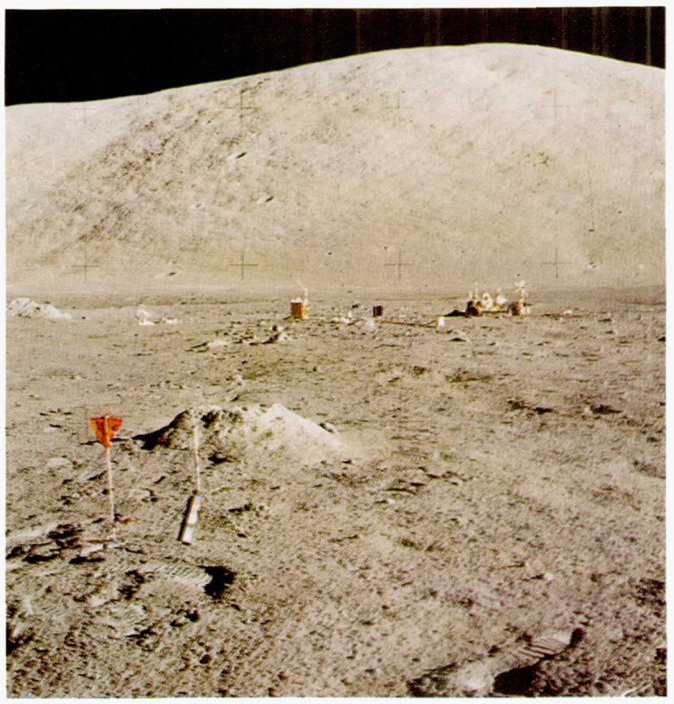
Panoramic view of Apollo 17 ALSEP. North Massif is in background.



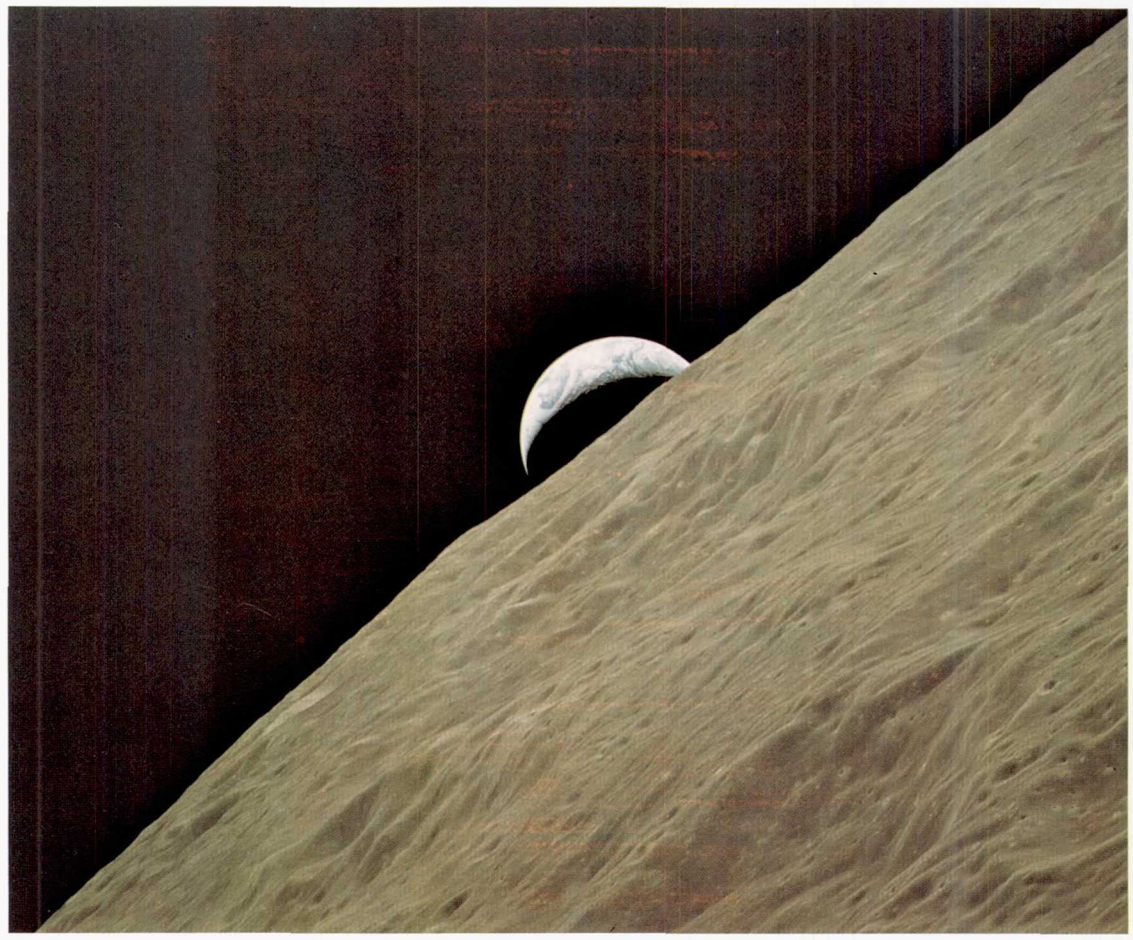
Apollo 17 wound up the project with a night launch on Dec. 7, 1972. That was unusual enough, but the most interesting distinction of the mission was the first auto repair on the Moon. Just after unloading the Rover, Apollo 17's commander, Gene Cernan, damaged a fender with a hammer and patched it with adhesive tape. On his first venture out with geologist Jack Schmitt, the fender fell off altogether and Cernan, troubled like all others on the Moon by the dust, exclaimed, "Oh, it pretty

Pale orange soil discovered during second EVA excited lunar scientists. It hinted of ancient volcanic activity.

