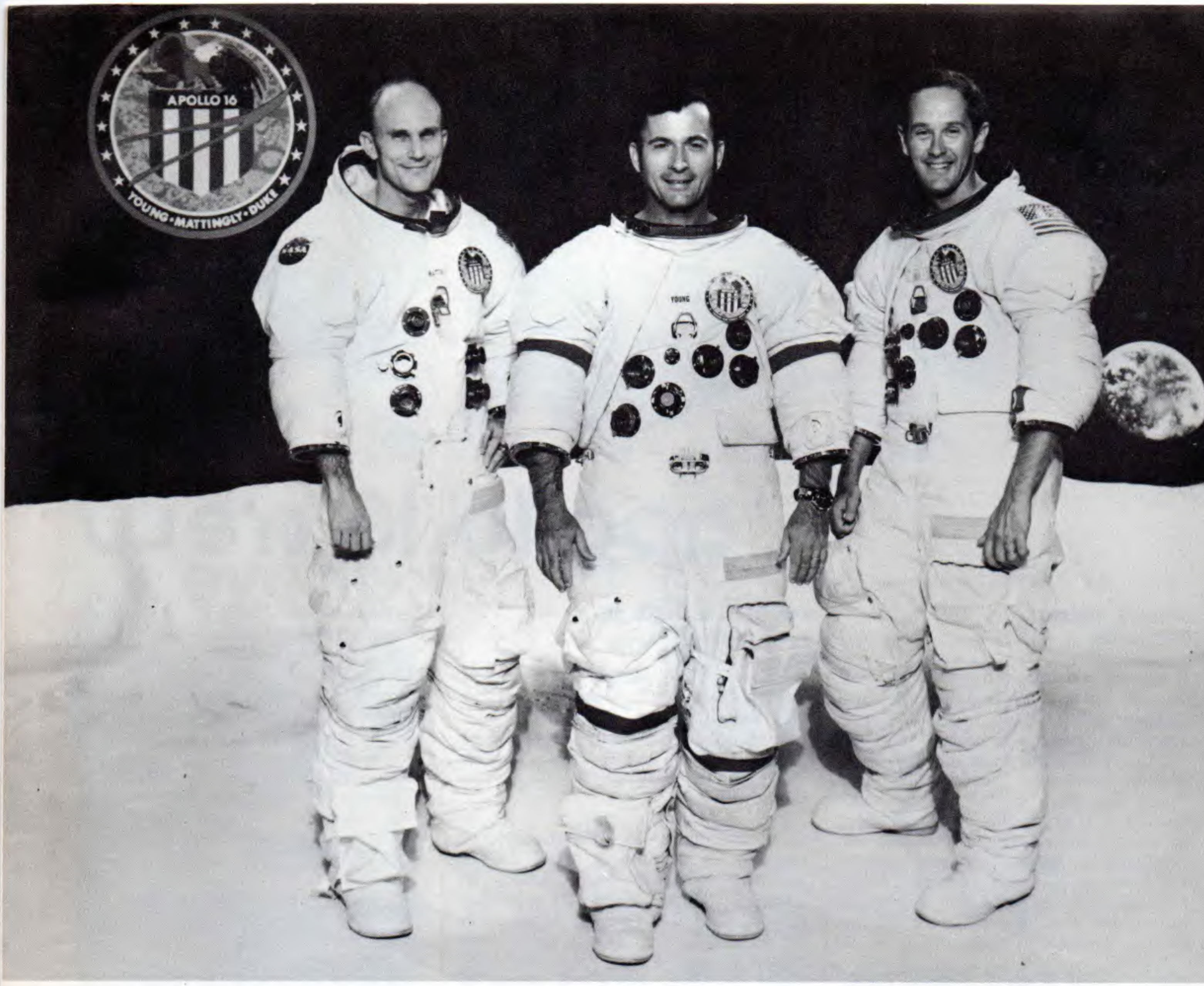
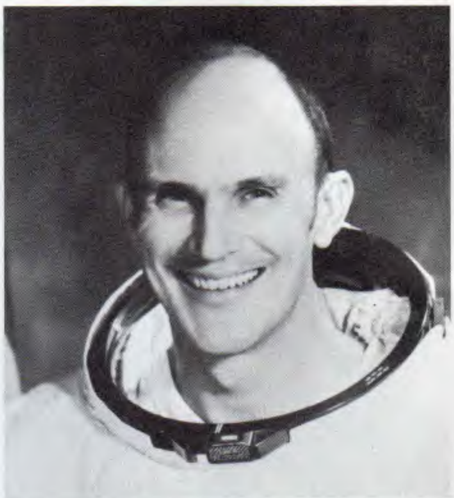



# apollo 16

SCIENTIFIC
INVESTIGATION
OF THE MOON...



# apollo 16 crew

**JOHN W. YOUNG**
**Commander**

A veteran astronaut, Young was pilot of the Gemini 3 with Astronaut Gus Grissom which orbited Earth on March 23, 1965. He was also back-up pilot for the Gemini 6 mission and was command pilot on the Gemini 10 mission in 1966. Young also served as back-up command module pilot on Apollo 11 in 1969, and he was the command module pilot on the Apollo 10 in 1969 that circled the Moon and returned to Earth in a test of the lunar module. Following that mission he became the back-up commander for the Apollo 13 mission in 1970.

Now a captain in the U. S. Navy, Young became a NASA astronaut in 1962. Since then he has logged almost 268 hours in space; and he has more than 5,400 hours in aircraft, including more than 4,400 hours in jets.

He was born in San Francisco, California, on September 24, 1930. After graduating from Orlando High School, in Orlando, Florida, Young received a BS degree in aeronautical engineering from the Georgia Institute of Technology in 1952. He also holds an honorary Doctor of Laws degree from the Western State University College of Law.

Young holds the NASA Distinguished Service Medal, two NASA Exceptional Service Medals, the U. S. Navy Distinguished Service Medal, and three U. S. Navy Distinguished Flying Crosses.

He and his wife Barbara are the parents of a son, John, 13, and a daughter Sandy, 15. They live in Houston, Texas.

**CHARLES M. DUKE, JR.**
**Lunar Module Pilot**

Astronaut Duke like his fellow crew member Mattingly is making his first trip into space. He was a member of the astronaut support crew for the Apollo 10 mission in 1969, and he was the backup lunar module pilot for the Apollo 13 mission 1970.

Duke was born in Charlotte, North Carolina, on October 3, 1935; and he attended Lancaster High School in Lancaster, South Carolina. He graduated from the Admiral Farragut Academy in St. Petersburg, Florida. He holds a BS degree in naval science from the U. S. Naval Academy and a MS degree in aeronautics and astronautics from the Massachusetts Institute of Technology.

A lieutenant colonel in the U. S. Air Force, Duke graduated from the U. S. Air Force Aerospace Research Pilot School in 1965 and also served as an instructor there. Duke has logged over 2,900 hours of aircraft time, including more than 2,500 hours of jet time. He was selected as an astronaut in 1966.

He and his wife Dorothy are the parents of two boys Charles, 7, and Thomas, 5. They live in Houston, Texas.

**THOMAS K. MATTINGLY**
**Command Module Pilot**

Astronaut Mattingly is making his first venture into space. He served as a member of the support crews on the Apollo 8 and Apollo 11 missions. Designated command module pilot for the Apollo 13 mission in 1970, his assignment was cancelled just 72 hours before liftoff when it was discovered that he had been exposed to measles and was not immune to the disease.

