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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 17 MISSION
5-DAY REPORT

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HOUSTON, TEXAS
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APOLLO 17 MISSION

5-DAY REPORT

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
December 1972

PREFACE

This report is based on an evaluation of preliminary data, and the stated values are subject to change in the Mission Report. Unless otherwise stated, all times are referenced to range zero, the integral second before lift-off. Range zero was 5:33:00 G.m.t., December 7, 1972. All distances quoted in miles are nautical miles.

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SUMMARY

Apollo 17, the final Apollo mission, was launched at 12:33:00 a.m. e.s.t. on December 7, 1972, from Complex 39A at the Kennedy Space Center. The spacecraft was manned by Captain Eugene A. Cernan, Commander; Commander Ronald E. Evans, Command Module Pilot; and Dr. Harrison H. Schmitt, Lunar Module Pilot. The launch was delayed 2 hours and 40 minutes because of a failure in the launch vehicle ground support equipment automatic sequencing circuitry 30 seconds prior to the scheduled lift-off.

The spacecraft/S-IVB combination was inserted into an earth parking orbit of 92.5 by 91.2 miles for systems checkout and preparation for the translunar injection maneuver. The translunar injection maneuver was retargeted to shorten the translunar coast period by 2 hours and 40 minutes so that the lunar landing could be made with the same lighting conditions as originally planned. After spacecraft separation, docking, and lunar module ejection, the S-IVB evasive maneuver was performed and the vehicle was subsequently targeted for lunar impact. The S-IVB impacted the lunar surface about 84 miles from the pre-planned point, and the impact was recorded by the Apollo 12, 14, 15, and 16 lunar surface seismometers.

One midcourse correction of 10.5 ft/sec was performed during the translunar coast phase to achieve the desired altitude of closest approach to the lunar surface. The crew performed a heat flow and convection demonstration and an Apollo light flash investigation during the translunar coast period. Also, the crew transferred to the lunar module twice and found all systems to be operating properly.

The scientific instrument module door was jettisoned about 4 1/2 hours prior to lunar orbit insertion. The docked spacecraft were inserted into a 170-by-52.6-mile lunar orbit following a service propulsion firing of 393 seconds. The first descent orbit insertion maneuver at 90 1/2 hours lowered the spacecraft orbit to 59 by 14.5 miles.

The crew entered the lunar module at 105 1/4 hours to prepare for descent to the lunar surface. After powering up the lunar module and undocking, the second lunar module descent orbit insertion maneuver was performed using the lunar module reaction control system to adjust the orbital conditions. The powered descent proceeded normally and the spacecraft was landed within 200 meters of the preferred landing point at 110:21:57. About 120 seconds of hover time remained at touchdown. The best estimate of the landing point is 30 degrees 45 minutes 25.9 seconds east longitude and 20 degrees 9 minutes 41 seconds north latitude on the 1:25 000-scale Lunar Topographic Photomap of Taurus Littrow, First Edition, September, 1972.

The first extravehicular activity began at 114:22. Lunar roving vehicle offloading and equipment unstowage proceeded normally, and television coverage was initiated about 1 1/4 hours into the extravehicular activity. The lunar surface experiment package was deployed approximately 155 meters northwest of the lunar module. Prior to moving the rover, the right rear fender extension was accidentally broken off and emergency repairs were made. The lunar surface experiment package deployment, deep core drilling, and neutron probe emplacement were accomplished. Two geologic units were sampled, two explosive packages were deployed and seven traverse gravimeter measurements were taken during the traverse. The samples collected weighed about 25 pounds.

The second extravehicular activity began at 137:55. The traverse was conducted with real-time modifications to station stop times because of geologic interests. At station 4, the crew discovered the first evidence of possible volcanic activity on the lunar surface in the form of orange soil. Five surface samples and a double core sample were taken at this site. Three explosive packages were deployed, seven traverse gravimeter measurements were taken, and all observations were documented photographically. The time of the second extravehicular activity was 7 hours 37 minutes with 77 pounds of samples gathered.

The third extravehicular activity began at 160:53. Specific sampling objectives were accomplished at stations 6 and 7 among some 3- to 4-meter-diameter boulders. Again, seven traverse gravimeter measurements were made. The surface electrical properties experiment was terminated because the receiver temperature was approaching the point of affecting the data tape; therefore, the tape was removed at station 9.

At the completion of the traverse, the crew selected a breccia rock, symbolic of the cohesiveness yet individuality of mankind, and dedicated pieces of the rock to nations represented by students visiting the Manned Spacecraft Center. A plaque on the landing gear of the lunar module commemorating the last Apollo landing was then unveiled.

