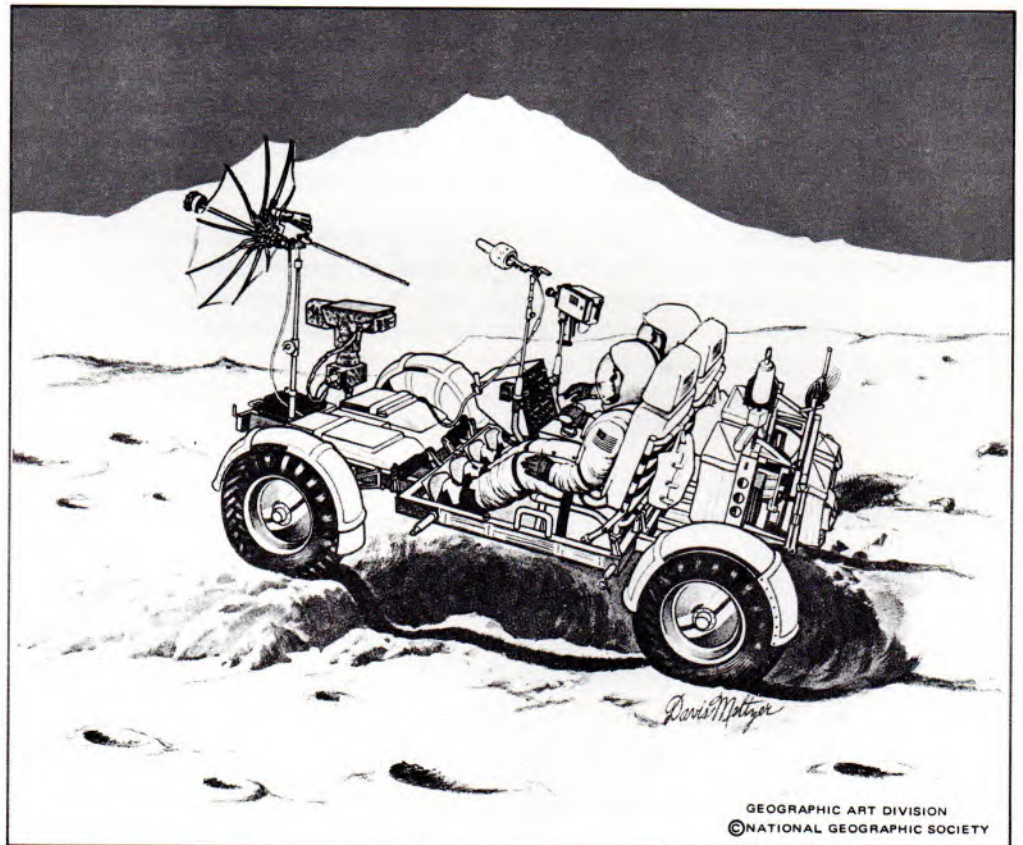




# apollo 15

**THE CELESTIAL ENDEAVOR**



**MCDONNELL DOUGLAS ASTRONAUTICS COMPANY**





## THE CELESTIAL ENDEAVOR


*On July 26, 1971, astronauts Scott, Worden, and Irwin will embark on an expedition that has been called "one of the greatest scientific endeavors ever undertaken." The fourth manned exploration of the Moon, Apollo 15 is expanded considerably in scientific scope and duration over previous missions. Return splashdown on August 7, 12 days and 7 hours after liftoff, will mark the longest mission yet attempted by the Apollo program.*

*New objectives for this mission include the use of more sophisticated equipment for scientific experiments in lunar orbit, extensive orbital photo-mapping and stereoscopic photography of the lunar surface, insertion of a scientific data-gathering subsatellite into lunar orbit, utilization of the first manned lunar roving vehicle, and extended lunar surface stay-time to almost twice that of previous missions. In addition, the spent S-IVB stage again will be targeted to impact the Moon in support of seismic investigations.*

*The work of our MDAC Saturn/Apollo team is, of course, of vital importance to the success of the mission. Your management recognizes your keen personal interest in this mission and is fully aware and appreciative of your individual contributions to our continuing success in the Saturn programs. We hope this Mission Brochure will help you and your family to enjoy more fully the news media coverage of the mission. I know that all of you will join with me in wishing total success to Apollo 15, and Godspeed to "Endeavor" and "Falcon."*

  
J. D. SHIELDS  
Program Manager, Saturn S-IVB

**MCDONNELL DOUGLAS ASTRONAUTICS COMPANY**

**MCDONNELL DOUGLAS**  
  
**CORPORATION**

# APOLLO MANNED FLIGHT HISTORY

FLIGHT	DATE	CREW		ACTIVITY
Apollo 7 (AS-205)	11 October 1968	Walter Schirra Walt Cunningham Don Eisele		Earth Orbit 163 Revolutions
Apollo 8 (AS-503)	21 December 1968	Frank Borman Bill Anders Jim Lovell		Lunar Orbit 10 Revolutions – 20 Hours and 11 Minutes in Orbit
Apollo 9 (AS-504)	3 March 1969	James McDivitt David Scott Rusty Schweikart		Earth Orbit – 151 Revolutions Lunar Module (LM) Manned
Apollo 10 (AS-505)	18 May 1969	Tom Stafford John Young Gene Cernan		Lunar Orbit – LM Lunar Operations
Apollo 11 (AS-506)	16 July 1969	Mike Collins Neil Armstrong Buzz Aldrin		First Lunar Landing 7-20-69 First Man on Moon 7-20-69 Site: Sea of Tranquility Lunar Surface Stay-Time – 22 Hrs
Apollo 12 (AS-507)	14 November 1969	Charles Conrad Allan Bean Dick Gordon		2nd Lunar Landing 11-18-69 Site: Surveyor III Lunar Surface Stay-Time – 33 Hrs
Apollo 13 (AS-508)	11 April 1970	Jim Lovell John Swigert Fred Haise		3rd Planned Lunar Landing (Lunar Landing Aborted) Site: The Highlands – Fra Mauro 1st S-IVB Lunar Impact
Apollo 14 (AS-509)	31 January 1971	Al Shepard Ed Mitchell Stuart Roosa		3rd Lunar Landing 2-4-71 Site: The Highlands – Fra Mauro Lunar Surface Stay-Time – 33.5 Hrs 2nd S-IVB Lunar Impact
		<b>Prime</b>	<b>Backup</b>	
Apollo 15 (AS-510)	26 July 1971	David Scott Al Worden Jim Irwin	Gordon Brand Schmitt	4th Lunar Landing 7-30-71 Site: Hadley-Apennines Lunar Surface Stay-Time—66.8 Hrs 3rd S-IVB Lunar Impact

# APOLLO 15 ASTRONAUTS

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**DAVID R. SCOTT** – Apollo 15 Commander – was born in San Antonio, Texas, in 1932. He and his wife Ann have two children – Tracy, age 10, and Douglas, 7.

After graduating from the U.S. Military Academy with a B.S. degree, Dave Scott was commissioned in the Air Force and received flight training. He is a graduate of the Experimental Test Pilot School, and the Aerospace Research Pilot School. In addition, he earned B.S. and M.S. degrees in aeronautics and astronautics from the Massachusetts Institute of Technology.

Colonel Scott joined the astronaut team in October 1963, and served as the pilot of Gemini VIII in March 1966. Following this mission, which saw the first successful docking of a spacecraft with a target vehicle, he was awarded the NASA Exceptional Service Medal. In March 1969, Scott was Command Module Pilot for the highly successful Apollo 9 mission.