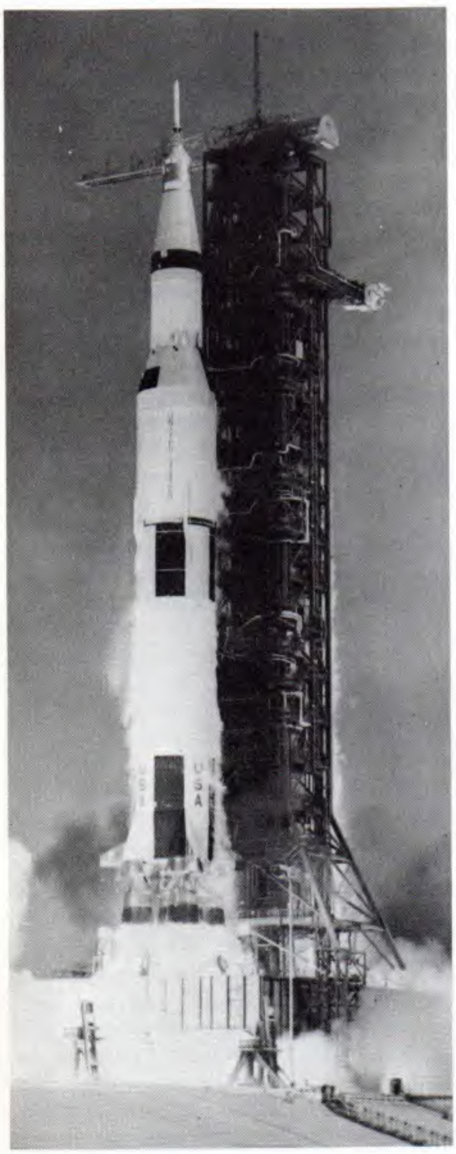
Born in Chicago, Illinois, on March 17, 1936, Mattingly graduated from Edison High School, in Miami, Florida, and attended Auburn University, where he received a BS degree in aeronautical engineering in 1958.

A lieutenant commander in the U. S. Navy, he is also a graduate of the U. S. Air Force Aerospace Research Pilot School. Mattingly has logged more than 4,000 hours in the air, with more than 2,200 hours in jet aircraft. He became an astronaut in 1966.

He and his wife Elizabeth live in Houston, Texas.

**SUCCESSFUL MISSIONS RESULT FROM QUALITY PERFORMANCE**


# schedule of events



| DATE | TIME/EST | EVENT AND BRIEF DESCRIPTION |
|---|---|---|
| Sun Apr. 16 1972 | 12:54 p.m. | LAUNCH<br>Lift-off from Launch Complex 39A at Kennedy Space Center. Insertion into orbit about Earth occurs l2 minutes later. |
| | 3:27 p.m. | TRANSLUNAR INSERTION (TLI)<br>Apollo leaves Earth orbit for Moon |
| Wed Apr 19 1972 | 3:28 p.m. | LUNAR ORBIT INSERTION (LOI)<br>Apollo enters an orbit around the Moon. Orbit is 69.5 miles by 204 miles (92.6 kilometers by 272 kilometers). |
| | 4:24 p.m. | THIRD STAGE IMPACT<br>The spent S-IVB stage of the Saturn 5 crashes into the Moon about 150 miles (240 kilometers) west of Apollo 12 landing site. |
| | 7:30 p.m. | DESCENT ORBIT INSERTION (DOI)<br>Apollo spacecraft with lunar module still attached changes orbit to 13 miles by 69.6 miles (17.3 kilometers by 92.8 kilometers). |
| Thur Apr. 20 1972 | 2:36 p.m. | CIRCULAR ORBIT<br>The spacecraft orbit is circularized at 72 miles (96 kilometers) above the Moon. |
| | 3:41 p.m. | LUNAR MODULE LANDING<br>The lunar module lands on the Moon. |
| | 7:34 p.m. | FIRST EXTRAVEHICULAR ACTIVITY (EVA 1)<br>Lunar rover checked out and loaded with equipment. Apollo Lunar Surface Experiments Package set up near lunar module. Astronauts drive west to Flag Crater and return by way of Spook Crater. |
| Fri. Apr. 21 1972 | 5:34 p.m. | SECOND EXTRAVEHICULAR ACTIVITY (EVA 2)<br>Astronauts drive south from lunar module to Stone Mountain for collection of samples from its lower slope. On the return to the lunar module they collect samples of material thrown out of South Ray Crater. |
| Sat. Apr. 22 1972 | 5:34 p.m. | THIRD EXTRAVEHICULAR ACTIVITY (EVA 3)<br>Astronauts drive north to North Ray Crater and Smokey Mountain to take photographs and collect geological samples. They return to lunar module, stopping at Palmetto Crater for additional samples of rocks and soil. |
| Sun. Apr. 23 1972 | 4:39 p.m. | LUNAR MODULE LIFT-OFF<br>Lunar module lifts off the Moon for rendezvous with the Apollo spacecraft. |
| Tues. Apr. 25 1972 | 4:08 p.m. | SUBSATELLITE LAUNCH<br>Apollo 16's scientific subsatellite released from the service module to orbit the Moon at 67.2 miles by 90.5 miles (87.2 kilometers by 120.6 kilometers). |
| | 7:15 p.m. | TRANS-EARTH INJECTION (TEI)<br>Apollo 16 leaves lunar orbit for Earth. |
| Weds. Apr. 26 1972 | 2:51 p.m. | Extravehicular Activity (EVA 4)<br>Astronaut Mattingly leaves the command module to retrieve films from mapping cameras in the scientific instrument module of the service module. |
| Fri. Apr. 28 1972 | 3:30 p.m. | SPLASH-DOWN<br>Apollo 16 lands in Pacific Ocean 1,182 miles (1,872 kilometers) south of Hawaii after a journey taking 290 hours and 36 minutes. |

**PRIDE IN PERFORMANCE MEANS SUCCESS IN SPACE**

# mission objectives

Apollo 16 continues the program of manned lunar exploration begun in 1969 with the landing of Astronauts Neil Armstrong and Edwin Aldrin in the Mare Tranquilatis (Sea of Tranquility). It is the fifth in a planned series of six such missions.

The landing site for the 12-day mission is some 45 miles (75 kilometers) north of the ancient Crater Descartes on the hilly, grooved, and furrowed western edge of the Kant Plateau in the central lunar highlands among some of the loftiest parts of the Moon that face Earth. The crater was named for the famous 16th Century French mathematician and philospher Rene Descartes. The coordinates of the landing site are 9° 00′ 01″South and 15° 30′ 59″ East.

The area is in the Caley Formation or Plain of the Descartes highlands and is believed to be relatively smooth or gently rolling and covered with rocks from ancient volcanic flows.

Bounding the landing site a few miles to the north and south are hills that rise some 1,300 to 1,600 feet (400 to 500 meters) above the place where the lunar module rests. A number of craters of recent origin abound in the area, some measuring as much as 3,300 feet (1 kilometer) in diameter.

This area of the Moon is important to geologists since facts about the composition, age, and types of surface material in the lunar highland volcanic area will greatly increase their knowledge of volcanic activity on the Moon and the role it played in lunar evolution. Geologic evidence indicates that this material is older than the Sea of Tranquility or the Sea of Storms sampled on Apollo 11 and 12 (about three and one-half billion years old) but younger than the Imbrium basin material sampled by Apollo 14. When combined with the very old rocks from Apollo 15 at the Hadley- Apennine site, the samples from Apollo 16 should help scientist develop the story of lunar evolution. Near the landing site are North Ray and South Ray, two young, large, craters, which have thrown out huge blocks of the basin fill where the astronauts plan to obtain fresh samples.

In addition, knowledge of the composition and age of the highland plains material will add greatly to understanding of the processes which modify large areas of the Moon.

Plans call for Commander John Young and Lunar Module Pilot Charles Duke to remain on the lunar surface for an estimated 72 hours and 58 minutes and make three trips in their lunar roving vehicle. The three trips will cover approximately 16 miles (25.6 kilometers) and require about 21 hours.