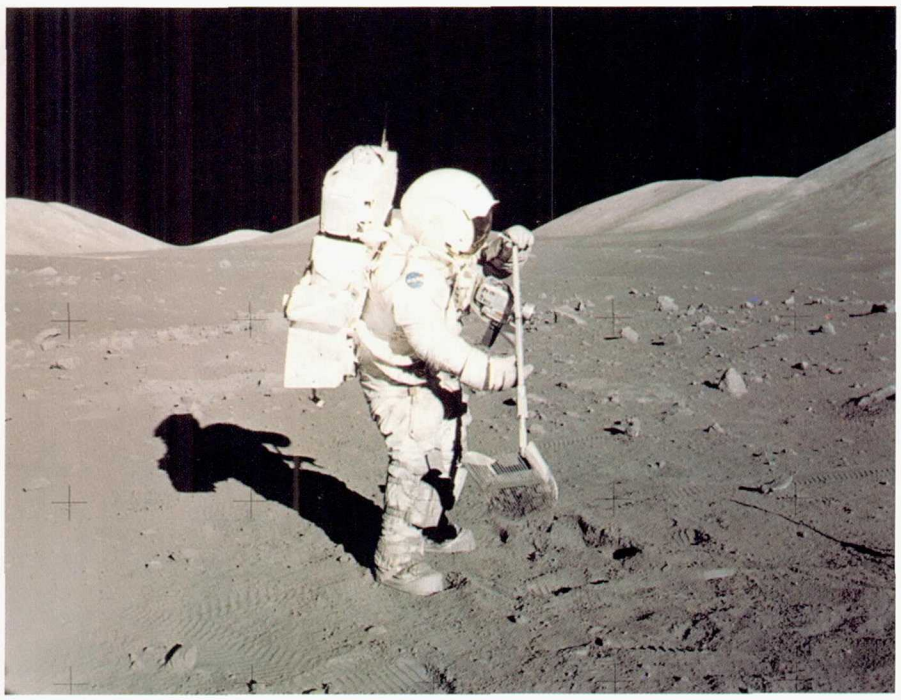
Sculptured Hills overlook another view of ALSEP.



Schmitt examines huge split lunar boulder.



Lunar farewell. Last Apollo crew viewed this Earthrise on Moon as they prepared to rocket out of lunar orbit back to Earth.



Schmitt collects rock sample.

Apollo 17 astronauts, left to right: Harrison H.Schmitt, Ronald E.Evans, and, seated, Eugene A.Cernan.

near makes me sick at losing that fender."

Later on, with coaching from the sidelines in Houston, the astronauts taped together a fender of sorts from unused plastic-coated map sheets.

It was near the end of their third exploration that Cernan and Schmitt, as related earlier, convinced Mission Control that they should linger to get a core sample from a trench near the Sculptured Hills. They also electrified observers on Earth by finding orange-colored soil in the Taurus-Littrow Valley, which hinted strongly at an ancient volcanic eruption on the Moon.

Cernan (left) and Evans drift before camera in their spacecraft.

Evans is hoisted aboard helicopter after splashdown. Recovery vessel in background.

Answers to Long-standing Questions

Project Apollo operations, ended with the splashdown and recovery of Apollo 17's America in the Pacific on Dec. 17, 1972. A dozen men walked and rode over 110 kilometers (60 miles) on the surface of the Moon, spending a total of 160 man-hours and conducting more than 50 major scientific experiments.

What did they learn?