**ALFRED J. WORDEN** – Command Module Pilot – was born in Jackson, Michigan, in 1932. He and his wife Pamela have two children – Merrill, age 13, and Allison, 11.

After graduating from the U.S. Military Academy with a B.S. degree, Al Worden was commissioned in the Air Force and received flight training. He is a graduate of the Instrument Pilot Instructors School, the British Empire Test Pilot School, and the Aerospace Research Pilot School. In addition, he has an M.S. degree in aeronautical/astronautical engineering and instrumentation engineering awarded by the University of Michigan.

Major Worden is one of the 19 astronauts selected by NASA in April 1966.



**JAMES B. IRWIN** – Lunar Module Pilot – was born in Pittsburgh, Pennsylvania, in 1930. He and his wife Mary have four children – Joy, age 11; Jill, 10; James, 8; and Jan, 6.

After graduating from the U.S. Naval Academy with a B.S. degree, Jim Irwin was commissioned in the Air Force and received flight training. He is a graduate of the Experimental Test Pilot School and the Aerospace Research Pilot School. In addition, he has an M.S. degree in aeronautical and instrumentation engineering awarded by the University of Michigan.

Lieutenant Colonel Irwin was one of the 19 astronauts selected by NASA in April 1966.



# APOLLO 15 VEHICLE CHARACTERISTICS

## VEHICLE DATA

STAGE/ MODULE	DIMENSIONS		WEIGHT	
	DIAMETER FEET	LENGTH FEET	DRY (LBS)	AT LAUNCH (LBS)
Launch Vehicle	63.0	363		6,494,710
S-IC Base	63.0			
S-IC	33.0	138	287,960	5,016,242
S-II	33.0	81.5	86,500	1,091,586
S-IVB	21.7	59.3	25,146	266,045
IU	21.7	3.0	4,492	4,492
SLA	21.7 Base 12.8 Top			3,961
LM				36,207
SM	12.8	22	13,480	54,067
CM	12.8	12		12,822
LES	12.0	34		9,190

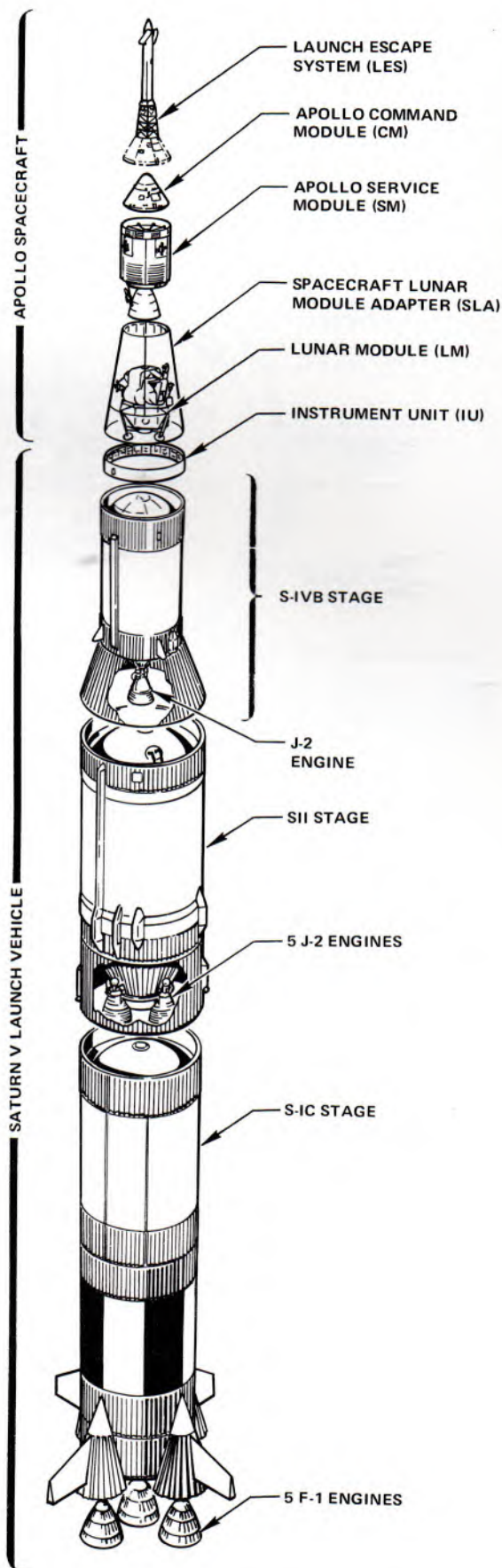
## ENGINE DATA

STAGE/ MODULE	QTY	MODEL	NOMINAL THRUST LBS		BURNTIME MINS
			EACH	TOTAL	
S-IC	5	F-1	1,530,000	7,650,000	2.7
S-II	5	J-2	230,000	1,150,000	6.5
S-IVB	1	J-2	204,000	208,093	1st 2.47 2nd 6.07
LM					
Descent	1		10,500	10,500	
Ascent	1		3,500	3,500	
SM	1		22,000	22,000	
LES	1		150,000	150,000	

## FLIGHT DATA

STAGE/ MODULE	EVENT	VELOCITY MPH	WEIGHT AT EVENT LBS
S-IC	Engine Cutoff	6,146	1,842,140
S-IIC	Engine Cutoff	15,616	476,943
S-IVB	Earth Orbital Insertion	17,461	309,771
S-IVB	Trans Lunar Injection	24,265	144,028
CSM/LM	Lunar Orbit Insertion	3,585	69,971
S-IVB	Lunar Impact	5,771	31,000
LM	Lunar Touchdown	0-2	19,216
LM	Lunar Liftoff		10,688
LM Ascent	Lunar Impact	3,756	
CSM	Trans Earth Insertion	5,640	
CM	Earth Insertion	22,500	

NOTE: The above values are all approximations.





# APOLLO 15 MISSION DESCRIPTION



The primary mission objectives for the Apollo 15 mission have been defined as follows:

- Perform selenological inspection, survey, and sampling of surface and subsurface materials and features in a preselected area of the Hadley-Apennine region of the Moon.
- Emplace and activate scientific equipment contained in the Apollo lunar surface experiment package (ALSEP).
- Evaluate capability of the modified lunar module (LM) and equipment to provide extended lunar surface stay-time, extended extravehicular activity (EVA) periods, and increased lunar surface mobility.
- Perform in-flight experiments and photographic tasks from lunar orbit.
- Perform the operations necessary to impact the spent S-IVB/IU on the lunar surface at a precise location in the vicinity of the Apollo 12 and 14 lunar landing sites.

Specific highlights peculiar to this mission as compared to previous ones are:

- Launch of the heaviest Saturn/Apollo payload to date – 107,500 pounds.
- Flying the longest Apollo mission to date – 12 days and 7 hours including more than 6 days in lunar orbit.
- Flying for the first time a modified LM that will permit almost twice the lunar surface stay-time of previous missions.
- Carrying out detailed orbital photo-mapping and lunar surface stereoscopic photography, using a three-camera system and a laser altimeter.
- Use of new buddy system life support equipment that extends EVA time from the previous 9 hours for each man to 20 hours each.
- Use of new space suits that are more comfortable and allow greater mobility.
- Traveling as far as five miles from the LM on an electrically-powered vehicle – the first time lunar surface transportation has been available to increase traverse distances manyfold.
- Placing in lunar orbit a subsatellite designed to send back data on the lunar environment for at least a year.

The Apollo 15 is scheduled to be launched from Pad 39A at Kennedy Space Center on July 26, 1971 at 6:34 AM PDT. The command and service module (CSM), lunar module (LM), and S-IVB stage will be inserted into a 90 nautical

mile (NM) circular earth parking orbit (EPO) by the S-I and S-II stages and a first burn of the S-IVB stage. During the EPO period of two or three revolutions, all systems will be checked out and the spacecraft made ready for translunar injection (TLI).