Objectives of the Apollo 16 mission are to:

**Perform inspection, survey, and sampling of materials and surface features in the Descartes area.**

**Emplace and activate scientific instruments of the Apollo Lunar Surface Experiments Package (ALSEP).**

**Make in-flight experiments and take photographs of Moon and space from the command module while in lunar orbit.**

The mission will begin, as did the preceding ones, from Kennedy Space Center with lift-off from Launch Complex 39A on April 16, 1972 at 12:54 p.m. EST. The first or S-IC stage of the Saturn 5 launch vehicle will burn for about 2.7 minutes and boost itself and the spacecraft to approximately 43 miles (68.8 kilometers) and then drop off into the Atlantic Ocean. The second or S-II stage will burn for 6.5 minutes lifting itself, the third stage, and spacecraft to an altitude of about 114 miles (182.4 kilometers) where it, too, will burn out and drop off into the Atlantic Ocean. The third or S-IVB stage will ignite and burn for 2.4 minutes to place itself and the spacecraft into an orbit around the Earth at a height of some 115 miles (184 kilometers). Once in Earth orbit, Astronauts Young, Mattingly, and Duke will checkout their spacecraft to make sure that everything is in order for the journey to the Moon. The Apollo spacecraft and lunar module, still attached to the S-IVB stage, will make between 1.8 and 2.8 revolutions of the Earth during the checkout.

The S-IVB stage will start and burn for six minutes to place the spacecraft on the proper path for its 71-hour and 23-minute trip to the Moon. The S-IVB will follow it on a different trajectory so that the spent stage will crash into the Moon about 150 miles (240 kilometers) west of the Apollo 12 landing site. It will impact on April 19 with the energy of approximately 10 tons (11 tons metric) of TNT exploding. The impact at 5,400 miles per hour (2,414 meters per second) will be sensed and measured by seismographs left on the Moon during previous Apollo missions. The information telemetered to Earth by them will help geologists to learn more about the internal structure of the Moon.

On the way to the Moon, Astronaut Mattingly will perform a demonstration that may have great potential in future pharmaceutical, medical, and biological research and technology. He will photograph the results of a small, fluid, electrophoresis unit. In the weightlessness of space, the movement of charged particles through a solution under the influence of an electrical field (electrophoresis) should be much more efficient than on Earth, where gravity impedes the process. The unit weighs only 5 pounds (2.3 kilograms). If the demonstration lives up to expectations, it could produce knowledge useful in the design of machines for space stations of the future that produce extremely pure virus vaccines, finer blood and other bodily fluid fractionations, and very pure enzymes.

For the first time in the Apollo program the astronauts on the Moon will set up a special camera during the first excursion from the lunar module that will photograph the Earth, the Andromeda Galaxy, the Coma cluster of galaxies, and the Magellanic Clouds. The pictures will help scientists to learn more about the distribution of interplanetary and intergalactic hydrogen. The Far Ultraviolet Camera/Spectrograph will be placed in the shadow of the lunar module and will automatically take pictures of these astronomical objects while Astronauts Young and Irwin go about their duties. When they leave, they will unload the camera and take the film with them. From examining the pictures made with the camera, scientists also may learn more about the Moon's atmosphere and the possibility that volcanic gases come from the interior of the Moon. The pictures will also provide further information on the solar wind.

Among the scientific instruments in the Apollo Lunar Experiments Package, (ALSEP) powered by a SNAP-27 atomic battery, are a passive seismometer, a magnetometer, a heat-flow detector, and an active seismometer. The passive seismometer will permit scientists to determine if the moonquakes beneath the highlands are as numerous and strong as those beneath the maria or seas, where similar instruments left on other Apollo missions are still transmitting data to Earth. This instrument will also permit the calculation of the density of the highlands crust by measuring the time it takes waves from moonquakes to travel through it. The magnetometer will collect information on the electrical conductivity of the interior of the Moon, from which can be determined its temperature.

The heat-flow detector will measure the flow of heat through the highlands soil. When compared with rates measured by similar instruments left on previous Apollo missions in the maria or seas, these data will give geologists a better picture of the origin of the two major areas of the Moon. The active seismometer will be used to help determine the thickness of the lunar soil layer formed by the impact of meteoroids and the depth of fill material in old craters of the upland area.

A special cosmic ray detector will also be used on the Apollo 16 mission. It will be operated on the flight to the Moon as well as on its surface. It is an instrument that records the energy, flux, and elemental distribution of primary cosmic ray nuclei well outside the disturbing effects of the Earth's atmosphere and magnetic field. It is mounted on the side of the lunar module, and the astronauts will bring back exposed panels from it when they return to Earth. The familiar "window shade" solar wind experiment that was used on previous Apollo missions will also be used on Apollo 16. An aluminum- platinum foil collector of solar wind particles, it is unrolled and left exposed to the solar wind while the astronauts are on the Moon. At the end of their exploration, it is rolled up and returned to Earth for study.

Some four hours after landing on April 20, at 2:36 p.m. EST, Astronauts Young and Duke will release the folded-up lunar rover from its stowage compartment in the lunar module and check it out. After setting up the ALSEP about 100 yards (90 meters) to the west of the lunar module and drilling a core sample of the soil to a depth of 8.6 feet (2.6 meters), the astronauts will take their first trip in the lunar rover, covering about 2 miles (3.2 kilometers). The trip will take about seven hours. The first stop will be Flag Crater, which is about 990 feet (300 meters) in diameter and about 1 mile (1.6 kilometers) from the lunar module. There the astronauts will collect rock samples which may include material thrown out of the crater from a depth of 200 feet (60 meters). Then they will turn back toward the lunar module, stopping at Spook Crater. There they will take photographs, collect rock and soil samples, and take a reading of the local magnetic field using a portable magnetometer.

The last stop on the first trip will be in the area in which they set up the ALSEP. For about eight minutes the astronauts will engage in the first lunar "Grand Prix." While Astronaut Young puts the lunar rover through its paces, starting, speeding up, and stopping, Astronaut Duke will photograph the activity. The purpose of the test is to record and evaluate the performance of the rover. After the "Grand Prix," the astronauts will arm the mortar of the active seismograph and take additional core samples of the soil. The mortar charges will be fired after the astronauts leave the Moon.

A second and 4-hour trip for Astronauts Young and Duke will begin on April 21 at 5:34 p.m. EST. They will again board the lunar rover and head south for the side of Stone Mountain, some 2.5 miles (4.2 kilometers) away. At the first stop, they will drill a double core, perform penetrometer measurements of the soil, collect rocks and soil samples, and take photographs. Then they will head the rover back down Stone Mountain, stopping along the side and at the base to take photographs and collect additional soil and rock samples in order to correlate the Descartes geology with that of the Cayley Plain. After about two hours, they will turn west with stops at Stubby and South Ray Craters. There they will take photographs, collect soil and rock samples, take double cores in an area that appears to have ejecta or material thrown out of South Ray Crater.

They will make another stop on the Caley Plain. There they will take core samples that will be stored in a special vacuum container to prevent contamination, and they will also pick up surface samples of rocks and soil. After about 25 minutes of this activity, the two astronauts will return to the ALSEP and lunar module area where they will take double cores, dig a trench in the soil and take samples from it, and also take soil measurements with the penetrometer.

The third excursion from the lunar module will be on April 22 at 5:34 p.m. EST. Astronauts Young and Duke will head the lunar rover toward North Ray Crater and Smoky Mountain about 3 miles (5 kilometers) to the north. Once on the rim of North Crater, They will take photographs of the area, make measurements with the portable magnetometer, and collect geological specimens. After some two hours, they will board the rover and start for Smoky Mountain. There they will take double cores, make photographs, and collect rock and soil samples. These tasks completed, they will head south, halting at Dog Leg and Dot Craters to collect rock and soil samples and to take local magnetic field measurements. The last stop before returning to the lunar module will be at Palmetto Crater. Astronauts Young and Duke will take more photographs, make measurements of the local magnetic field, and collect additional rock and soil specimens.

