APOLLO 16

JOHN F. KENNEDY SPACE CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

A BRIEF HISTORY OF PROJECT APOLLO

When the Apollo 16 mission which you are about to witness gets under way, the history of Project Apollo, the largest and most complex of America's space endeavors to date, will be drawing very near to its close. Only one more lunar landing mission, Apollo 17, is planned, with that launch scheduled for December of this year.

The initial goal of landing American explorers on the Moon and returning them safely to Earth was achieved -- as the whole world knows -- with Apollo 11. A whole new chapter in human history was opened when Neil Armstrong made his famous "one small step for a man, one giant leap for mankind" on July 20, 1969. For the first time in history, a man from Planet Earth had set foot on another heavenly body.

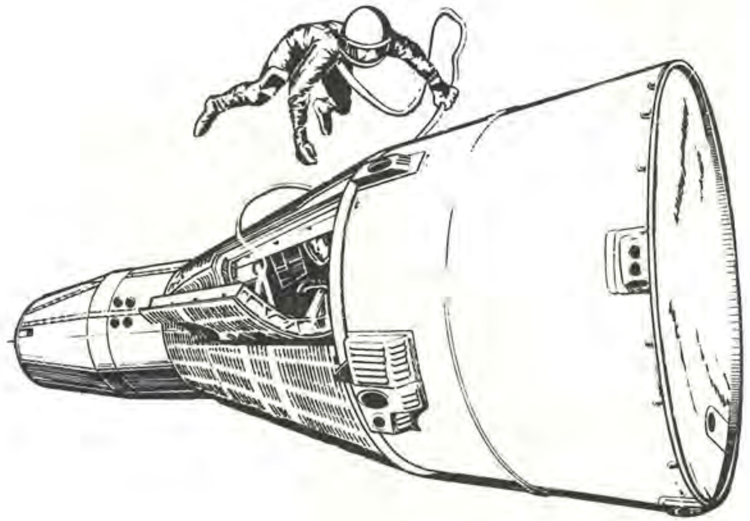
Project Mercury

But long years of preparation had preceded this flight. Project Mercury, America's pioneer effort in manned space flight, now seems like ancient history. It is hard to believe that Astronaut Alan B. Shepard, Jr.'s fifteen-minute suborbital flight took place only a little more than a decade ago, on May 5, 1961.

Seven months later, after a successful suborbital flight by Virgil Grissom, Astronaut John Glenn made a historic three-orbit flight around the Earth, meeting or exceeding all original goals set for Project Mercury. Three more orbital flights by Astronauts Scott Carpenter, Walter Schirra, and Gordon Cooper were made in succeeding months to confirm previous findings and to obtain additional data. These missions were flown with Mercury/Atlas vehicles.

Project Gemini

The pace quickened and our abilities to operate in space were greatly increased with Project Gemini, a larger two-man spacecraft. John Young, spacecraft commander of this Apollo 16 mission, flew the first manned Gemini mission, Gemini 3, with Virgil Grissom on March 23, 1965.



Gemini 4 marked the first American "walk in space" by Astronaut Edward White. These and later Gemini flights, culminating in Gemini 12, demonstrated that man can:

- Maneuver his craft in space.
- Leave his craft, survive, and do useful work in space if he is properly clothed and equipped.
- Rendezvous (find and come near) and dock (link up) his craft with another vehicle in space.
- Function effectively during prolonged space flight of at least two weeks and return to Earth in good physical condition.
- Control a spacecraft during its descent from orbit and land it within a selected area on Earth.

Thus, in Gemini, man developed and perfected much of the technology and skills that are crucial to the mastery of space. But Gemini did even more. Experiments conducted during the flights provided scientific, technical, and engineering data adding greatly to overall knowledge.

Project Apollo

Armed with the scientific, technical, and engineering data made available by the two previous projects, NASA moved into Project Apollo, beginning with unmanned testing of the mighty Saturn V launch vehicle, standing 363 feet tall with the Apollo spacecraft on top, developing more than 7.5 million pounds of thrust, and capable of sending more than a quarter of a million pounds into Earth orbit.

In October 1968 NASA assigned the new vehicle its first manned mission, sending Astronauts Walter Schirra, Donn Eisele, and Walter Cunningham aloft in Apollo 7 to orbit the Earth 163 times. Next, in December 1968, came Apollo 8 -- the maiden voyage to the vicinity of the Moon. The famed photograph of the Earth from the Moon taken on Christmas Eve gave Earthlings a new look at their home planet, and a new appreciation of its ecology.