The TLI maneuver performed by a second burn of the S-IVB stage will place the CSM, LM, and S-IVB into a translunar trajectory. During translunar coast the CSM will separate from the S-IVB, rotate end-for-end, then dock with the LM. The CSM and LM then separate from the S-IVB. The S-IVB will then perform an evasive maneuver and the maneuver into lunar impact trajectory.

After approximately three days in translunar coast the S-IVB will crash onto the Moon and the CSM/LM will be inserted into a 58-by-170 NM lunar orbit, with the lunar orbit insertion (LOI) maneuver being performed on the back side of the Moon.

After about four hours in lunar orbit, during the third revolution, the descent orbit insertion (DOI) maneuver will place the CSM/LM into an approximately 9-by-58 NM orbit. The LM will separate from the CSM during the 12th revolution and land at the Hadley Apennines site during the 14th revolution.

The lunar module astronauts will be on the lunar surface for a period of approximately 67 hours. During this time the astronauts will conduct three EVA trips, each of approximately 7 hours duration, in addition to the normal tasks of sleeping, eating, and recharging their portable life support systems. For the first time a lunar roving vehicle (LRV) will be used to transport the astronauts during the lunar surface explorations.

Subsequent to separation from the LM, the CSM will maneuver into a 55-by-65 NM orbit. While in lunar orbit the CSM will perform scientific experiments and photograph the lunar surface. During the 45th revolution the CSM will maneuver to a coplanar orbit with the LM ascent trajectory for rendezvous with the LM. Following rendezvous, the astronauts will transfer the lunar samples to the command module (CM) and the LM will be jettisoned and deorbited to impact the Moon.

The transearth injection (TEI) maneuver will occur at the start of the 75th revolution to place the CSM into transearth trajectory. Just prior to TEI the CSM will launch the subsatellite into a 55-by-75 NM lunar orbit. During the three day return trip to Earth, an EVA will be performed by one of the astronauts to retrieve film cassettes from the scientific instrument module bay (SIM) in the service module (SM).

Prior to reentry into Earth's atmosphere, the SM will be jettisoned to burn up in the atmosphere. The CM will reenter Earth's atmosphere and splashdown in the Pacific Ocean on 7 August at 1:46 PM PDT – 12 days and 7 hours after liftoff.

# APOLLO 15 MISSION EVENT SCHEDULE

DATE	EVENT	CLOCK TIME (PDT) HR:MIN
<b>MONDAY</b> July 26/Day 1	Crew Enter Command Module . . . . .	.2:40 AM
	Start Automatic Terminal Countdown . . . . .	.6:31 AM
	S-IC Ignition – Lift Off . . . . .	.6:34 AM
	S-II Ignition . . . . .	.6:37 AM
	S-IVB Ignition . . . . .	.6:43 AM
	Earth Orbit Insertion . . . . .	.6:45 AM
	S-IVB Ignition (Restart) . . . . .	.9:24 AM
	*Live TV (25 Min) – Transposition & Docking . . . . .	.9:59 AM
	Spacecraft/S-IVB Final Separation . . . . .	10:50 AM
S-IVB Evasive Maneuver Burn . . . . .	11:13 AM	
<b>TUESDAY</b> July 27/Day 2	*Live TV (45 Min) – Spacecraft Interiors – Scott and Irwin Transfer to Lunar Module . . . . .	.4:19 PM
<b>THURSDAY</b> July 29/Day 4	Spacecraft Lunar Orbit Insertion (LOI) . . . . .	1:05 PM
S-IVB Lunar Impact . . . . .	1:49 PM	
Lunar Target Site: 3° 39' south latitude, 7° 35' west longitude. Vicinity of Ocean of Storms, 186 miles east of Apollo 14 site.		
Experiment: The S-IVB lunar impact velocity of 5,771 mph, creates a force equivalent to 21,200 pounds of TNT. This man-made moonquake will provide a stimulus for the passive seismographs which were deployed and activated on the lunar surface during the Apollo 12 and 14 missions.		
Lunar Descent Orbit Insertion (DOI) . . . . .		
.5:50 PM		
<b>FRIDAY</b> July 30/Day 5	*Live TV (10 Min) – Hadley-Apennine Landing Site . . . . .	.5:32 AM
	Separation of Command Service Module/Lunar Module . . . . .	10:48 AM
	Powered Descent Insertion (PDI) . . . . .	.3:03 PM
	Touchdown on Lunar Surface . . . . .	.3:15 PM
	Anticipated Location: Hadley-Apennine Range – North Central part of Moon. (26° 4' 54" north latitude, 3° 39' east longitude).	
Astronauts prepare lunar module (Falcon) for ascent burn; Scott conducts standup EVA from hatch of Falcon; Then identifies landmarks; Checks traverse routes; Locates rille, front, North Complex; mare surface; Takes 360° panoramic photography; Selects ALSEP location. Ingress cabin; Both astronauts eat, then sleep for 7.5 hours.		
<b>SATURDAY</b> July 31/Day 6	*Live TV (6 Hours, 45 Min) of Lunar Surface, EVA-1 . . . . .	.6:34 AM
	Scott and Irwin out of Lunar Module . . . . .	.6:34 AM
	Lunar Surface Activities: Setup TV; Deploy and check out Lunar Rover Vehicle (LRV); Collect contingency samples; Drive LRV to Elbow Crater; Panoramic photo and TV; Collect radial samples; Drive to St. George Crater; Observe ejecta distribution; Drive double core tube; Penetrometer test; Drive to Apennine front; Take documented samples; Return to LM; Deploy ALSEP; Polarimetric photography; Deploy U.S.A. Flag.	
Scott and Irwin Reenter Lunar Module . . . . .		
.1:17 PM		
Remove and store pressure suits; Recharge portable life support system (PLSS); Send debriefing report to Houston; Eat, sleep 7.5 hours, eat, and prepare for EVA-2.		