While Astronauts Young and Duke are exploring the Caley Plain and Descartes uplands, their fellow crewman orbiting 60 miles (96 kilometers) above them will be equally busy. Astronaut Mattingly will spend 147 hours and 40 minutes circling the Moon. During the time he will be operating a variety of scientific instruments and taking photographs.

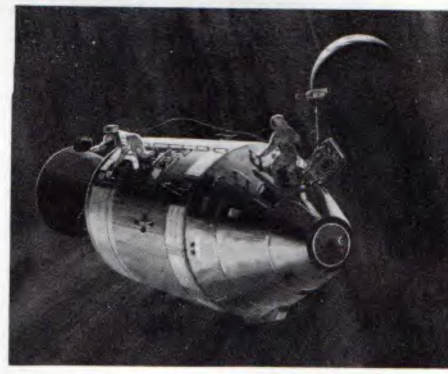
As did Apollo 15, Apollo 16 carries a special group of instruments in the scientific instrument module bay of the service module. Included among these is a gamma-ray spectrometer, which gives an indication of the chemical composition of the lunar soil as the spacecraft passes over it. There are also x-ray and alpha-particle spectrometers that do the same thing by different means. In addition, a mass spectrometer analyzes the lunar atmosphere to determine what it is made of and if volcanic gases can be detected in it.

Two special cameras map the lunar surface as the spacecraft orbits over it. One is a panoramic camera with a 24-inch (61-centimeter) lens that can resolve objects as small as 3.3 feet (1 meter). This camera also makes stereo-pairs so that geologists can study the Moon's surface features in three dimensions. Each picture takes in an area of the Moon's surface 18 miles by 216 miles (22 kilometers by 339 kilometers). The other is a mapping camera with a 3-inch (7.6-centimeter) lens which can resolve objects only 66 feet (20 meters) or larger. At the spacecraft altitude of 72 miles (115 kilometers), each picture from this camera includes an area of 110 miles by 110 miles (167 kilometers by 167 kilometers). At the same time as it is photographing the lunar surface, it is also taking pictures of the star field. A special laser is also used with this camera to measure the height, within 6.6 feet (2 meters), between the spacecraft and the Moon. The laser fires pulses of light at a rate of 3.75 per minute. These two cameras and the laser will provide information for a highly accurate map of about 8% of the Moon's surface or about 1,160,000 square miles (300,440,000 hectares).

Apollo 16 also will carry a scientific subsatellite as did Apollo 15. It is a six-sided box only 31 inches (77.5 centimeters) long and weighs 78.5 pounds (172.7 kilograms). It contains three instruments powered by solar cells mounted on the outside of the satellite.

The S-band transponder provides data on the Moon's gravitational field and perhaps will help explain the mascons that have been previously noted during the Apollo explorations of the Moon. A Particle Shadows/Boundary Layer instrument provides data that help clarify the formation and movements of the Earth's magnetic field and also provides data on the interaction of the Moon with floating clouds of charged particles. In addition, a magnetometer provides information on the physical and electrical properties of the Moon and its interaction with charged particle clouds. The subsatellite will be launched on April 25 at 4:08 p.m. into an orbit of 67.2 miles by 90.5 miles (87.2 kilometers by 120.6 kilometers).

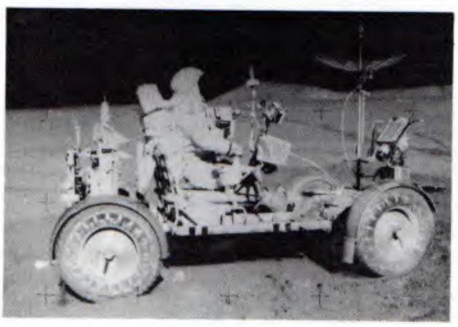
Within the command module, Astronaut Mattingly will also take a variety of pictures using a 70-mm and a 35-mm camera. Photographs made with them will study the Earth and lunar atmospheres in the ultraviolet region. While the spacecraft is in the shadow of the Moon and out of sight of Earth, Astronaut Mattingly will take pictures of the still-unexplained **gegenshein** or faint light glow on either side of the Earth-Sun line on the opposite side of the Earth from the Sun.



Mattingly's photographic tasks will not be completed, however, until the Apollo spacecraft is headed back to Earth. On April 26 at 2:51 p.m. EST, he will leave the command module and walk through space back to the scientific instrument bay of the service module. There, he will remove the film packs from the panoramic and mapping cameras and return them to the command module.

After a flight of 69 hours and 54 minutes, the Apollo 16 is scheduled to splash down in the Pacific Ocean at a point 1,182 miles (1,872 kilometers) south of Hawaii on April 28 at 3:30 p.m. EST. At that time some 290 hours and 36 minutes will have gone by since it lifted off from Cape Kennedy 12 days earlier.

# lunar roving vehicle



Lunar Roving Vehicle (LRV) is a small dune-buggy-like car that permits two Apollo astronauts to drive away from the immediate vicinity of their landing site on the Moon, make geological and astronomical observations, collect rock and soil samples, deploy scientific instruments, and return to their lunar module base. On Earth the LRV weighs some 480 pounds (216 kilograms); however, on the Moon it weighs about 80 pounds (36 kilograms). As light as it is, it can carry the two astronauts, their portable life support systems, scientific instruments, and their collection of lunar material samples. In all, the LRV can carry about twice its own weight.

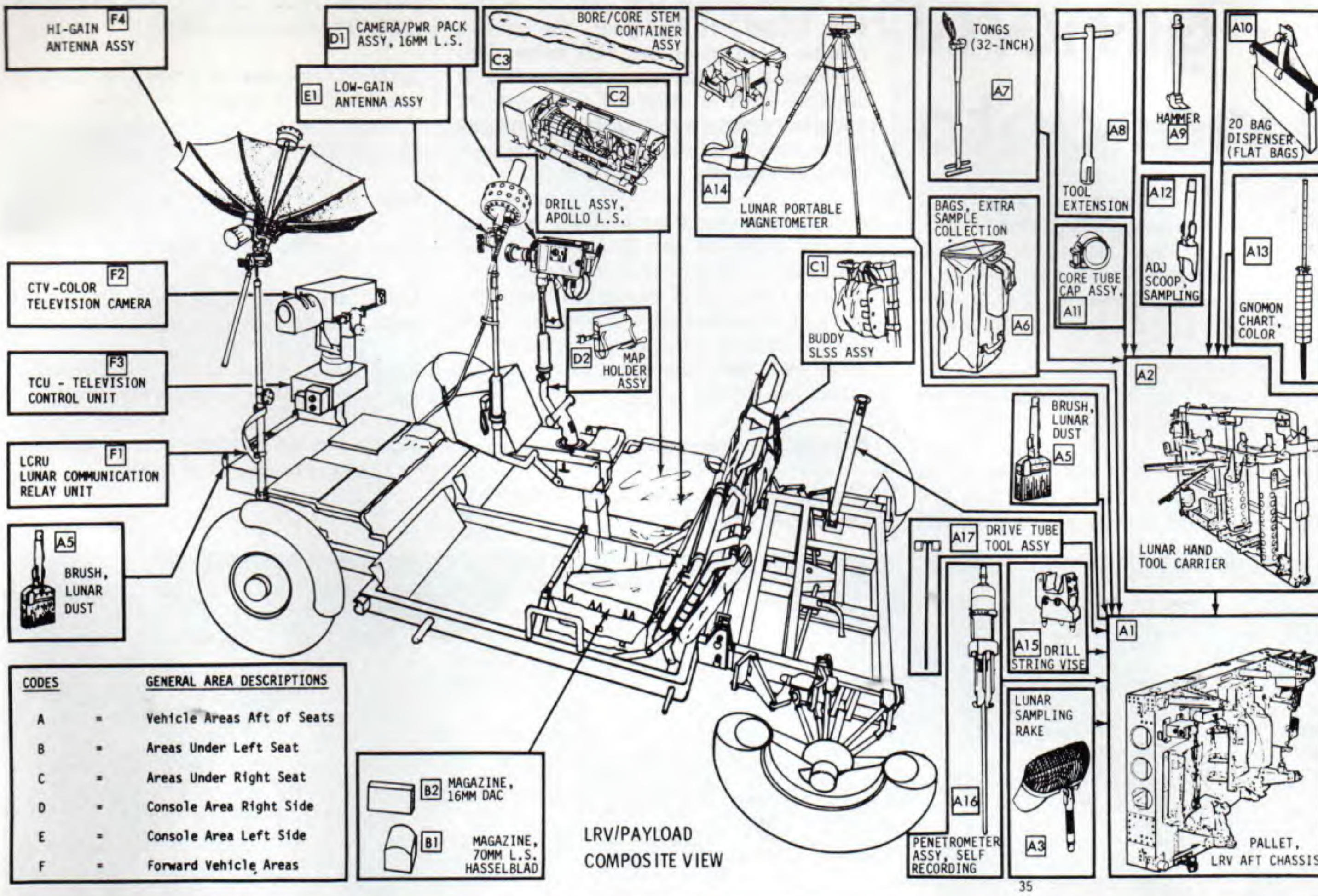
While it may look like a dune-buggy, it is designed for low speed and high torque. It is limited to a maximum of 8 miles per hour (3.5 meters per second) for safety reasons. Higher speed could present a danger to the crew due to the rough lunar surface. But it has power to climb a 25 degree slope.