Two months later, Apollo 9 tested the lunar module, the Moonlanding craft, for the first time in space. This Earth-orbital mission was followed in May 1969 by Apollo 10, which performed every maneuver required for a lunar landing except the actual touchdown.

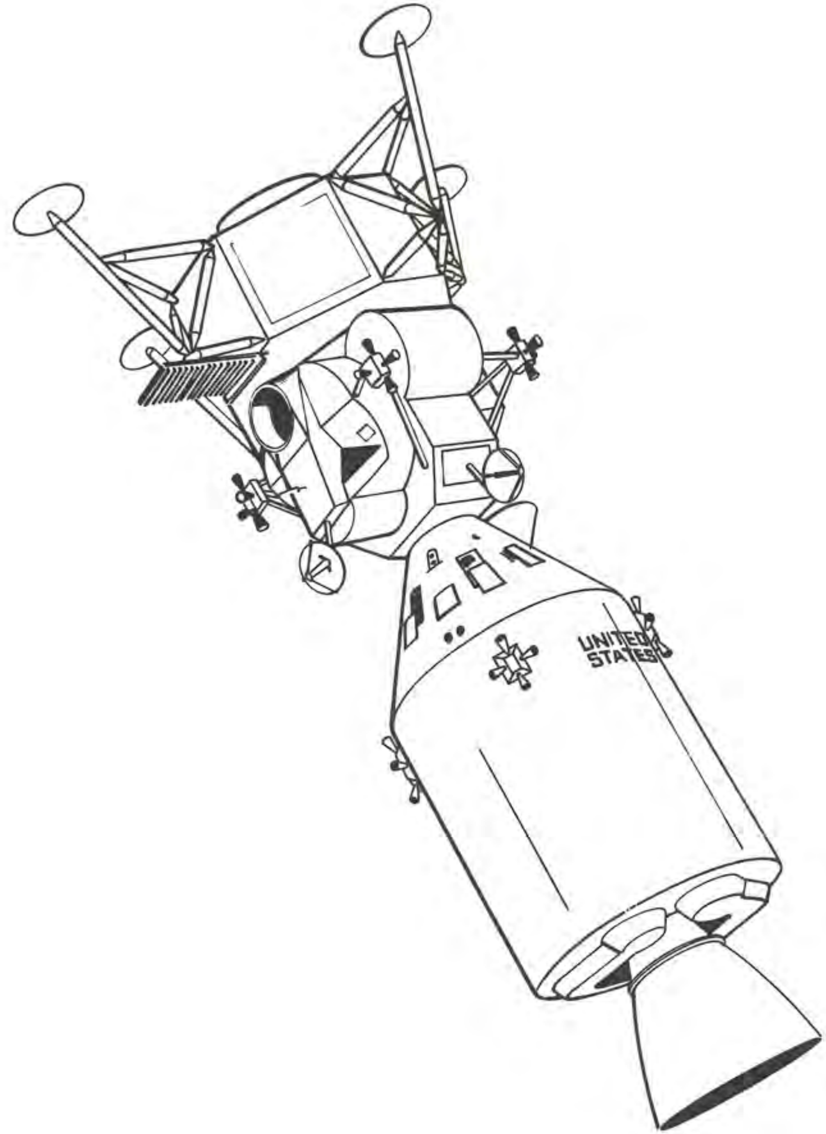
Then came Apollo 11, in July 1969. Neil Armstrong and Edwin Aldrin explored the Sea of Tranquility, a mare area.

Apollo 12 in November 1969 explored the Ocean of Storms, another mare region.

Apollo 13 headed for Fra Mauro, a hilly upland region, on April 11, 1970, but ran into trouble and returned after passing behind the Moon.

Apollo 14, launched January 31, 1971, profiting from the lessons of Apollo 13, successfully explored Fra Mauro.

Apollo 15, launched six months later on July 26, went to Hadley Rille, at the foot of some of the Moon's highest mountains, the 12,000-15,000-foot Apennines. It brought back, among other things, the so-called "Genesis Rock," with an age estimated at some 4.1 billion years.



And Now -- Apollo 16

Apollo 16 is scheduled to explore the highland regions of the Moon near the crater Descartes. This landing site is extremely important from the viewpoint of lunar science. It will give our astronauts their first chance to collect rocks and soil samples in the lunar highlands, believed by some scientists to be the oldest region on the Moon. They will also be able to study and collect new volcanic rocks on the Moon. These samples, along with those collected on earlier missions, will help fill in more pieces in the gigantic jigsaw puzzle that may someday help us understand the early history of the Moon, the solar system, and our own Earth itself.