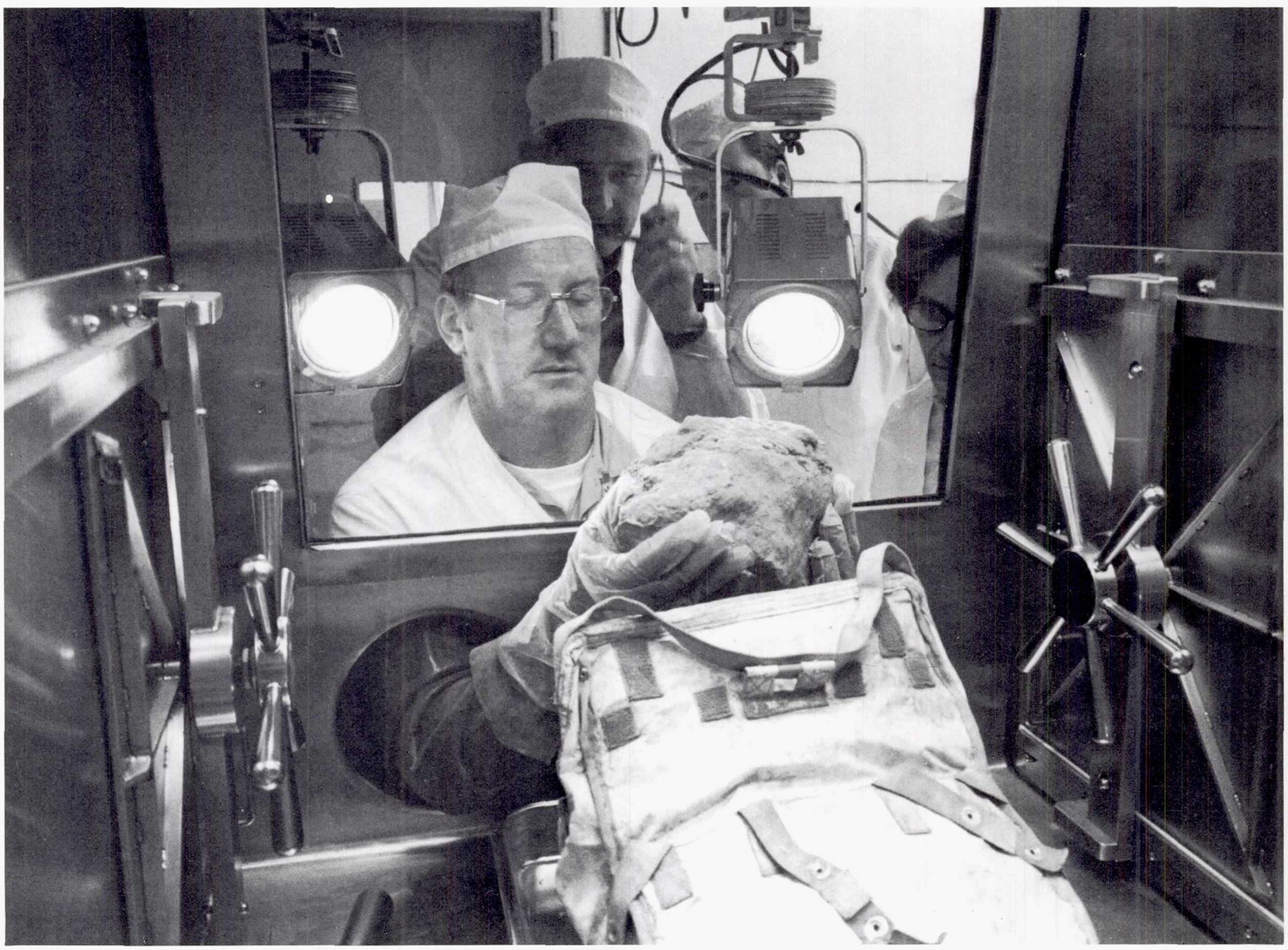
They learned, for an example, that the center of the Moon's mass is on the side nearer the Earth, that the Moon was hot at some time and may still be hot at its core, that its chemical composition is very like the Earth's but in different proportions and that the Moon was formed more than four billion years ago in a manner and place still to be determined.

The findings stream in steadily—from laboratories in 16 nations where scientists have been studying the 382 kilograms (841 pounds) of rock and soil and the many thousands of photographs brought home by Apollo. After the last mission was flown, what's more, a dozen experiments planted on the Moon in five lunar laboratories have continued to pour information back to Earth.

What this tells about the Moon matters mostly for what it tells about

Photomicrograph of lunar igneous rock distinctly shows individual mineral grains.

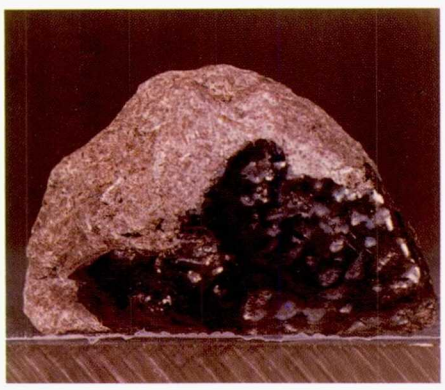
Lunar rock named "Big Mulie," collected on Apollo 16 mission, is examined at Lunar Receiving Laboratory, Houston, Texas.