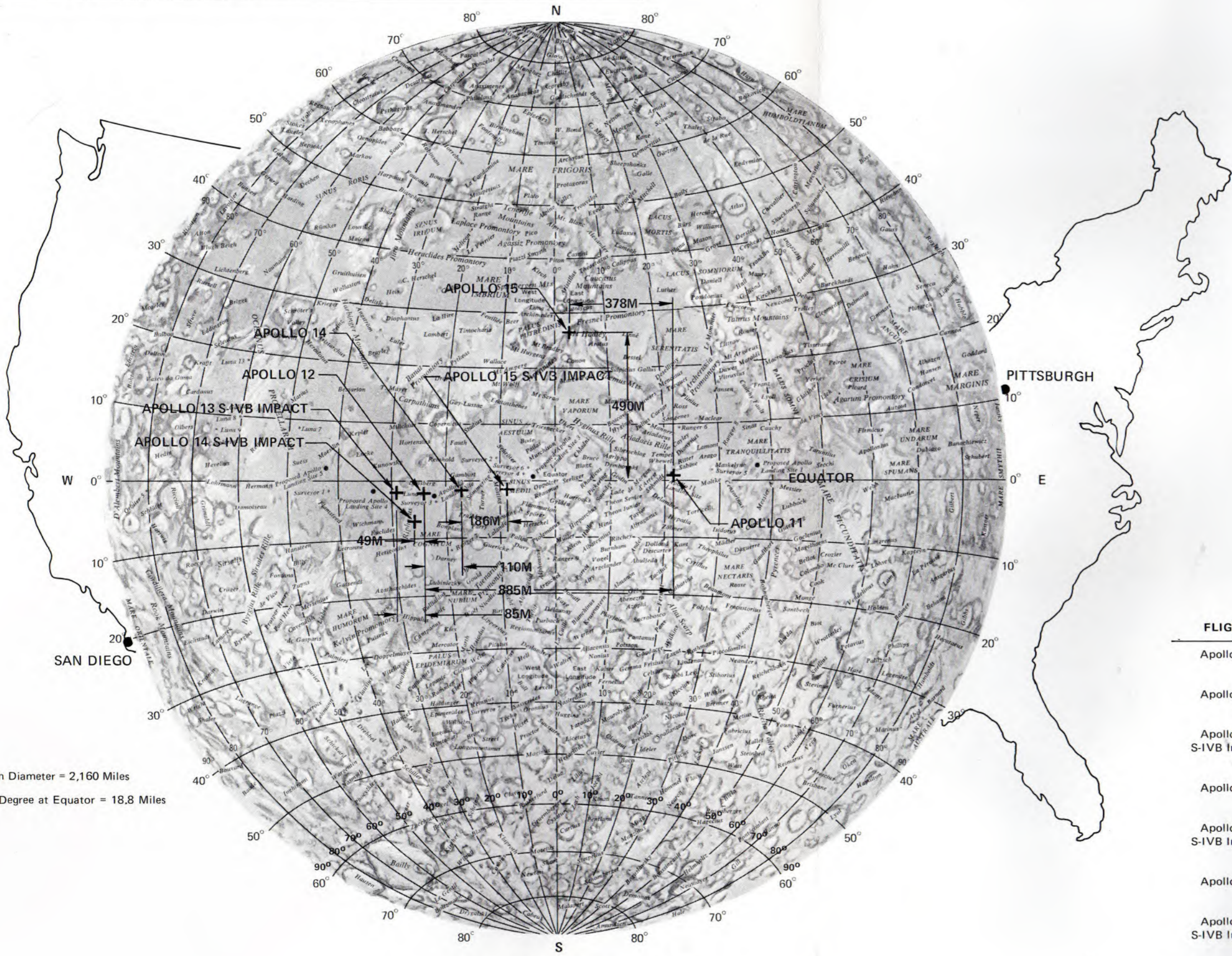
\*Indicates TV transmission and release time to networks. Consult your TV guide for local viewing times.

# MISSION EVENT SCHEDULE (CONT'D)

DATE	EVENT	CLOCK TIME (PDT) HR:MIN
<b>SUNDAY</b> August 1/Day 7	Scott and Irwin out of Lunar Module . . . . .	3:54 AM
	*Live TV (6 Hours, 30 Min) of Lunar Surface, EVA-2 . . . . .	4:04 AM
	Lunar Surface Activities: Drive LRV south to Apennine front; Describe ejecta at South Cluster; Observe debris flows, lateral variations in material and surface textures; Document samples and description of front material; Dig exploratory trench; Take panoramic photography; Traverse front area on foot; Take 500 mm lens photography; Stereo photography of upslope side; Return to LM; Store samples.	
	Scott and Irwin Reenter Lunar Module . . . . .	10:44 AM
	Weigh sample return container and collection bags; Remove and store suits; Recharge PLSS; Send debriefing report to Houston; Eat, sleep 7 hours, eat, and prepare for EVA-3.	
<b>MONDAY</b> August 2/Day 8	Scott and Irwin out of Lunar Module . . . . .	12:34 AM
	*Live TV (5 Hours, 40 Min) of Lunar Surface, EVA-3 . . . . .	12:44 AM
	Lunar Surface Activities: Drive LRV to Terrace area of Hadley Rille; Describe rille and far wall; 500 mm lens photography; Drive single core tube; Documented samples at rille rim; Take stereo photography; Travel to North Complex; Evaluate performance of LRV; Take soil/rock sample; Compare ejecta with other materials; Return to LM; Store samples.	
	Scott and Irwin Reenter Lunar Module . . . . .	6:24 AM
	Disconnect and remove PLSS; Weigh rock bags; Jettison equipment; Clean up cabin; Eat.	
	*Live TV (15 Min) of Lunar Module Liftoff . . . . .	10:04 AM
	Liftoff Lunar Module . . . . .	10:11 AM
	Lunar Orbit Insertion (LOI) . . . . .	10:19 AM
	*Live TV (6 Min) Rendezvous . . . . .	11:44 AM
	*Live TV (4 Min) Docking LM/CSM . . . . .	12:05 PM
	Jettison Lunar Ascent Module . . . . .	3:55 PM
	Lunar Ascent Module Impacts Moon with equivalent force of approximately 1,700 pounds of TNT. Impact point 30 miles northwest of Apollo 15 site . . . . .	6:09 PM
<b>WEDNESDAY</b> August 5/Day 10	Subsatellite Launch from CSM into 55 x 75 NM Lunar orbit with one year life expectancy . . . . .	1:10 PM
	Transearth Insertion (TEI) CSM . . . . .	2:18 PM
<b>THURSDAY</b> August 5/Day 11	Transearth Extravehicular Activity. Worden retrieves film cassettes from scientific instrument bay of service module . . . . .	8:34 AM
	*Live TV (30 Min) of Transearth EVA . . . . .	8:41 AM
<b>SATURDAY</b> August 7/Day 13	Separation - Command Module/Service Module . . . . .	1:17 PM
	Earth Insertion (EI) Command Module . . . . .	1:32 PM
	S-Band Communication Blackout (3 to 4 minutes) . . . . .	1:33 PM
	Splashdown - Command Module . . . . .	1:46 PM
	Splashdown will occur in the Pacific Ocean north of Oahu, Hawaii. (N Lat. 26°/W Long. 158°)	

\*Indicates TV transmission and release time to networks. Consult your TV guide for local viewing times.