LRV is slightly over 10 feet (3 meters) long, 6 feet (1.8 meters) wide, and has a wheelbase of 7.5 feet (2.3 meters). It has a ground clearance of 13 inches (33 centimeters) on level soil. Since both the front and rear wheels steer, the LRV has a very tight turning radius--no more than its own length. It is powered by electric batteries that furnish energy to an electric motor in each of four 32-inch (81.3 centimeter) wheels.

The drive and steering mechanism has several built-in safety devices. If either the rear or front steering mechanism fails, the other will provide full service. Similarly, if a motor on a wheel should go out, it can be decoupled; and the remaining motors can drive the LRV. In addition, there are two separate battery systems to provide power for the wheels--each one with sufficient power to drive the vehicle through its full mission.

LRV is steered by a control stick, similar to the lunar module, rather than a steering wheel. It is mounted in the center of the vehicle, between the two astronaut passengers; and it can be operated by either of them, although the astronaut on the left is the designated driver. To start, the driver flips on the power switch and tilts the stick forward. The LRV then moves in that direction. If he wants to turn left or right, he merely tilts the stick in the appropriate direction. To back up, he tilts the stick backward. If he wants to apply the four-wheel brakes, he pulls straight back on the stick. It also has a parking brake which will hold the loaded LRV on a 30-degree slope. The LRV can cross crevasses 28 inches (45.7 centimeters) wide and go over bumps a foot high and still remain stable.

Since the Moon is much smaller in diameter than the Earth, the LRV will move over the horizon more quickly on the Moon than it would on Earth. Inasmuch as a compass is of no use on the Moon, which has no north or south magnetic poles, a special navigation system has been devised to continuously




**A variety of scientific instruments and other equipment is carried on the lunar rover by the astronauts of Apollo 16.**

compute where the LRV is and what direction and distance it is back to the lunar module base. The system uses the angle of the Sun and the declination of the lunar module from it to set a gyroscope before the astronauts leave in the LRV. An instrument mounted on the "dashboard" continuously displays the heading of the vehicle in terms of an assumed lunar north, the bearing in degrees back to the lunar module, the distance (in kilometers) back to it, and the total number of kilometers travelled by the LRV. Another instrument shows the speed of the LRV in kilometers per hour.

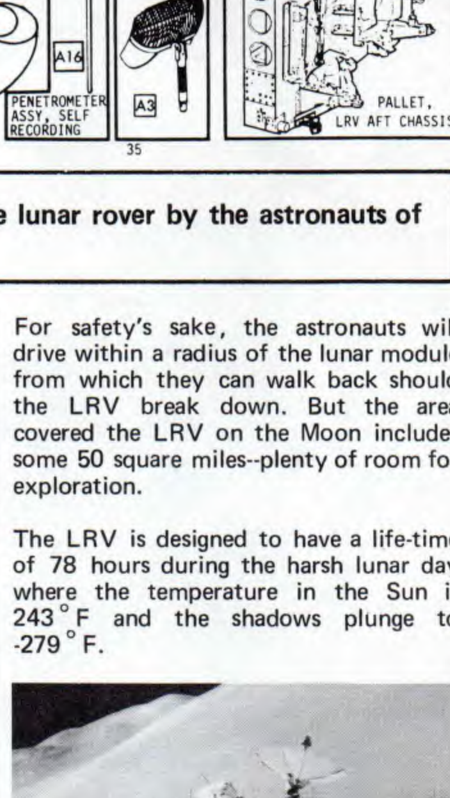
Also carried on board the LRV is a color TV camera and communication system that permit the astronauts to transmit pictures and voice communications directly from the vehicle to Earth. In addition, a still-picture camera is mounted on the chest of each astronaut. The TV camera can be remotely controlled from Mission Control Center in Houston.

For the trip to the Moon, the LRV is literally folded up and stowed inside the lunar module. The chassis is hinged in three places and the four wheels are pivoted nearly flat against the folded chassis, occupying only 30 cubic feet (.84 cubic meters) of space. Thus trebled up, the LRV is stowed in the descent stage of the lunar module in quadrant No. 1 to the right of the ladder down which the astronauts descend to the Moon's surface.

To remove the LRV from the lunar module, the first astronaut descends the ladder and removes a contingency cable from quadrant No. 1. The second astronaut then pulls a D-ring mounted on the side of the lunar module. By pulling the ring, the LRV is released at the top. The first astronaut then pulls a series of cables which lowers the LRV from the lunar module and unfolds it as it moves to the surface. Once on the surface with the four wheels deployed, the astronauts then mount the camera, load equipment, and scientific instruments and prepare for the lunar trip.

For safety's sake, the astronauts will drive within a radius of the lunar module from which they can walk back should the LRV break down. But the area covered the LRV on the Moon includes some 50 square miles--plenty of room for exploration.

The LRV is designed to have a life-time of 78 hours during the harsh lunar day where the temperature in the Sun is 243°F and the shadows plunge to -279°F.



# general lunar data

There are 32 known satellites in the Solar System with our Moon ranking fifth in size among them. However, with a diameter about a fourth that of Earth, the Moon is much larger in relation to its parent planet than any of the other satellites.

Most conspicuous of the visible features of the Moon are the maria, or seas, which are the dark, level plains. Early astronomers thought the maria to be water-filled areas. For the most part, the Moon is mountainous and crater pitted, the mountains rising as high as 29,000 feet (7,700 meters) and the craters ranging from inches to 180 miles (288 kilometers) in diameter. The surface is covered with a layer of fine grained material resembling silt or sand, as well as small rocks and boulders. There is no air, wind, or moisture.

Among scientists there are three theories on the origin of the Moon: (1) it was once part of the Earth and split off into its own orbit, (2) it evolved as a separate body at the same time as Earth, and (3) it formed elswhere in space and wandered until it was captured by Earth's gravitational field.

**Physical Characteristics**

Diameter - 2,160 miles (3,456 kilometers) (about l/4 that of Earth)

Distance from Earth - 238,857 miles (382,171 kilometers) mean.