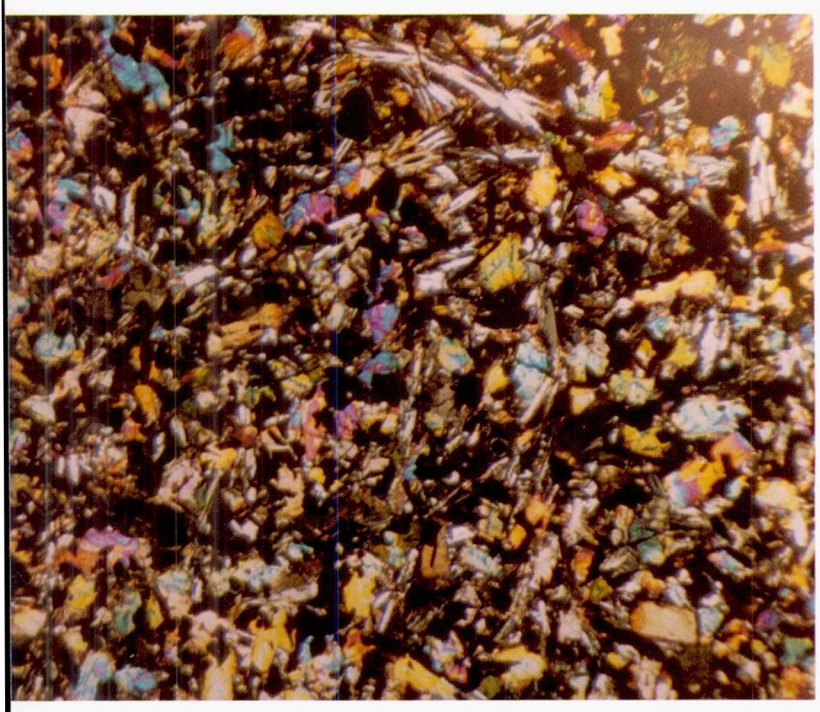


the Earth and the Sun, the spacecraft that carries three billion of us and the great energy source so essential to our survival. From clues gathered on the Moon science, is beginning to piece together the history of the Earth and the Sun and round out our understanding of our environment.

That understanding, as Jack Schmitt once put it, is needed "so that we can start to tackle this long-term—50, 100, 200-year—problem, the problem of preserving and protecting the environment on the Earth."

Glass splash on lunar rock. Dark bubbly looking material is glass formed when a meteorite impacted the Moon. It was still hot when it struck this rock and stuck in place.