# APOLLO LUNAR LANDING SITES

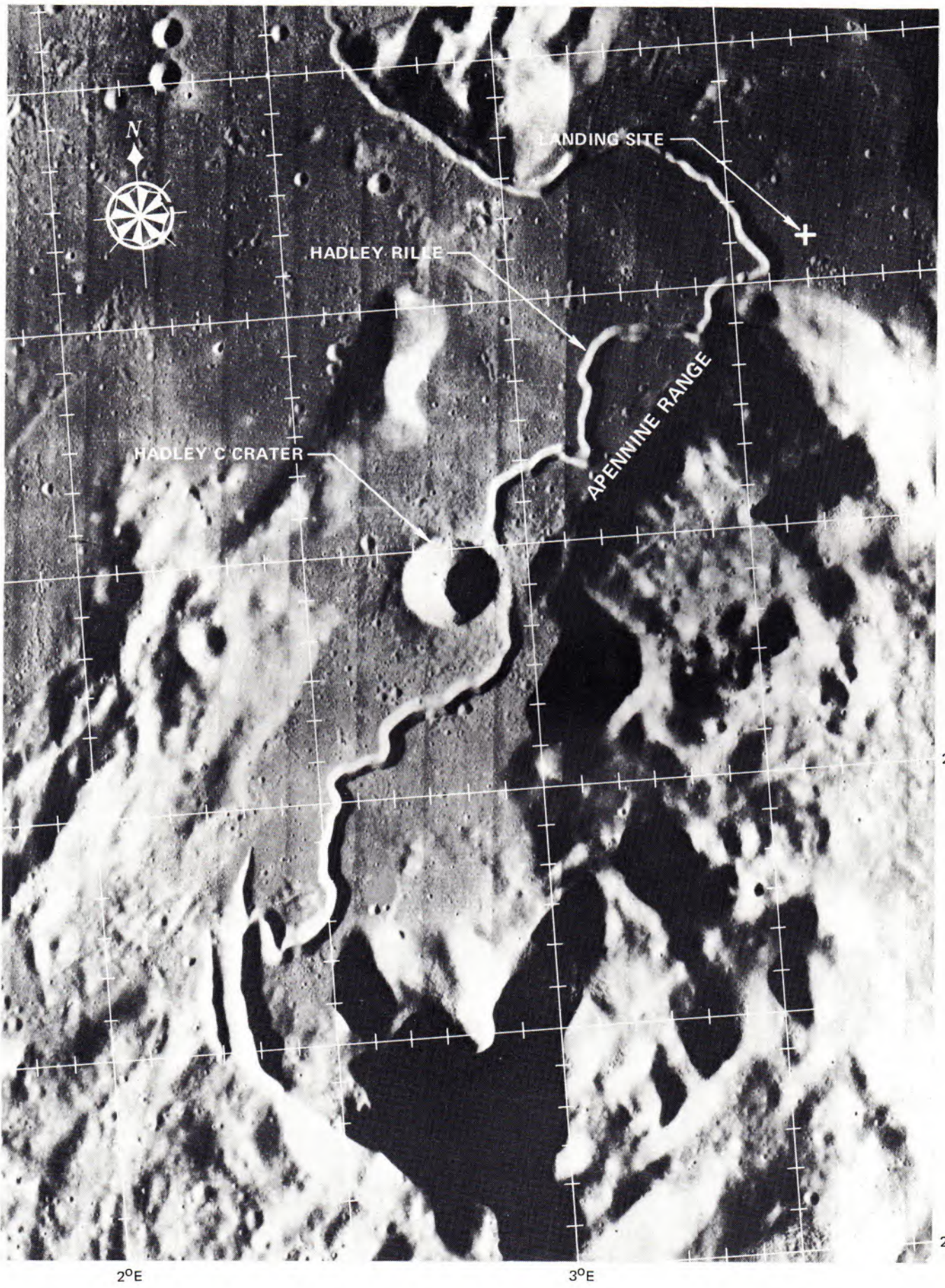


Moon Diameter = 2,160 Miles  
One Degree at Equator = 18.8 Miles

FLIGHT	LUNAR LANDING DATE	LANDING SITE
Apollo 11	20 July 1969	Sea of Tranquility (Lat. 0° 43'N/Long. 23° 42'E)
Apollo 12	28 November 1969	Sea of Storms (Lat. 3° 11'S/Long. 23° 23'W)
Apollo 13 S-IVB Impact	14 April 1970	85 Miles West and 13 Miles North of Apollo 12 Site. (Lat. 2° 30'S/Long. 27° 54'W)
Apollo 14	5 February 1971	Fra Mauro Area (Lat. 3° 40'S/Long. 17° 29'W)
Apollo 14 S-IVB Impact	3 February 1971	49 Miles West and 87 Miles South of Apollo 12 Site. (Lat. 1° 36'S/Long. 33° 15'W)
Apollo 15	30 July 1971	Mt. Hadley Area, Apennines Range (Lat. 26° 5'N/Long. 3° 40'E)
Apollo 15 S-IVB Impact	29 July 1971	186 Miles East of Apollo 14 Site (Lat. 3° 39'S/Long. 7° 35'W)

USA/MOON COMPARISON

# APOLLO 15 LUNAR LANDING SITE



2°E

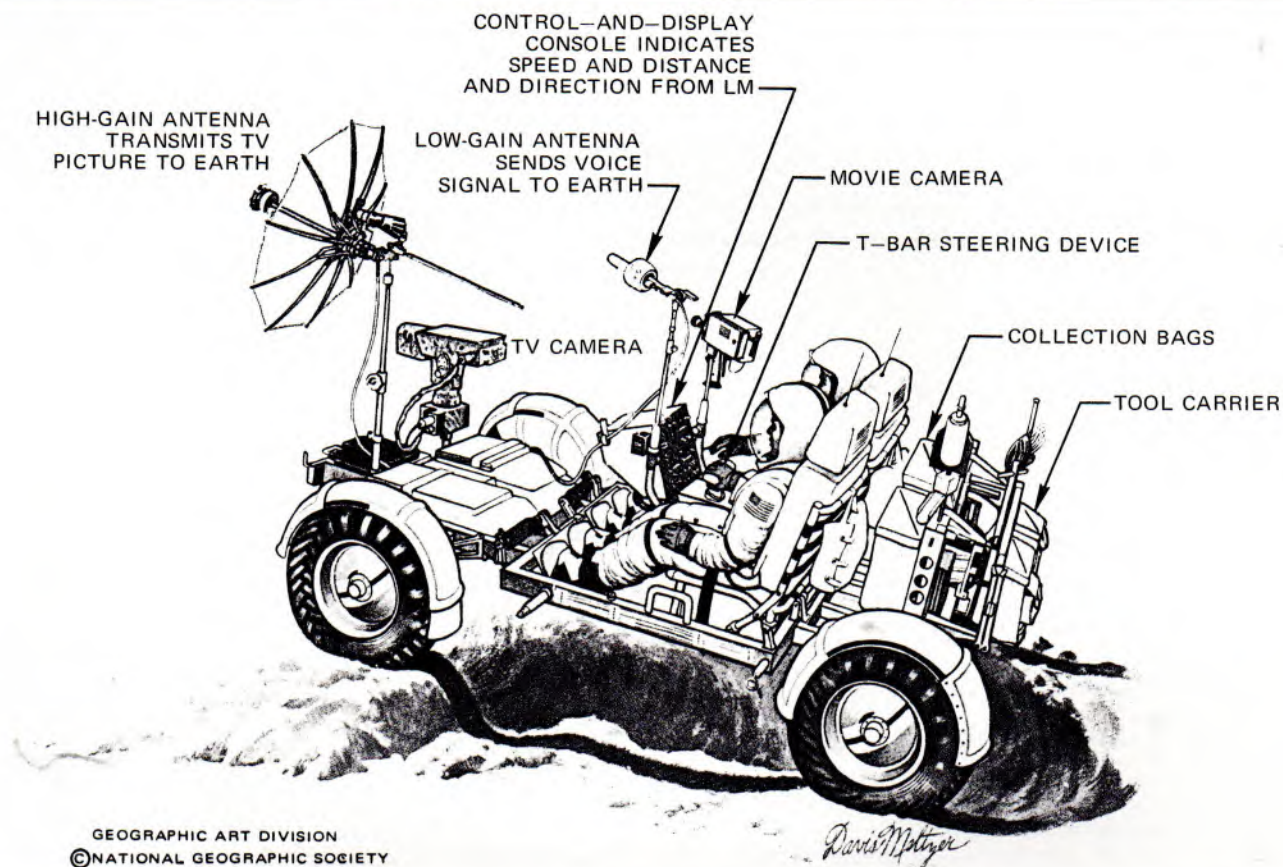
3°E

26°

25°N

24°N

# LUNAR ROVING VEHICLE (LRV)



The lunar roving vehicle (LRV) weighs approximately 480 pounds and resembles a stripped-down dune buggy. It can carry more than twice its weight in passengers, scientific instruments, and lunar soil samples. It is about 10-feet long and 6-feet wide, and has a 7 1/2-foot wheelbase. Powered by two silver zinc batteries driving four electric motors, one on each of four wheels, the vehicle has a top speed of approximately eight miles per hour. During the astronauts' staytime on the moon, they can make vehicle sorties totaling approximately 40 miles (60 kilometers).