The crew entered and repressurized the spacecraft after 7 hours and 15 minutes of lunar surface activity. Samples amounting to about 155 pounds were obtained on the third extravehicular activity for a grand total of 257 pounds for the mission. The total distance traveled with the rover during the three extravehicular activities was about 33 kilometers.

In addition to the panoramic camera, the mapping camera, and the laser altimeter carried on previous missions, three new scientific instrument module experiments rounded out the Apollo 17 complement of orbital science equipment. An ultraviolet spectrometer measured lunar atmospheric density and composition, an infrared radiometer mapped the thermal characteristics of the moon, and a lunar sounder acquired data on subsurface structure.

Lunar ascent was initiated at 185:21:37 and was followed by a normal rendezvous and docking. After transferring samples and equipment from the ascent stage to the command module, the ascent stage was jettisoned for the deorbit firing and lunar impact. The preliminary coordinates of the ascent stage impact are 19.963 degrees north and 30.501 degrees east, about 0.7 mile from the planned target.

Transearth injection was initiated at about 234 hours with a 144.9-second firing of the service propulsion system. A 1 hour and 6 minute transearth extravehicular activity was conducted by the Command Module Pilot. The film cassettes were retrieved from the scientific instrument module cameras and lunar sounder and the scientific equipment bay was visually inspected.

Entry and landing were normal. The spacecraft landed at 0 degrees 43 minutes 12 seconds south latitude and 156 degrees 12 minutes 36 seconds west longitude, as determined by the onboard computer. Total time for the Apollo 17 mission was 301 hours, 51 minutes, and 59 seconds.

TRAJECTORY

Lift-off occurred at 5:33:00 G.m.t. (12:33:00 a.m., e.s.t.) on December 7, 1972, from launch complex 39. The launch countdown had proceeded smoothly until T minus 30 seconds, at which time a failure in the automatic countdown sequencer occurred which resulted in a delay of the launch by 2 hours and 40 minutes. As a result, the launch azimuth was adjusted to 90 degrees 30 minutes and 14 seconds. An earth parking orbit of 92.5 miles by 91.2 miles was achieved. The vehicle remained in earth orbit for approximately 3 hours before a 351-second translunar injection maneuver was initiated. The resultant velocity was such that the spacecraft would reach lunar orbit at the time specified in the flight plan. This was done so that the sun angle for lunar landing would be at the same elevation as planned. A clock update was made at 65 hours to match the flight plan timeline. The sequence of events and a summary of the maneuvers performed on the mission are given in tables I and II.

The spacecraft was separated from the S-IVB after the transposition, docking, and lunar module ejection sequence. An evasive maneuver was performed and the S-IVB was targeted for the moon. Impact occurred at 4 degrees 12 minutes south and 12 degrees 18 minutes west, about 84 miles from the planned target point. During translunar coast of the spacecraft, a midcourse correction was made at the second option point.

The spacecraft initiated the lunar orbit insertion maneuver at 86:14:23 and entered into a 170-mile by 52.6-mile orbit. About 4 1/2 hours later, the first descent orbit insertion maneuver lowered the orbit to 59 by 14.5 miles. The command and service module and lunar module stayed in this orbit nearly 24 hours before undocking and separating. After undocking, the lunar module lowered its orbit to 59.6 miles by 6.2 miles by performing the second descent orbit insertion. From this orbit, the lunar module initiated its powered descent at 110:09:53 and landed at 20 degrees 9 minutes 41 seconds north latitude, 30 degrees 45 minutes 25.9 seconds east longitude at 110:21:57. The landing point was within 200 meters of the preferred landing point as shown in figure 1.

The command and service module performed a circularization maneuver on the revolution after separation and before the second descent orbit insertion maneuver. The resultant 70-mile by 54-mile orbit did not decay as much as predicted. Consequently, a small (9.2 ft/sec) orbital trim maneuver was performed about 70 hours later to lower the orbit.

In preparation for rendezvous, the command and service module performed a plane change maneuver to properly orient its orbit with the lunar module. This maneuver was a combination of an inclination change (3.2°) and a nodal shift (6.1°).

The lunar module ascended from the moon at 185:21:37. The ascent maneuver was about 3 seconds longer than planned because of the lunar module's weight. The firing also had a small (7 ft/sec) out-of-plane component. A vernier orbit adjustment of 10 ft/sec was initiated at 185:32:12 to correct these small orbital anomalies. The two spacecraft docked at 187:37:15.

When the lunar module was jettisoned at 191:18:31, the separation velocity of the lunar module was less than had been planned. After jettison, the command and service module performed a separation maneuver of 2 ft/sec.