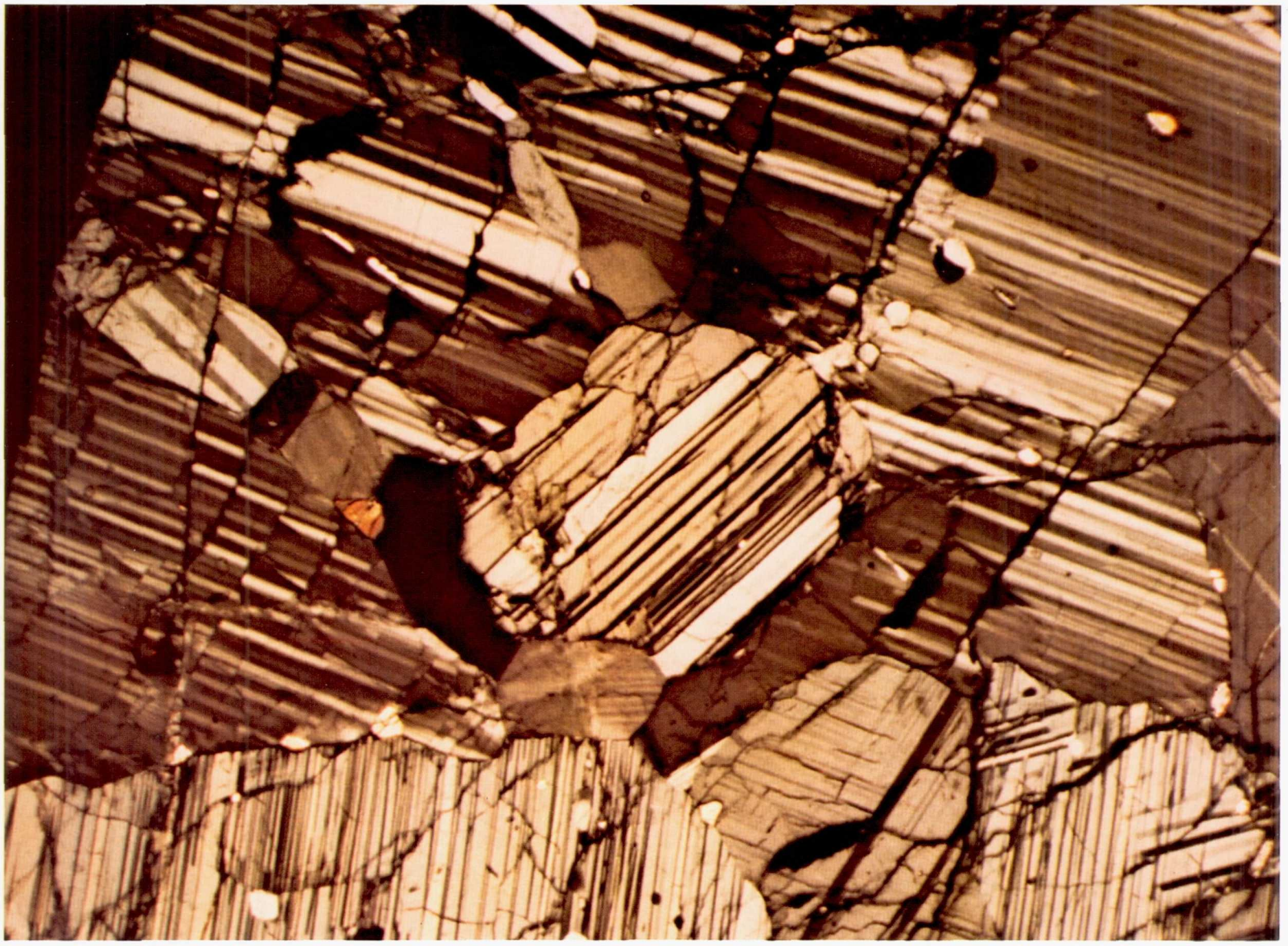


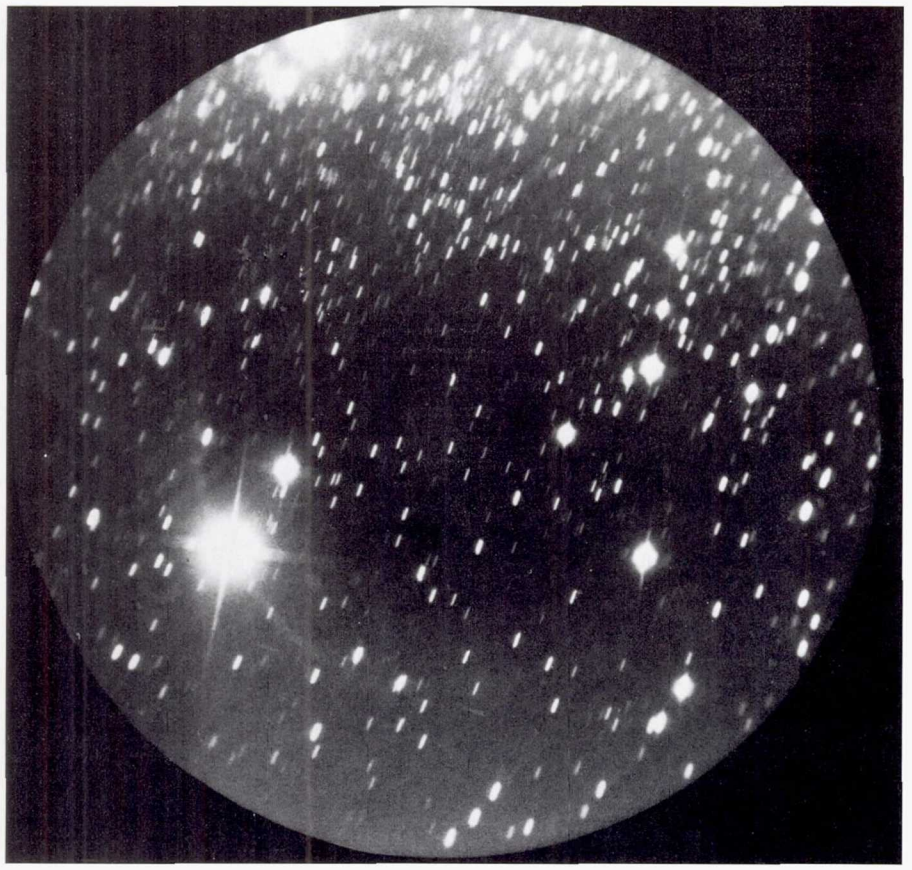


Mineral grains are clearly visible in lunar igneous rock. Small black areas are due to mineral ilmenite which is opaque.

Instruments set up by Apollo expeditions have detected distinct layering beneath the surface of the Moon. The Moon appears to be solid to a depth of approximately 800 kilometers (roughly 500 miles), which is about halfway to its center. The Moon is at least partially molten at depths below 1000 kilometers (600 miles). Contrary to prevailing pre-Apollo opinion that the Moon was cold, the Moon seems to have a warm interior. Apollo instruments detected heat flowing outward from the Moon's interior at a rate slightly lower than that of Earth but surprisingly large for the Moon's size. These artist's renderings compare the internal structures of the Moon and Earth.

Photomicrograph shows a rock almost entirely feldspar, and therefore, anorthosite.





Most of the material in this photomicrograph is lunar glass. Note swirls caused by flow of glass when it was still hot enough to be fluid.

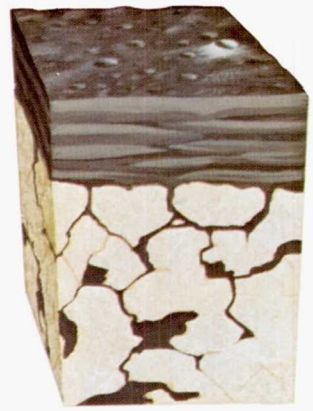
Ultraviolet images of very hot blue stars near the center of the Milky Way appear in this ultraviolet camera exposure. Streaks are caused by the Moon's rotation during 30-minute exposure. Bright object at lower left is not a star, but the planet Jupiter.

Apollo expeditions landed on and explored six areas of the Moon. Their locations are shown on the Moon map on opposite page. Their principal physical features are briefly described and depicted on this page.