The LRV will be carried to the moon in the cargo compartment of the descent stage of the Lunar Module (LM). To save space, the frame is hinged, with three segments folding together. The four wheels fold against the chassis. When the astronauts leave the LM for their first extravehicular activity (EVA) they will release the LRV from its stowage compartment. Deployment is semi-automatic. Springs unfold the vehicle and its wheels, and they lock together in the deployed position.

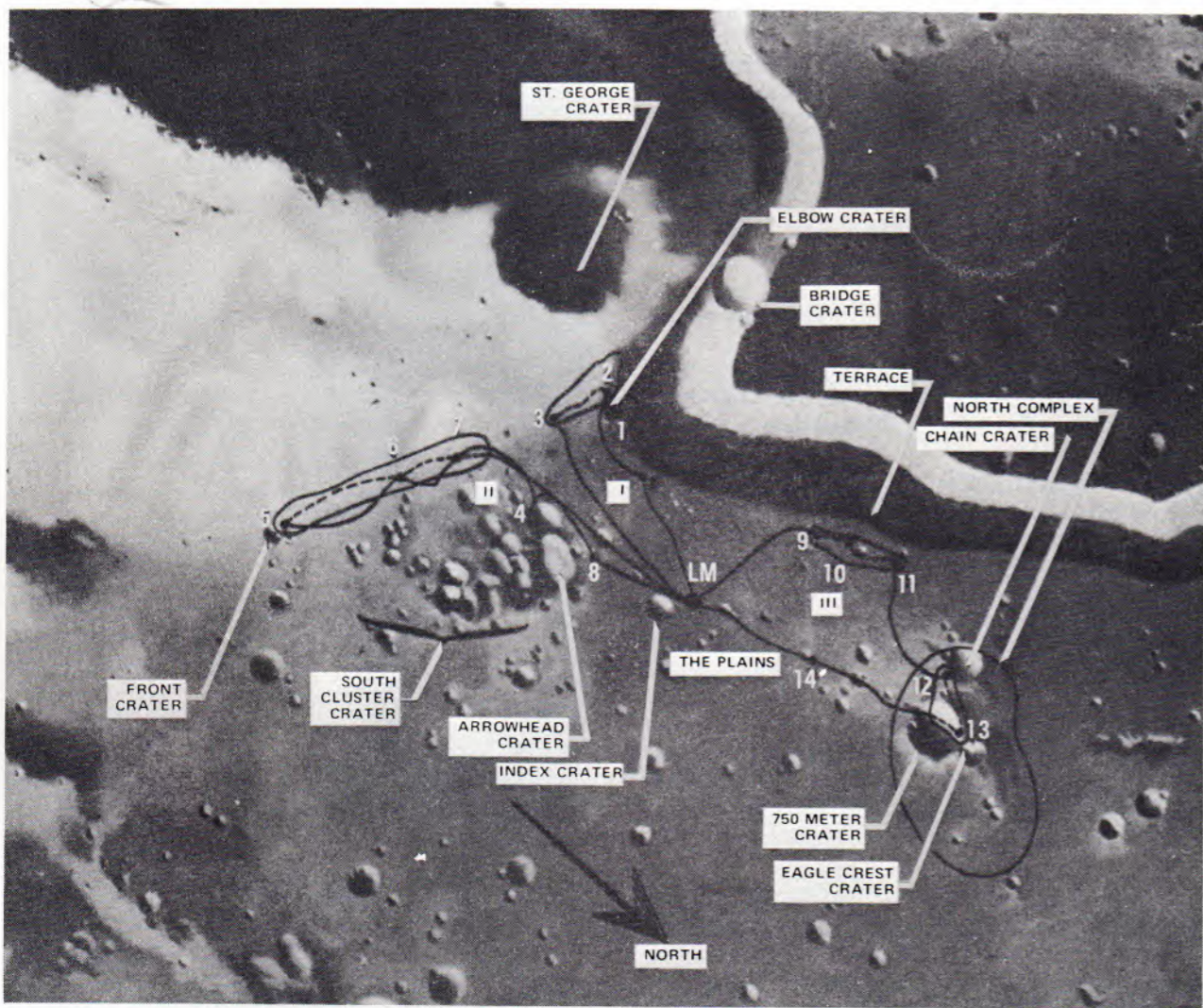
The two astronauts sit side by side in the open-frame vehicle. Between them is a hand control (joy stick). The LRV can travel forward or in reverse at variable speeds. The driver sets a toggle switch to provide power to the drive motors, then uses the joy stick to control movement. He tilts the stick forward to go ahead, backwards for reverse, left or right for steering, and pulls straight back to apply the brakes. All four wheels turn to steer around obstacles. The turn radius is less than the length of the vehicle.

The LRV can negotiate step-like obstacles 1-foot high and cross crevasses 28-inches wide with its 32-inch diameter wheels. The wheels are woven of zinc-coated piano wire and have spun aluminum hubs and titanium bump stops. Chevron-shaped treads of titanium are riveted to the wire mesh around each wheel's outer circumference. Each wheel weighs 12 pounds on earth (equivalent to 2 pounds on the moon). The fully loaded vehicle, carrying a total weight of 1,000 pounds, can climb and descend slopes as steep as 20 degrees. A parking brake can hold the vehicle stationary on slopes of 30 degrees. Loaded ground clearance is at least 14 inches on a flat surface.

The vehicle will carry a lunar communications relay unit (LCRU) for direct communication with earth when the LRV is out of line-of-sight with the LM. The LCRU will relay voice and bio-medical data from the astronauts' suit-contained communications and, in addition, it will relay television coverage to the earth. The LCRU will be mounted on the LRV after the astronauts are on the lunar surface.

The moon is much smaller than the earth; therefore, the astronauts will be quickly over the horizon and out of sight of the LM. Since a magnetic compass cannot be used on the moon, the LRV has a built-in navigation system that will tell the astronauts the direction and distance back to the LM at all times, as well as the total distance they have traveled.

# APOLLO 15 LUNAR EXPLORATION



## Landing Site Description

The Apollo 15 landing area, termed Hadley-Apennine, is situated in the north central part of the moon (latitude 26° 04' 54" north, longitude 3° 39' 30" east) at the western foot of the Apennine Mountains and by the side of Hadley Rille. The Apennines rise 12,000 to 15,000 feet above the lunar surface and ring the southeastern edge of Mare Imbrium (Sea of Rains). This landing site is extremely attractive from the viewpoint of lunar science. It will give the astronauts their first chance to collect rocks from lunar mountains and to study first-hand a rille which resembles in many ways the channels cut on earth by meandering streams.

A perspective view of the landing site, looking south toward the base of Mount Hadley Delta (11,000 feet above landing site) with Hadley's Rille to the west, is shown in the drawing at left. This drawing combines the precision available from modern-day digital computers and the insights that can come only from an artist. Thus, the features are very accurately drawn but they are displayed as will be seen through the astronauts eyes.

## Hadley Rille

Hadley Rille is a V-shaped sinuous rille that roughly parallels the Apennine Mountains along the eastern boundary of Mare Imbrium. It originates in an elongated depression in an area of low domes that are probably volcanic in nature. It has an average width of about one mile, a depth that varies generally from 600 to 900 feet but at the landing site is 1,200 feet, and is about 80 miles long. The approximate slope of the sides of the rille is about 25 degrees. Many fresh outcrops of rock that are apparently layered are seen along and just below the rille rim. Such sinuous rilles are very common on the surface of the Moon. Their origin in general, and of Hadley Rille in particular, is very puzzling to lunar scientists and has been debated for many years. It has been attributed by various scientists to flowing water (although as a result of studying rocks returned on previous missions, we no longer believe this hypotheses), the flow of hot gases associated with volcanism, the flow of lava, and to collapsed lava tubes.