Surface Temperature - +243° F (Sun at zenith) -279° F (night)

Surface Gravity - 1/6 that of Earth

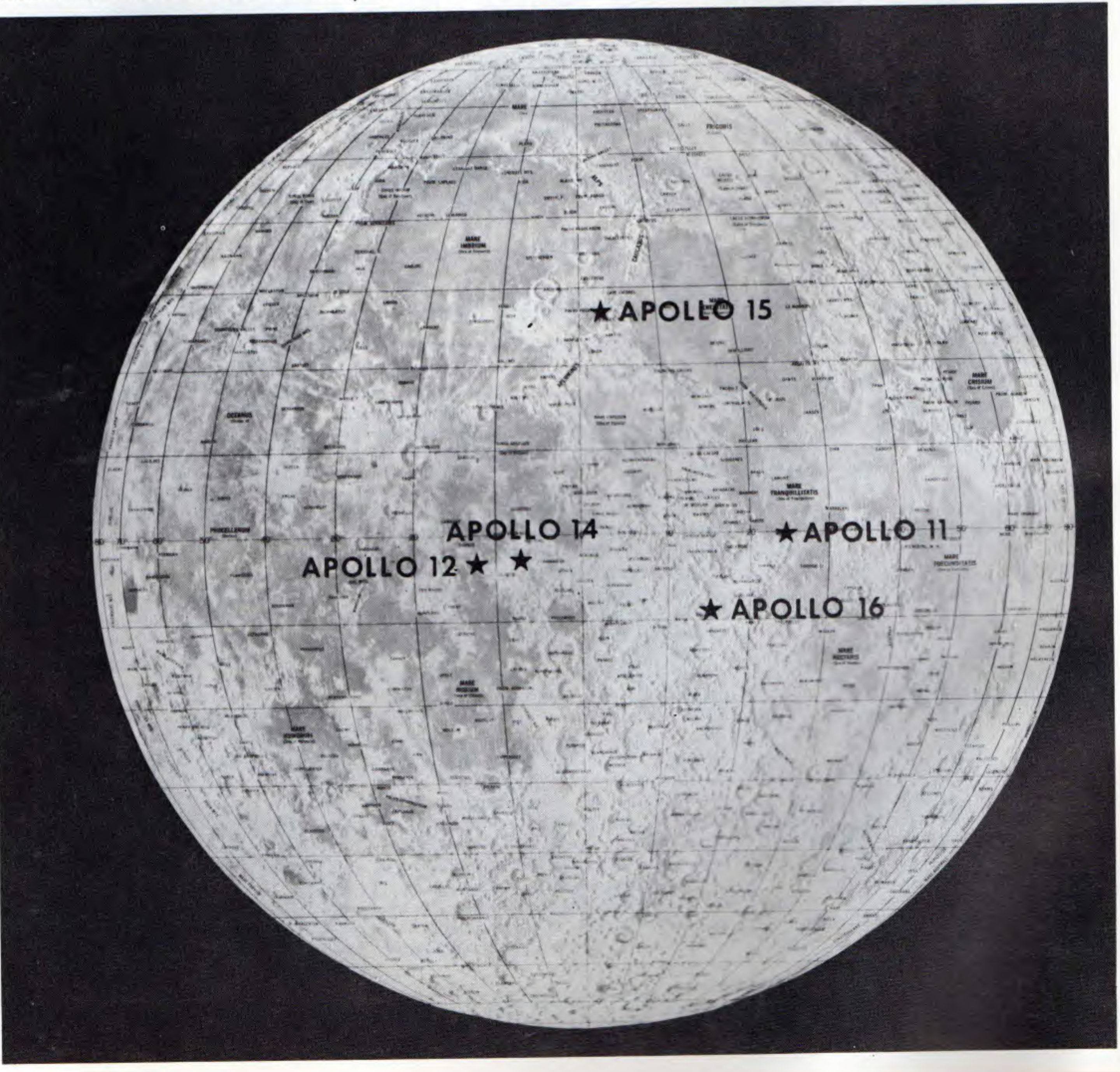
Mass - 1/100 that of Earth

Volume - 1/50 that of Earth

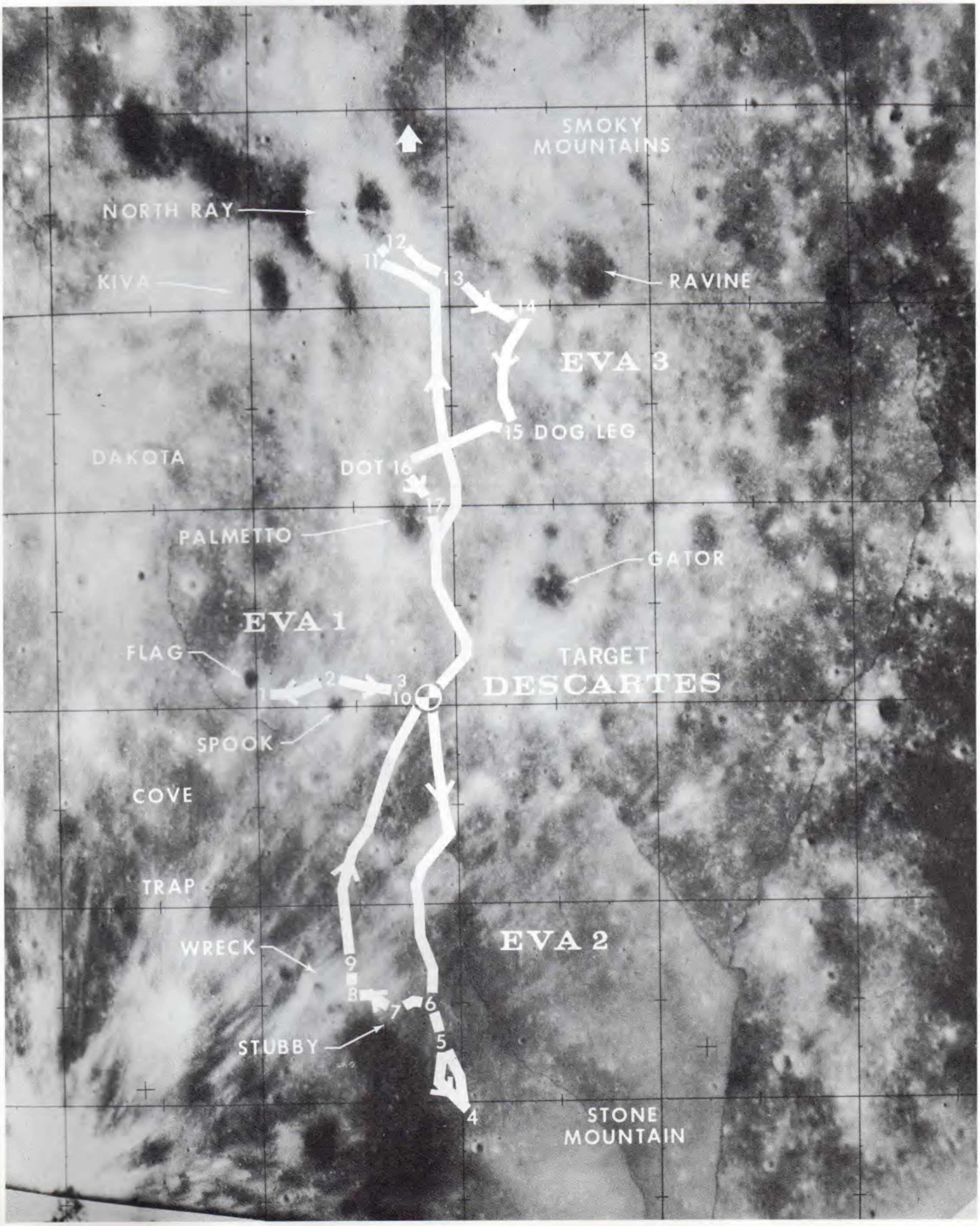
Lunar Day and Night - 14 Earth days each