Apollo 12: *This mission alighted on a ray, or band of ejecta, blasted from the crater Copernicus, 400 kilometers (250 miles) to the north. The ray lies atop Oceanus Procellarum, composed of layers of dark mare basalt that welled upward from the mantle some 3.2 billion years ago.*

Apollo 14: *Ejecta thrown up by the Imbrium impact, 1120 kilometers (700 miles) distant, formed the Fra Mauro hills site. Mission samples give a date for the cataclysm: about 4 billion years ago. Basalts of Oceanus Procellarum lap against the hills, proving that the uplands predate the lava flows.*

Apollo 15: *The Apennine Mountains soar nearly 5 kilometers (three miles), and enigmatic Hadley Rille slashes a 300 meters (1,000-foot) canyon at the spectacular site. This mission and Apollo 16 collected highland rock dated as being more than 4 billion years old.*



Apollo II: *Jumbled boulders ejected from whitish West crater covered this first lunar site. Neil Armstrong, clearing West's debris, found a level area for setting down. The site lies in Mare Tranquillitatis, which filled with lava 3.7 billion years ago.*

Apollo 16: *Seeking rocks from loftier terrain, Apollo 16 visited the Descartes highlands. Debris hurled from North Ray crater, right, and nearby South Ray crater strews the surface, while beneath lie deposits from more ancient meteorite impacts. These highlands and those of Apollo 14, 15, and 17 abound with breccias —rock fragments and soil that have adhered because of the heat and pressure of impacts.*

Apollo 17: *Massifs created by the impact that dug the Serenitatis basin guard the valley of Taurus-Littrow. After lava filled the valley some 3.7 billion years ago, an avalanche brought down highland rock, putting it handily in reach of the lunar explorers.*