## Secondary Crater Cluster

A group of craters, labeled "South Cluster" will be observed and photographed during the second EVA. This group or cluster of craters is thought to have formed from impact of a group of objects that struck the Moon at the same time. Those objects were, in turn, thrown out from some other spot on the Moon by the impact of a single object from space. Hence the term secondary impact crater is applied to such craters.

Because the objects that created secondary impact craters came from some other spot on the Moon, the rock samples collected from such features may include samples from other parts of the Moon, and perhaps from considerable distance. An additional reason for collecting rocks in, or near craters, is that the impact, in forming the crater, always exhumes rocks from the bottom of the crater.

Thus, for those two reasons, that we may sample distance localities and that we may see changes in the rocks with depth, the collection of samples at South Cluster is an important scientific objective of the Apollo 15 mission.

## North Complex

Not all features on the Moon's surface were formed by impacting objects. Some were formed by internal processes. It is never easy on the basis of photographs or telescopic observations to distinguish between an internal and an external origin for a particular feature.

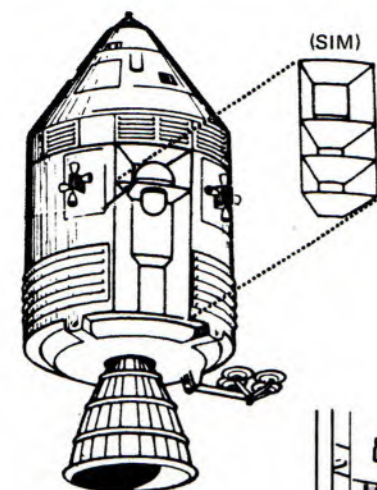
The features in the North Complex appear to have resulted from internal processes. Apollo 15 will give us the first opportunity to study at first-hand the form of such features and the nature of their rocks and soils.

## Lunar Surface Exploration

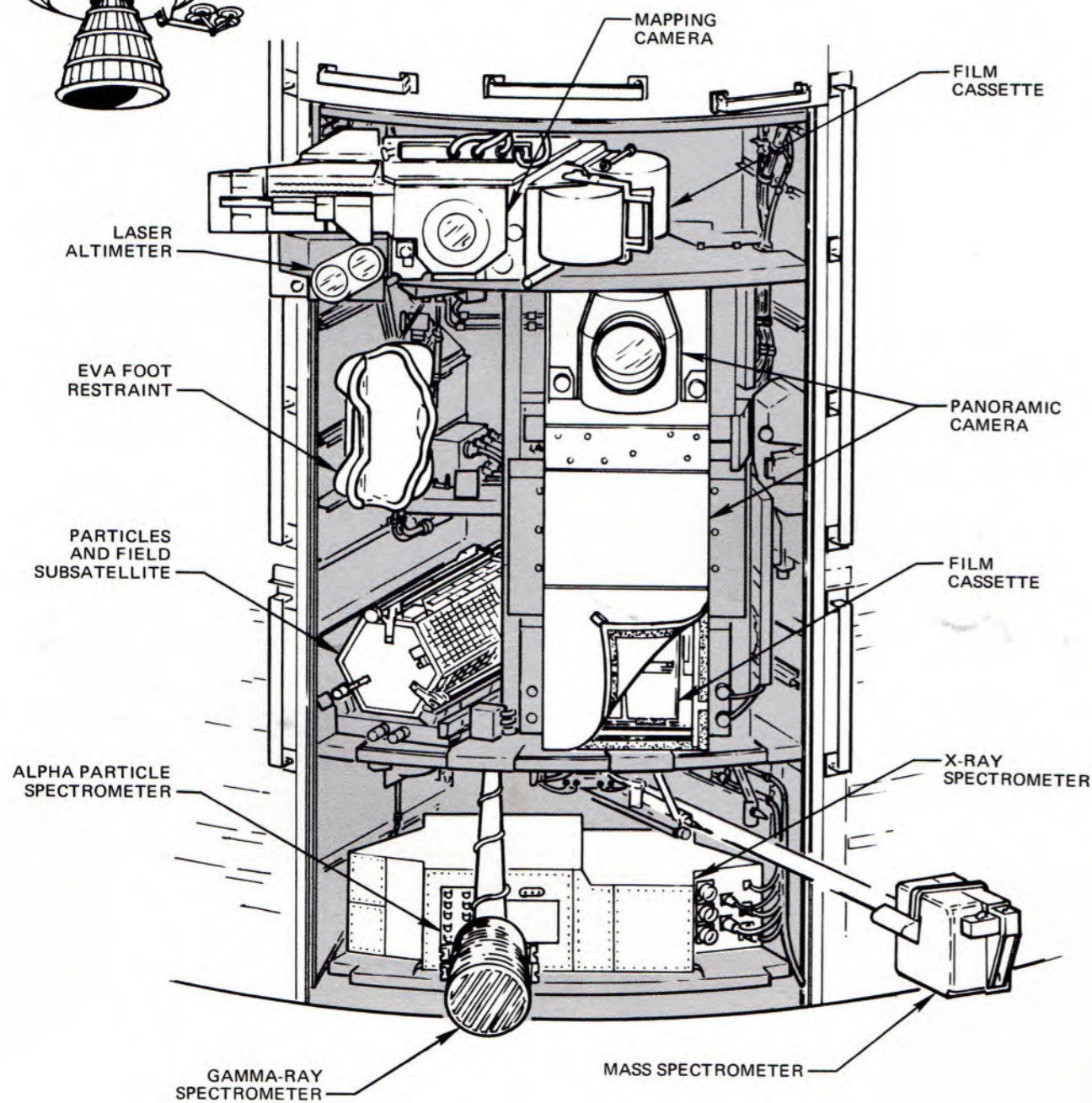
The Lunar Module crew will perform a Standing Extravehicular Activity (SEVA) from the hatch of the LM and three Extravehicular Activity (EVA) explorations with the Lunar Rover Vehicle while on the lunar surface. The drawing at lower left identifies the three traverses and significant landmarks of interest. The numerals noted along the traverses are "station stops" where the astronauts will conduct the activities noted below.