The lunar module deorbit firing began at 192:58:14 with impact occurring at 193:17:21. Preliminary data places the impact point at 19.963 degrees north and 30.501 degrees east, which is 0.7 mile from the prelaunch target.

The command and service module transearth injection was initiated at 234:02:09. Only one midcourse correction was required during the transearth phase to correct the trajectory. This maneuver was initiated at 298:38:01.

The command module separated from the service module 15 minutes prior to entry interface (400 000 feet) at 301:23:49. Entry occurred at 301:38:38 with the command module landing at 301:51:59 at a latitude of 17.88 degrees south and a longitude of 166.11 degrees west as read from the onboard computer.

TABLE I.- SEQUENCE OF EVENTS

Events	Elapsed time Hr:min:sec
Lift-off (Range zero = 342:05:33:00 G.m.t.)	00:00:00.6
Earth orbit insertion	00:11:53
Translunar injection maneuver	03:12:37
S-IVB/command and service module separation	03:42:29
Translunar docking	03:56:45
Spacecraft ejection	04:45:00
First midcourse correction	35:30:00
Scientific instrument module door jettison	81:32:40
Lunar orbit insertion	86:14:23
S-IVB lunar impact	86:59:43
Descent orbit insertion	90:31:37
Lunar module undocking and separation	107:47:56
Circularization maneuver	109:17:29
Lunar module descent orbit insertion	109:22:42
Powered descent initiation	110:09:53
Lunar landing	110:21:57
Start first extravehicular activity	114:21:49
Apollo lunar surface experiment package first data	117:21:00
End first extravehicular activity	121:33:42
Start second extravehicular activity	137:55:06
End second extravehicular activity	145:32:02
Start third extravehicular activity	160:52:48
End third extravehicular activity	168:07:56
Orbital trim maneuver	178:54:02
Plane change	179:53:54
Lunar ascent	185:21:37
Lunar module vernier adjustment maneuver	185:32:12
Terminal phase initiation	186:15:58
Docking	187:37:15
Lunar module jettison	191:18:31
Separation maneuver	191:23:31
Lunar module deorbit firing	192:58:14
Lunar module impact	193:17:21
Transearth injection	234:02:09
Start transearth extravehicular activity	254:54:40
End transearth extravehicular activity	256:00:24
Second midcourse correction	298:38:01
Command module/service module separation	301:23:49
Entry interface (400 000 feet)	301:38:38
Begin blackout	301:38:55
End blackout	301:42:15
Drogue deployment	301:46:18
Landing	301:51:59

TABLE II.- MANEUVER SUMMARY

Maneuver	System	Firing time, sec	Velocity change, ft/sec	Resultant orbit	
				Apocynthion, miles	Pericynthion, miles
Translunar injection	S-IVB	351	10 376		
First midcourse correction	Service propulsion	1.6	10.5		
Lunar orbit insertion	Service propulsion	393.2	2988	170	52.6
First descent orbit insertion	Service propulsion	22.1	197	59	14.5
Command and service module separation	CSM reaction control	3.4	1.0	61.5	11.5
Lunar orbit circularization	Service propulsion	3.7	70.5	70	54
Second descent orbit insertion	LM reaction control	21.5	7.5	59.6	6.2
Powered descent initiation	Descent propulsion	727	6698		
Orbital adjustment	CSM reaction control	30	9.2	67.3	62.5
Lunar orbital plane change	Service propulsion	20.1	366	62.8	62.5
Ascent	Ascent propulsion	444	6075.7	48.5	9.1
Vernier adjustment maneuver	LM reaction control	10	10	48.5	9.4
Terminal phase initiation	Ascent propulsion	3.2	53.8	64.7	48.5
Separation maneuver	CSM reaction control	12	2	63.9	61.2
Lunar deorbit	LM reaction control	116	286		
Transearth injection	Service propulsion	144	3046.3		
Second midcourse correction	CSM reaction control	9	2.1		