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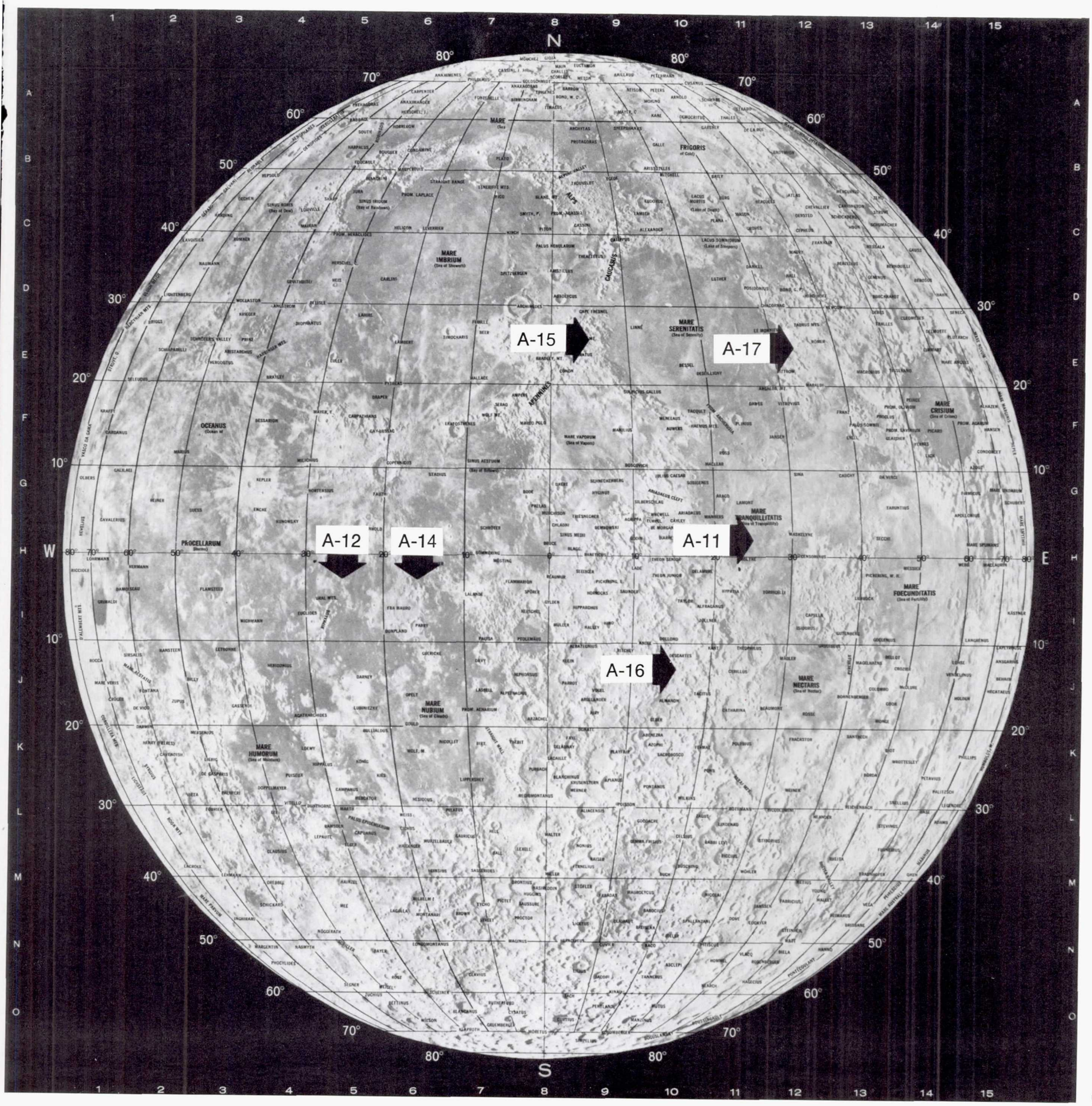
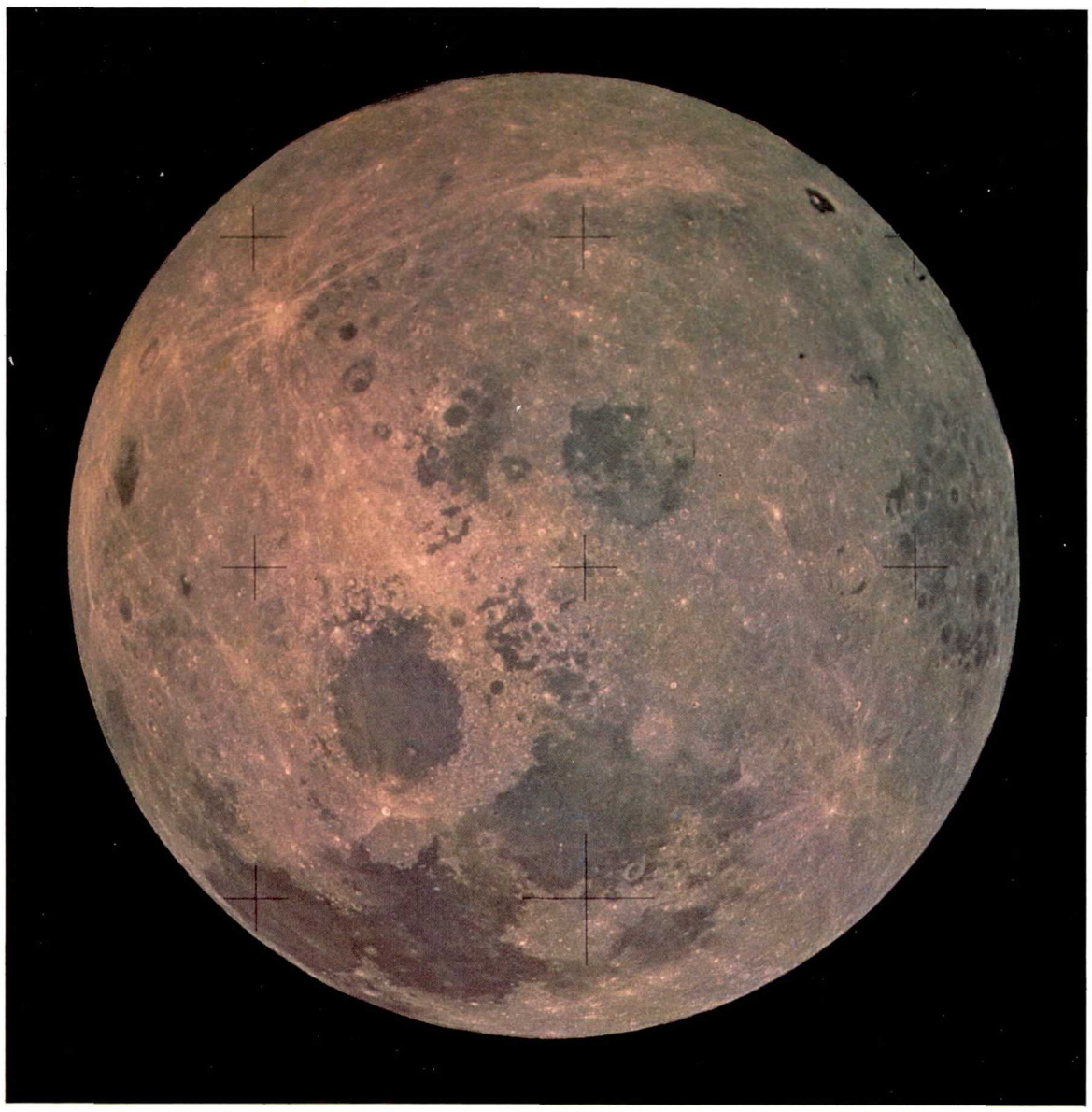
Apollo lunar landing sites.