Lunar geologists have as their goal the reading of the historical record of the Moon for the past five billion years. That record was once contained in the Earth's crust, but it has been largely worn away by the winds and rains of our planet's atmosphere, and we know little of Earth's surface history earlier than perhaps 3.5 million years ago.

The Moon, by comparison, has almost no atmosphere, and its surface features erode so slowly that we can read its history in billions rather than millions of years.

Our growing knowledge of the Moon's surface and its early formation allow us to draw many interesting and exciting conclusions about the structure and history of Earth's crust.

We have learned a great deal, but there is a great deal more to learn. Apollo 16 and the final lunar mission of the series, Apollo 17, will help give us some of the answers we are looking for.

Of one thing we can be sure. The scientific results that have been obtained from this unprecedented technological achievement should rank in history as among the most important of all time.

The Apollo 16 Mission -- Flight Profile

On April 16 at 12:54 p.m. EST, according to plan -- Apollo 16 -- carrying Astronauts John W. Young, spacecraft commander; Thomas K. Mattingly II, command module pilot; and Charles M. Duke, Jr., lunar module pilot -- will lift off from Pad A of Launch Complex 39, Kennedy Space Center. About two hours and 35 minutes later the spacecraft will be injected into the carefully calculated flight path that will carry it to the Moon, a journey of 71 hours and 23 minutes.

Apollo 16's code names are *Casper* for the command module (after TV's friendly ghost) and *Orion* for the lunar module (after the constellation also known as "The Hunter.") While *Casper* orbits the Moon with Astronaut Mattingly aboard to carry out a series of scientific tasks, *Orion* will descend to the lunar surface with Astronauts Young and Duke, landing at 3:41 p.m. on April 20. There they will take part in three periods of extravehicular activity of about seven hours each. (This is a new record total of 21 hours; Apollo 15's EVA total, longest of previous Moon landing missions, was 18 hours, 37 minutes.)

As with Apollo 15, a battery-powered wheeled vehicle called a lunar roving vehicle (LRV) will help the explorers cover more territory in their allotted time. The first EVA will occur at 7:19 p.m. on April 20; the second, 5:44 p.m., April 21; and the third, 5:19 p.m., April 22.

When all the many exploration tasks have been completed some 72 hours after the landing (also a record -- Apollo 15's total staytime was 67.3 hours), *Orion* will lift off from the lunar surface at 4:39 p.m., April 23 to rejoin *Casper*. Additional tasks will be carried out in lunar orbit for the next two days, until 7:15 p.m. on April 25. At that time, *Casper* will begin the return flight to Earth.

At 2:49 p.m. on April 26, Astronaut Mattingly will climb out of the spacecraft in view of the TV camera, and take a "space walk," maneuvering himself along handholds to the Scientific Instrument Module (SIM) Bay on the Service Module. There he will retrieve photographic film showing closeups of the Moon from orbit and return with it to the Command Module. (This is necessary because the Service Module is jettisoned near Earth.)

Some 69 hours and 54 minutes later will come the splashdown, at 3:30 p.m. on April 28, in the Pacific Ocean about 1853 kilometers (1000 nautical miles) south of Hawaii. Prime recovery ship will be the *U.S.S. TICONDEROGA.*

The Landing Site

Plans call for the LM to touch down on a rather smooth surface called the Cayley Plains, which lies between two bright rayed craters called North Ray and South Ray (see map). The rocks that lie beneath these plains are called the Cayley Formation, the largest single rock unit in the highlands on the side of the Moon which faces Earth. Scientists believe there may be debris (in the Cayley Plains and the Descartes formation which lies adjacent) from two totally different volcanic events that occurred as much as 200 million years apart.

The Cayley Plains were probably formed by lava that flowed out from sublunar volcanoes about four billion years ago. No previous Apollo crew has sampled any of this lava flow material, which covers many of the ancient highland regions of the Moon and make up an estimated 7 to 9 per cent of its face.