Mean velocity in Orbit - 2,287 miles per-hour (3,659 kilometers per hour)

Month (Period of rotation around Earth) - 27 days, 7 hours, 43 minutes



# lunar landing site



# apollo 16 vehicle characteristics

## VEHICLE DATA

| STAGE/ MODULE | DIMENSIONS LENGTH FEET (Meters) | DIMENSIONS DIAMETER FEET (Meters) | WEIGHT AT LAUNCH POUNDS (Kilograms) |
|---|---|---|---|
| Complete Vehicle | 365 (109.5) | 33.0 (9.9) | 6,408,040 (2,883,618) |
| S-IC | 138 (41.4) | 33.0 (9.9) | 4,930,000 (2,218,500) |
| S-II | 81.5 (24.5) | 33.0 (9.9) | 1,101,000 (495,450) |
| S-IVB | 59.3 (17.8) | 21.7 (6.5) | 260,000 (117,000) |
| IU | 3.0 (.09) | 21.7 (6.5) | 4,500 (2,025) |
| SLA | 28.0 (8.4) | 21.7 base (6.5) 12.8 top (3.8) | 4,200 (1,890) |
| LM | 23 (6.9) | 31 (9.3) | 41,700 (18,765) |
| SM | 24.8 (7.4) | 12.8 (3.8) | 55,400 (24,930) |
| CM | 10.5 (3.2) | 12.8 (3.8) | 13,090 (5,891) |
| LES | 33.4 (10) | 2.2 (0.6) | 9,200 (4,130) |

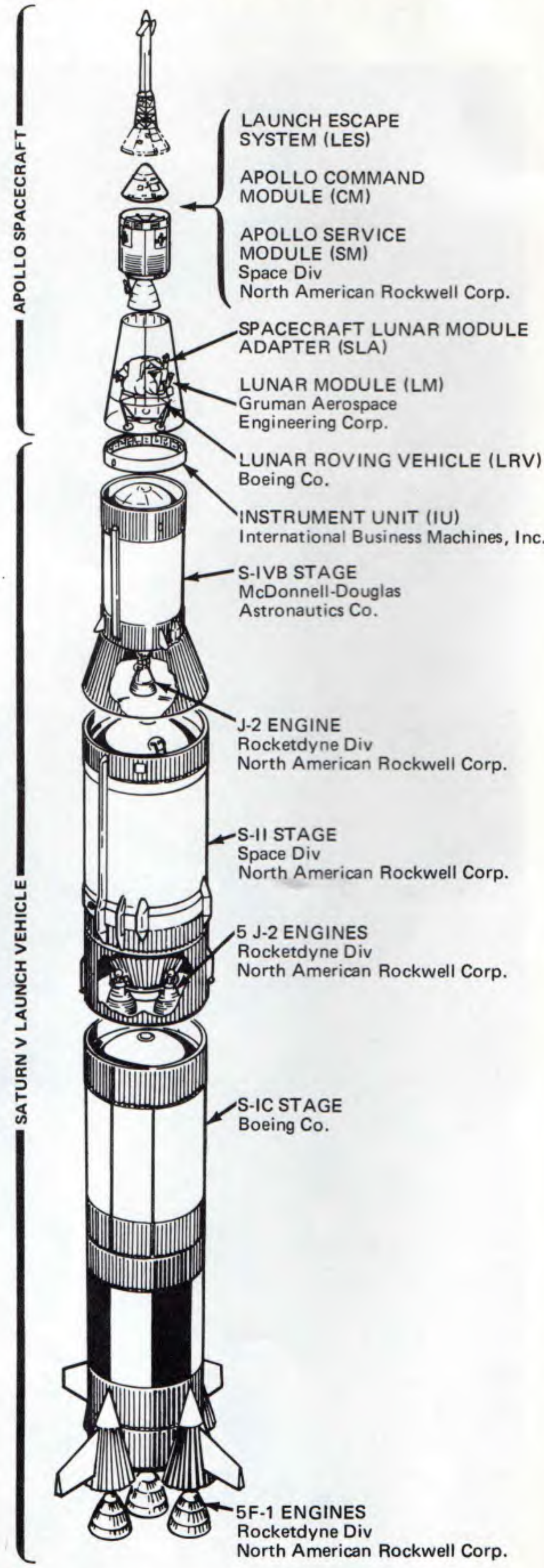
## ENGINE DATA

| STAGE/ MODULE | MODEL | QTY | NOMINAL THRUST Each Pounds (Newtons) | NOMINAL THRUST Total Pounds (Newtons) | BURNING TIME (Minutes) |
|---|---|---|---|---|---|
| S-IC | F-1 | 5 | 1,522,000 (6,849,000) | 7,787,495 (35,043,728) | 2.7 |
| S-II | J-2 | 5 | 232,840 (1,047,780) | 1,164,210 (5,238,945) | 6.5 |
| S-IVB | J-2 | 1 | 200,130 (900,585) | 200,130 (900,585) | 2.4 (1st) 6.0 (2nd) |
| LM Descent | MIRA-10 K | 1 | 10,000 (45,000) | *10,000 (45,000) | 15.0 (total) |
| LM Assent | 8258 | 1 | 3,500 (15,750) | 3,500 (15,750) | 7.6 (total) |
| SM | AJ10-137 | 1 | 20,500 (922,500) | 20,500 (922,500) | 12.5 (total) |
| LES | LPC-A2 | 1 | 150,000 (675,000) | 150,000 (675,000) | 3.2 (sec) |

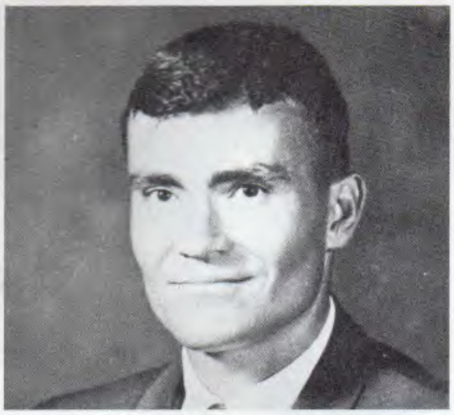
*Can be throttled over the range 1,280 - 9,870 pounds (5,760 - 44,415 Newtons).

## FLIGHT DATA

| EVENT | STAGE/ MODULE | VELOCITY Miles / Hour | VELOCITY Kilometers / Hour |
|---|---|---|---|
| Engine Cut-off | S-IC | 6,100 | 9,760 |
| Engine Cut-off | S-II | 15,600 | 24,960 |
| Earth Orbital Insertion | S-IVB | 17,170 | 28,470 |
| Translunar Injection | S-IVB | 23,800 | 38,080 |
| Lunar Orbital Insertion | CSM/LM | 3,585 | 5,736 |
| Lunar Touchdown | LM descent | 0-2 | 0-3.2 |
| Lunar Lift-off | LM ascent | 4,418 | 6,601 |
| Lunar Impact | LM ascent | 3,756 | 6,010 |
| Trans-Earth Insertion | SM | 5,640 | 9,024 |
| Earth Insertion | CM | 24,640 | 39,424 |




**QUALITY AND RELIABILITY INSURE PROGRESS IN SPACE**



# apollo 16 back-up crew

**FRED W. HAISE, JR.**
**Commander**

Astronaut Haise was the lunar module pilot on the Apollo 13 mission in 1970, and previously served as back-up lunar module pilot on the Apollo 8 and 9 missions in 1968 and 1969. A former U. S. Naval and U. S. Air Force pilot, he was also a research pilot with NASA before being selected as an astronaut in 1966.

Haise was born in Biloxi, Mississippi, on November 14, 1933, and graduated from Biloxi High School. After attending Perkinson Junior College, he received his BS degree in aeronautical engineering from the University of Oklahoma in 1959.