Station	Elapsed Time (Hrs:Min)	Geological Features	EVA I
			Observations/Activities
LM	0	Smooth Mare	Egress LM; Observe LM; Deploy LRV; Prepare for Traverse.
1	1:51	Southern Part of Elbow Crater Ejecta Blanket	Observe Distribution of Ejecta; Radial Samples; Panoramic Photography.
2	2:14	North of St. George Crater	Radial Sampling; Comprehensive Sample; Double Drive Core Tube; 500 mm Photo; Stereo Pan; Penetrometer Test; Fill Sample Container.
3	3:08	Base of Apennine Front	Documented Samples; Describe Vertical & Lateral Front Changes; Panoramic Photo; Observe EVA II Route.
LM	3:50	Smooth Mare	ASLEP Deployment; Store Samples; Ingress LM.
			EVA II
4	1:17	Edge of Crater at South Cluster	Soil/Rare Sample; Documented Samples; Panoramic Photo; 500 mm Photo; Exploratory Trench.
5	2:26	Rim of Front Crater at Apennine Front	Documented Samples; Stereo Pan; Exploratory Trench Upslope; 500 mm Photo; Stereo Pairs Upslope.
6	3:32	Base of Apennine Front	Description/Comparison of Front; Documented Samples; Panoramic Photo; Exploratory Trench; Drive Core Tube; 500 mm Photo; Stereo Pairs.
7	4:24	Base of Apennine Front	Observe Lateral Variations; Selective Samples; Photography; Complete Sampling.
8	5:30	Mare Near Arrowhead Crater	Comprehensive Samples; Double Core Tube; Documented Samples; Panoramic Photo; Trench; Fill Sample Container; Penetrometer Test.
LM	6:20	Smooth Mare	Store Samples & Records; Ingress LM.
			EVA III
9	1:06	At Rim of Hadley Rille, Southern End of Terrace	Describe Rille; 500 mm Photo; Comprehensive Samples; Drive Core Tube; Panoramic Photo; Documented Samples; Penetrometer Test.
10	1:59	Along Rille Rim at the Terrace	500 mm Panoramic Photo; Same Photos as Station 9 for Stereo Base; Documented Samples.
11	2:15	At Northeast End of Terrace	Observe & Describe Rille; Compare with Previous Observations; 500 mm Photo; Documented Samples; Panoramic Photo.
12	2:58	Rim of Chain Crater in North Complex	Documented Samples; Panoramic Photo; Drive Core Tube; Describe Wall of Crater.
13	3:29	Between Eagle Crest and 750 Meter Crater	Documented Sampling; Stereo Photo; Drive Core Tube; Trench; Soil Samples; 500 mm Photo; Penetrometer Test.
14	4:41	180 Meter Crater in Mare South of North Complex	Documented Samples; Fillet/Rock Sample; Radial Sampling; Equidimensional Rock Samples; Panoramic Photo; Trench.
LM	5:16	Smooth Mare Fill	Store Samples and Records; Ingress LM.

# APOLLO 15 SCIENTIFIC INSTRUMENT MODULE (SIM)



Equipment for conducting orbital experiments is mainly located in the scientific instrument module (SIM) bay of the service module (SM), which accommodates more than 1,000 pounds of such equipment. Additional experiment equipment and all necessary control and displays are located in the command/service module (CSM). A single foot restraint in the SIM bay will be used for EVA during transearth coast to transfer film cassettes from the SM to the CM.



## ORBITAL EXPERIMENTS

The broad objectives of exploring the Moon are to understand its origin, history and processes of evolution; and to attempt to relate these to Earth's own history. To achieve these objectives, lunar exploration attempts to determine the physical and chemical nature of the Moon as a body, the differences in properties of observed features on the surface, and the formation of these features in a chronological sequence.

The process of understanding the Moon can be broken roughly into three regimes: bulk body properties, composition and structure of the surface and subsurface, and atmospheric properties. The Apollo orbital-science experiments can be roughly divided into investigations of these three regimes.

### Bulk Body Properties

Bulk body properties include temperature, density, electrical parameters, heat-energy budget, and chemical composition. Apollo orbital experiments that contribute to investigation of the lunar bulk properties by supplementing emplaced surface experiments and returned sample analysis center around the particles-and-fields subsatellite. On Apollo 15 (and 17) a small spin-stabilized subsatellite will be ejected from the SM into a 55-by-75 nautical mile orbit. It will be solar-panel powered and equipped with an S-band-transponder data link. In addition to carrying charged-particle detectors and a biaxial magnetometer, it will allow gravitational profile studies through doppler tracking experiments with the transponder. Useful life of the subsatellite is expected to be at least one year.

### Surface and Subsurface Composition and Structure

Perhaps the heaviest emphasis of our efforts to understand the Moon to date has been placed upon study of the composition and structure of the lunar surface and near subsurface. The following lunar-orbit experiments and equipment will support such studies.

**GEOCHEMISTRY GROUP** — This group consists of the gamma-ray, X-ray, and gamma-ray spectrometers. Data from these three experiments will present a coherent picture of the surface distribution of a range of geologically significant elements. The gamma-ray spectrometer will be deployed from the SIM bay on a 25-foot boom to remove it from spacecraft/gamma-ray interaction.

**INFRA-RED SCANNING RADIOMETER** — This instrument uses a scanning mirror and a telescope to focus radiation from the lunar surface on to a thermistor bolometer. The experiment will provide data that will considerably improve present knowledge of lunar thermal conductivity, bulk density, and specific heat.

**DOWNLINK BISTATIC RADAR OBSERVATIONS** — This experiment makes use of the Apollo S-band and VHF

communication systems to reflect radio signals off the Moon for reception on Earth. The bulk electrical properties will indicate material compositions over broad surface areas.

**LUNAR SOUNDER** — This experiment comprises a three-frequency transceiver system, antennas, and an optical recorder. The experiment will develop a map of the lunar surface indicating subsurface layers, lunar-rubble depth, and layers or pockets of moisture or front-bearing soil should they exist. With the three frequencies involved, the experiment should provide data from as deep as 1.5 kilometers; and with full-orbit coverage the data should prove a major factor in understanding the structure of the lunar subsurface.

**PHOTOGRAPHIC SYSTEM** — Two camera systems and a laser altimeter comprise the Apollo photographic system. The *Panoramic Camera System* can give two-meter surface resolution from orbital altitude. It takes 1,650 frames on a 6,500-foot film roll. This high-resolution, stereoscopic photography will support detailed study of a wide variety of lunar features of scientific interest. Its companion, the three-inch *Mapping Camera System*, will produce high-quality metric photography. This system comprises a terrain camera and a stellar camera. A single film cassette will carry 3,600 frames for both the stellar and terrain cameras. The *Laser Altimeter* will fire a pulse synchronously with the mapping camera, indexing altitude at the center of the camera frame to within two meters. The laser altimeter will also sample altitude at 60-second intervals independent of camera operation.

### Lunar Atmosphere

The Apollo lunar-atmosphere experiments will involve a mass spectrometer, a far-ultraviolet (UV) spectrometer, and ultraviolet photography.

**MASS SPECTROMETER** — This magnetic sector-field device will also be deployed from the SIM bay on a 21-foot boom to remove it from contaminants. Analysis of the composition and density of neutral molecules will give information about the lunar atmosphere and its variation with altitude and solar illumination. Emissions from the lunar surface may be detected, indicating possibly active volcanic areas.

**FAR-UV SPECTROMETER** — This experiment will measure resonance re-radiation over the 1,000 to 1,700 Angstrom-unit range. From the experiment will come data on interaction of solar wind with the atmosphere, as well as fundamental data on the ambient atmosphere.

**UV PHOTOGRAPHY** — The Earth and Moon will be photographed from the command module during Earth orbit, translunar coast, and Moon orbit. The photographs will be taken in three UV regions and one visible region of the spectrum, using one 35 mm and one 16 mm camera.

# S-IVB LUNAR IMPACT



## LUNAR IMPACT SEISMIC EXPERIMENTS

The seismic equipment placed on the Moon as part of the Apollo Lunar Surface Experiment Packages (ALSEP's) carried by Apollo 12 and 14 will be used to obtain seismic data generated by impact of the Apollo 15 S-IVB stage on the lunar surface. Impact data from the deorbited Apollo 15 Lunar Module (LM) ascent stage will be similarly obtained, but with the addition of data detected by the Apollo 15 ALSEP seismic equipment. Apollo 13 and 14 S-IVB stages and the LM ascent stages of Apollo 12 and 14 were likewise utilized for seismic investigations. The map

shows the location of various impact points in relation to the ALSEP's left on the Moon by Apollo 12 and 14.

The data thus obtained from known impact energy at preselected locations are extremely valuable in determining lunar structure and formation, particularly when such data are recorded at specific multiple locations. The energy generated by the 31,000 lbs mass of the S-IVB crashing into the Moon at approximately 5,770 mph is equal to the detonation of about 11 tons of TNT. The actual point and time of impact will be determined to within 2.7 miles and 1.0 second, respectively.