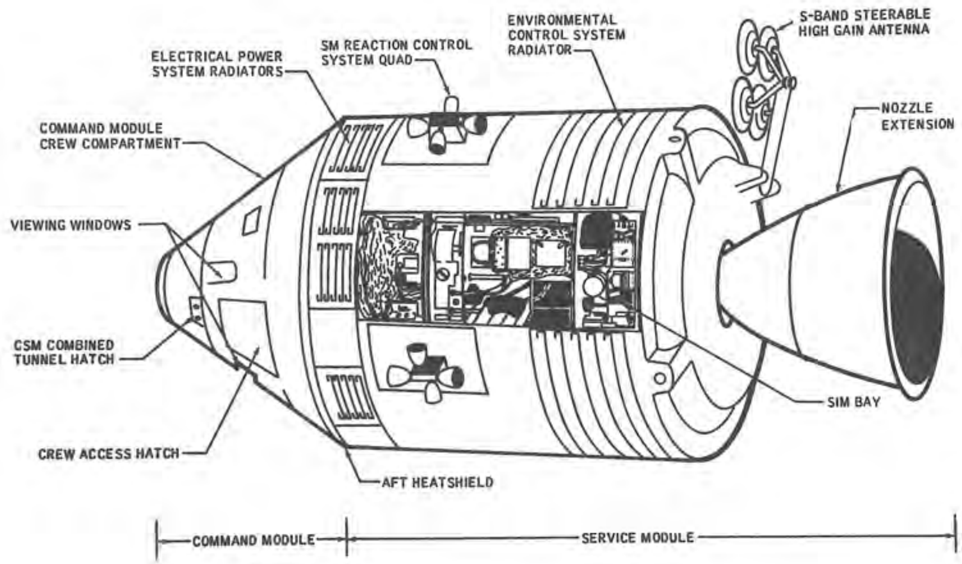
Touchdown is scheduled for 3:41 p.m. on April 20.

This map of the landing site is made from an aerial photograph taken on the Apollo 14 mission. The traverse routes are indicated, along with geographic names of various features to be visited.

Orbital Experiments

Meanwhile, Astronaut Mattingly in the Command/Service Module (CSM) will have plenty of experiments to perform as he continues in orbit about the Moon. He will use cameras and a scientific instrument module (SIM). From the orbital photography will come high-resolution panoramic views of the Moon's surface. High quality metric photographs will also be obtained. These orbital experiments will obtain data over a large part of both front and back sides of the Moon because the path of the point directly beneath the spacecraft, termed ground track, is different for each revolution of the spacecraft. The orbit of the CSM is not parallel to the Moon's equator, and as the Moon rotates slowly about its axis, the ground track is somewhat different for each CSM revolution.

Several of these orbital experiments will measure the approximate chemical composition of the Moon's surface materials. Others are intended to measure the variations of gravity and of the magnetic field around the Moon. A laser altimeter will be used to obtain precise elevations of features that lie on the Moon's surface beneath the orbiting CSM.



First EVA Period -- Setting up the Experiments

The first time Young and Duke step outside the LM onto the lunar surface, they will have a wide variety of tasks to perform. After inspecting the spacecraft, they will move out at least 300 feet from the LM and set up scientific equipment (the Apollo Lunar Surface Experiments Package or ALSEP) that will continue to send data to Earth long after they have left the Moon. They will put television cameras in place so that their activities can be observed from Earth. They will also unfold and set up for operation a four-wheeled vehicle called the Lunar Roving Vehicle (LRV) or Rover, which will be used to transport themselves and their equipment over the lunar surface. It takes about seven minutes to deploy the Rover completely. It is powered by two silver-zinc, 36-volt batteries, and has an individual electric motor for each of the four wheels. It will carry about 1,000 pounds, and can travel at speeds up to about 10 mph on level ground. There is a navigation system that contains a directional gyroscope and provides information about the total distance traversed as well as directional headings.

Both astronauts sit in seats with safety belts.

If the Rover should happen to break down at any time during the mission -- there were some minor problems with the steering during the first EVA of Apollo 15, but problems were corrected in later EVAs -- a series of optional walking traverses have been planned. Limits of these journeys on foot have been set at 3 to 3 1/2 kilometers (about two miles) from the LM, the maximum distances that astronauts can walk on the Moon and still have safe quantities of oxygen and other necessary supplies in their portable life support systems.

If time and life-support consumables permit, they will collect lunar samples, which they will document through oral descriptions and accompanying photographs. If any kind of emergency arises that would prevent the collecting of quantities of samples as planned, at least a small contingency sample will be picked up for return to our Earth laboratories.