Haise and his wife Mary are the parents of a daughter, Mary, 16, and three sons, Frederick, 14, Stephen, 11, and Thomas, 2. They live in Houston, Texas.

**EDGAR D. MITCHELL**
**Lunar Module Pilot**

Astronaut Mitchell, U. S. Navy, was the lunar module pilot on the Apollo 14 mission in 1971. Previously he served as a member of the astronaut support crew for the Apollo 9 mission in 1969 and as back-up lunar module pilot on the Apollo 10 mission in the same year. He was selected as an astronaut by NASA in 1966.

Mitchell was born in Hereford,Texas, on September 17, 1930. He graduated from Artesia High School, in Artesia, New Mexico, and received a BS degree in industrial management from the Carnegie Institute of Technology. He also holds a BS degree in aeronautical engineering from the U. S. Naval Postgraduate School and a Doctor of Science degree from Massachusetts Institute of Technology in aeronautics and astronautics.

He and his wife Louise are the parents of two daughters, Karlyn, 19, and Elizabeth, 13. They live in Houston, Texas.

**STUART A. ROOSA**
**Command Module Pilot**

Astronaut Roosa, U.S. Air Force,was the command module pilot for the Apollo 14 mission in 1971. He was also a member of the astronaut support crew for the Apollo 9 mission in 1969. After serving as a test pilot in the U. S. Air Force, he was selected as an astronaut by NASA in 1966. His total number of flight hours is more than 4,300, including more than 3,900 hours in jet planes.

Roosa was born in Durango, Colorado, on August 16, 1933. He graduated from Claremore High School, in Claremore, Oklahoma. After studying at both the University of Arizona and Oklahoma State University, he graduated from the University of Oklahoma with a BS degree in aeronautical engineering.

Roosa and his wife Joan are the parents of three sons, Christopher, 13, John 11, Stuart, Jr., 10, and a daughter, Rosemary, 9. The family lives in Houston, Texas.

# apollo missions

**APOLLO 4/NOVEMBER 9, 1967**
First unmanned flight of Saturn V; reentry test of command module

**APOLLO 5/JANUARY 22, 1968**
Saturn 1B, vehicle 204, puts first unmanned lunar module in Earth orbit

**APOLLO 6/APRIL 4, 1968**
Second unmanned Earth orbital flight of Saturn V tests Apollo spacecraft

**APOLLO 7/OCTOBER 11-22, 1968**
First manned Apollo flight aboard Saturn 1B, 205, tests spacecraft command and service modules in Earth orbit
(Schirra, Eisele, Cunningham)

**APOLLO 8/DECEMBER 21-27, 1968**
First manned flight of Saturn V that orbited the Moon
(Borman, Lovell, Anders)

**APOLLO 9/MARCH 3-13, 1969**
First manned flight of the lunar module in Earth orbit
(McDivitt, Scott, Schweickart)

**APOLLO 10/MAY 18-26, 1969**
Dress rehearsal for lunar landing; flying complete spacecraft to lunar orbit
(Stafford, Young, Cernan)

**APOLLO 11/JULY 16-24, 1969**
First lunar landing and exploration of Moon's surface
(Armstrong, Aldrin, Collins)

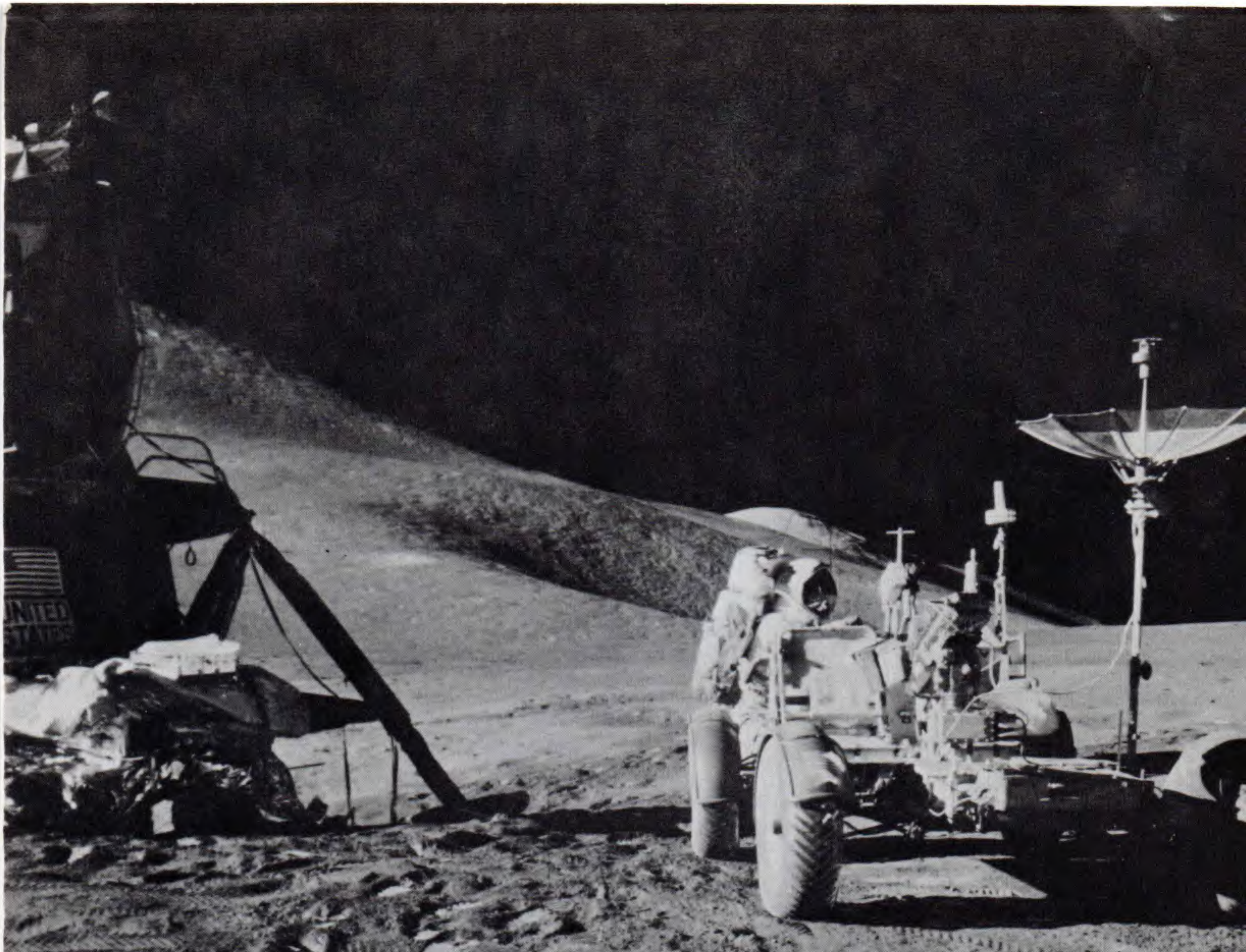
**APOLLO 12/NOVEMBER 14-24, 1969**
Second lunar landing and exploration of Moon's surface
(Conrad, Gordon, Bean)

**APOLLO 13/APRIL 11-17, 1970**
Circled the Moon and returned to Earth without landing after trouble in the service module
(Lovell, Haise, Swigert)

**APOLLO 14/JAN. 31-FEB. 9, 1971**
Third lunar landing and exploration of Moon's surface
(Shepard, Mitchell, Roosa)

**APOLLO 15/ JUL. 26-AUG. 7, 1971**
Fourth lunar landing and exploration of Moon's surface
(Scott, Worden, Irwin)

**INSURE ASTRONAUT SAFETY THROUGH QUALITY PERFORMANCE**




MANNED FLIGHT AWARENESS
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