	Spacecraft Name	*Crew*	*Date*	*Fight Time (Hrs., Min., Sec.)*	*Revolutions*	*Remarks*
Mercury	Freedom 7	Alan B. Shepard, Jr.	5/5/61	00:15:22	Suborbital	America's first manned space flight.
	Liberty Bell 7	Virgil I. Grissom	7/21/61	00:15:37	Suborbital	Evaluated spacecraft functions.
	Friendship 7	John H. Glenn, Jr.	2/20/62	04:55:23	3	America's first manned orbital space flight.
	Aurora 7	M. Scott Carpenter	5/24/62	04:56:05	3	Initiated research experiments to further future space efforts.
	Sigma 7	Walter M. Schirra, Jr.	10/3/62	09:13:11	6	Developed techniques and procedures applicable to extended time in space.
	Faith 7	L. Gordon Cooper, Jr.	5/15—16/63	34:19:49	22	Met the final objective of the Mercury program—spending one day in space.
Gemini	Gemini 3	Virgil I. Grissom John W. Young	3/23/65	04:52:31	3	America's first two-man space flight.
	Gemini 4	James A. McDivitt Edward H. White, II	6/3—7/65	97:56:12	62	First walk in space by an American astronaut. First extensive maneuver of spacecraft by pilot.
	Gemini 5	L. Gordon Cooper, Jr. Charles Conrad, Jr.	8/21—29/65	190:55:14	120	Eight day flight proved man's capacity for sustained functioning in space environment.
	Gemini 7	Frank Borman James A. Lovell, Jr.	12/4—18/65	330:35:01	206	World's longest manned orbital flight.
	Gemini 6A	Walter M. Schirra, Jr. Thomas P. Stafford	12/15—16/65	25:51:24	16	World's first successful space rendezvous.
	Gemini 8	Neil A. Armstrong David R. Scott	3/16—17/66	10:41:26	6.5	First docking of two vehicles in space.
	Gemini 9A	Thomas P. Stafford Eugene A. Cernan	6/3—6/66	72:20:50	45	Three rendezvous of a spacecraft and a target vehicle. Extravehicular exercise—2 hours, 7 minutes.
	Gemini 10	John W. Young Michael Collins	7/18—21/66	70:46:39	43	First use of target vehicle as source of propellant power after docking. New altitude record—475 miles.
	Gemini 11	Charles Conrad, Jr. Richard F. Gordon, Jr.	9/12—15/66	71:17:08	44	First rendezvous and docking in initial orbit. First multiple docking in space. First formation flight of two space vehicles joined by a tether. Highest manned orbit—apogee about 853 miles.
	Gemini 12	James A. Lovell, Jr. Edwin E. Aldrin, Jr.	11/11—15/66	94:34:31	59	Astronaut walked and worked outside of orbiting spacecraft for more than 5½ hours—a record proving that a properly equipped and prepared man can function effectively outside of his space vehicle. First photograph of a solar eclipse from space.

	Spacecraft Name	*Crew*	*Date*	*Fight Time (Hrs., Min., Sec.)*	*Revolutions*	*Remarks*
Apollo	Apollo 7	Walter H. Schirra Donn Eisele Walter Cunningham	10/11—22/68	260:8:45	163	First manned Apollo flight demonstrated the spacecraft, crew and support elements. All performed as required.
	Apollo 8	Frank Borman James A. Lovell, Jr. William Anders	12/21—27/68	147:00:41	10 rev. of Moon	History's first manned flight to the vicinity of another celestial body.
	Apollo 9	James A. McDivitt David R. Scott Russell L. Schweickart	3/3—13/69	241:00:53	151	First all-up manned Apollo flight (with Saturn V and command, service, and lunar modules). First Apollo EVA. First docking of CSM with LM.
	Apollo 10	Thomas P. Stafford John W. Young Eugene A. Cernan	5/18—26/69	192:03:23	31 rev. of Moon	Apollo LM descended to within 9 miles of Moon and later rejoined CSM. First rehearsal in lunar environment.
	Apollo 11	Neil A. Armstrong Michael Collins Edwin E. Aldrin, Jr.	7/16—24/69	195:18:35	30 rev. of Moon	First landing of men on the Moon. Total stay time: 21 hrs., 36 min.
	Apollo 12	Charles Conrad, Jr. Richard F. Gordon, Jr. Alan L. Bean	11/14—24/69	244:36:25	45 rev. of Moon	Second manned exploration of the Moon. Total stay time: 31 hrs., 31 min.
	Apollo 13	James A. Lovell, Jr. John L. Swigert, Jr. Fred W. Haise, Jr.	4/11—17/70	142:54:41	—	Mission aborted because of service module oxygen tank failure.
	Apollo 14	Alan B. Shepard, Jr. Stuart A. Roosa Edgar D. Mitchell	1/31—2/9/71	216:01:59	34 rev. of Moon	First manned landing in and exploration of lunar highlands. Total stay time: 33 hrs., 31 min.
	Apollo 15	David R. Scott Alfred M. Worden James B. Irwin	6/26—7/7/71	295:11:53	74 rev. of Moon	First use of lunar roving vehicle. Total stay time: 66 hrs., 55 min.
	Apollo 16	John W. Young Thomas K. Mattingly II Charles M. Duke, Jr.	3/16—27/72	265:51:05	64 rev. of Moon	First use of remote controlled television camera to record lift-off of the LM ascent stage from the lunar surface. Total stay time: 71 hrs., 2 min.
	Apollo 17	Eugene A. Cernan Ronald E. Evans Harrison H. Schmitt	12/7—19/72	301:51:59	75 rev. of Moon	Last manned lunar landing and exploration of the Moon in the Apollo program returned 243 lbs. of lunar samples to Earth. Total stay time: 75 hrs.

The launch of Apollo 17, the first in darkness, nearly turned night to day.



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