One of the most interesting experiments to be deployed during the first EVA will be a tripod-mounted telescope-camera called the Far Ultraviolet Camera Spectrograph. They will set it up in the shadow of the LM, where it will gather ultraviolet imagery and radiation data on the Earth's upper atmosphere, auroras, and corona. They will point the instrument several times during each exploration period, using elevation and azimuth adjustments and an automatic exposure sequencer. It will be aimed not only at Earth, but also at various celestial objects, including the Andromeda Galaxy, the Magellanic Clouds, and the Coma cluster of galaxies whose ultraviolet radiation cannot be seen from Earth. The instruments will collect data on the solar wind, star clouds and nebulas, galaxy clusters, lunar atmosphere, and possibly, lunar volcanic gases. It will also map the location of interplanetary, interstellar, and intergalactic hydrogen.

Second EVA Period -- Journey to Stone Mountain

When Young and Duke start out on their second day on the Moon, they will head the Rover south toward a 5,000-foot peak called Stone Mountain, a part of the so-called Descartes Formation that scientists believe was formed as much as 200 million years after the Cayley Formation to which it is adjacent.

The primary objective of this EVA is to take samples from as high up as possible in the Descartes Mountains -- specifically, Stone Mountain. Once this is done, additional samples will be taken down the slope. A ray sample will be taken from South Ray and from the area where the Cayley and Descartes units come together.

Third EVA Period -- Journey to North Ray Crater

On EVA 3, the prime objective is to reach North Ray Crater, a "young" crater about one kilometer (two-thirds of a mile) wide and 180 meters (600 feet) deep, with walls as steep as any on the Moon. (It was formed by the impact of a meteorite which dug deeply into the Cayley Formation and threw large blocks of rock out over its rim.)

The astronauts hope to find stratigraphy (in layman's terms, bedrock) in the walls of the crater. Because the walls are so steep, it may not be possible to make an actual descent, but in any event they will take a number of 500-millimeter photographs which will show a great deal of detail.

The astronauts will also sample some of the very large rocks that lie on the rim of the crater, and document their locations from the 500mm photographs of the wall.

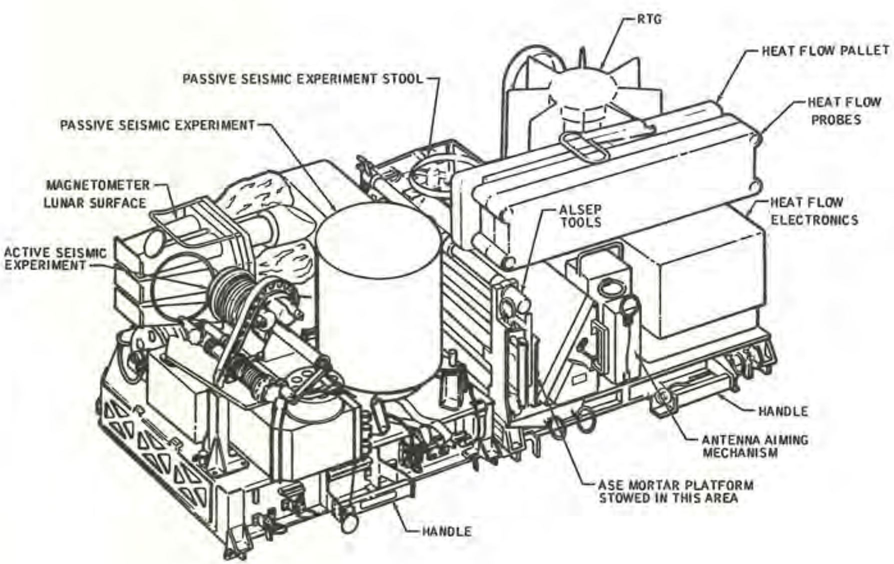
They will also sample the Descartes region of Smoky Mountain, again at the point where it intersects with the Cayley Formation.

Experiments

An electric drill, with improvements over the one used for Apollo 15, will be used to drill holes of varying depths. Core samples will be taken, and heat sensors (extremely sensitive electronic thermometers) will be placed in some of the holes to give new data about the Moon's internal temperature and heat flow. The comparable experiment on Apollo 15 indicated that the Moon may be somewhat warmer than previously believed. Heat measurements are among the fundamental data needed to determine the history and evolutionary status of a planetary body.

In addition to the experiments described elsewhere, some of the other experiments will include:

- A seismometer that reports to Earth on Moonquakes and impacts of objects on the Moon.
- An active seismic experiment, in which small explosive charges will be detonated on the Moon.
- Two magnetometer experiments to show levels of magnetism in the highlands.
- A special device that will capture a very thin layer of the dust that covers the lunar surface.
- A cosmic ray detector that will report on the abundance, energy, and frequency of cosmic rays, which are the most energetic of all atomic-particle radiation in space. From the Moon, these particles can be detected when they are still free of the disturbing effects of Earth's magnetic field and atmosphere.



Liftoff From the Moon

When the appointed tasks on the lunar surface are completed, Young and Duke will reenter *Orion*, repressure the cabin, eat, and prepare the ascent stage of the LM for liftoff to rejoin *Casper* in lunar orbit.

Liftoff is scheduled for 4:39 p.m. on April 23.

Once docked with the mother ship, the two lunar module crewmen will transfer the samples of lunar material and exposed photographic films to the Command Module.

Seismic Experiment with LM Ascent Stage

As in previous Apollo lunar landing missions, the lunar module ascent stage will be used for one final experiment when its usefulness as a vehicle has ended. It will be maneuvered by remote control so that it crashes on the Moon. The reverberations from the crash will be sensed by seismometers that have previously been set up on the lunar surface.

Deploying the Subsatellite

Just before they head Earthward on April 25, the crew will put a manmade satellite into orbit around the Moon, a twin of one that was deployed by Apollo 15 last August. Called a subsatellite, since it will be orbiting the Moon which is itself a satellite of Earth, the device -- housed in a box-like container that looks much like a rural mailbox -- will be pushed out of the CSM by a spring mechanism and go into an orbit of 102 to 139 kilometers (63 to 86 miles) above the Moon.

The subsatellite carries three experiments: a magnetometer to determine the strength and direction of interplanetary and Earth magnetic fields in the lunar region; an S-band transponder to determine variations in the lunar gravity field by their effect on the subsatellite's orbital motions; and a charged particles detector to measure electron and proton flux.

When clear of the spacecraft, the subsatellite will put out three even spaced booms, each about 1.5 meters (5 feet) long. The magnetometer is carried on one of these booms, keeping it away from interference by magnetic fields caused by the subsatellite itself. The other two booms balance that one to stabilize the craft as it spins at about 12 revolutions per minute.

Its sensors are powered by solar cells and a rechargeable battery for passes around the dark side of the Moon. The instruments are expected to keep sending data to Earth for about a year after Apollo 16 returns.

APOLLO 16 CREW

Spacecraft Commander

John W. Young, *a captain in the U. S. Navy, was born in San Francisco, California, on September 24, 1930. He earned a Bachelor of Science degree in Aeronautical Engineering from the Georgia Institute of Technology in 1952. He also holds two honorary doctorates: Doctor of Laws, Western State University College of Law, 1969; and Doctor of Applied Science, Florida Technological University, 1970.*

One of the most experienced of the astronauts currently on active duty, he served as a pilot with command pilot Gus Grissom on the first manned Gemini flight, was the command pilot for Gemini 10, and command module pilot for Apollo 10.

Young is married to the former Susy Feldman of St. Louis, Missouri; he has two children by a previous marriage.

Command Module Pilot

Thomas K. Mattingly II, *a lieutenant commander in the U. S. Navy, was born in Chicago, Illinois, March 17, 1936. He earned a Bachelor of Science degree in Aeronautical Engineering from Auburn University in 1958.*

This will be Mattingly's first mission in space. He almost made it with the ill-fated Apollo 13 mission, but was exposed to the measles just prior to the flight and was replaced on the mission by Astronaut John Swigert. However, the landing mission was aborted when an oxygen tank ruptured early in the flight.

Prior to reporting for duty at the Manned Spacecraft Center, he was a student at the Air Force Aerospace Research Pilot School. He has logged 4,200 hours of flight time -- 2,300 hours in jet aircraft.

Mattingly is married to the former Elizabeth Dailey of Hollywood, California.

Lunar Module Pilot

Charles M. Duke, Jr., *a lieutenant colonel in the Air Force, was born in Charlotte, North Carolina, on October 3, 1935. He holds a Bachelor of Science degree in Naval Sciences from the U. S. Naval Academy in 1957 and a Master of Science degree in Aeronautics and Astronautics from the Massachusetts Institute of Technology in 1964.*

He was selected to be a NASA astronaut in 1966, after experience as an instructor at the Air Force Aerospace Research Pilot School.

Apollo 16 will be his first space flight.

Duke is married to the former Dorothy Meade Claiborne of Atlanta, Georgia; they are the parents of two children.

Cover Art: Alfred Jordan
Text: Jefferson D. Bates