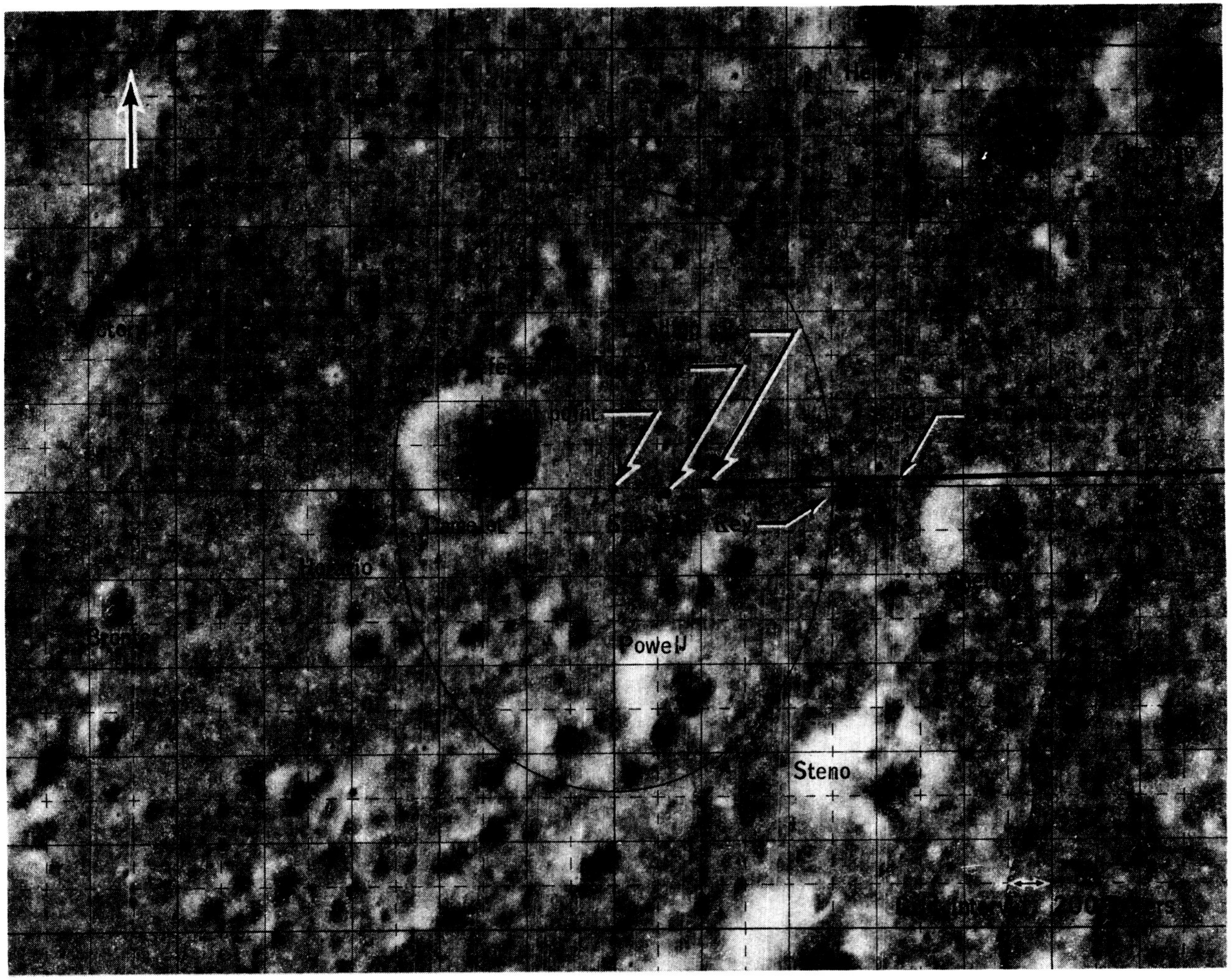

Figure 1.- Preliminary landing location.

EXTRAVEHICULAR ACTIVITIES

There were four periods of extravehicular activities on Apollo 17 with an accumulated time of about 23 hours and 10 minutes. Three periods were on the lunar surface (see fig. 2) and the fourth was during the trans-earth phase of the mission.

FIRST LUNAR SURFACE EXTRAVEHICULAR ACTIVITY

The first extravehicular activity began at 114:22 with a planned duration of 7 hours. The Commander's egress was at 114:28 with the Lunar Module Pilot egressing about 6 minutes later. Lunar roving vehicle off-loading and equipment unstowage proceeded normally, as did geology and experiment pallet configuration, rover loadup, and lunar surface experiment package unloading and fueling. Television coverage began after the ground-commanded television camera and high gain antenna had been installed on the rover. The first pictures were received 1 hour and 16 minutes into the extravehicular activity. The American flag and the cosmic ray experiment were deployed before leaving for the Apollo lunar surface experiment package site.

The Lunar Module Pilot carried the lunar surface experiment package to a site approximately 155 meters west-northwest of the lunar module. The Commander drove to the experiment package site and parked the rover between the selected heat flow experiment deployment position and the intended deep core sample location for optimum television coverage. The rover was pointed up-sun for optimum battery cooling, and the battery covers were opened. Lunar surface experiment package deployment, deep core drilling, and neutron flux probe emplacement were normal with no major hardware problems experienced, although more time was consumed than planned because of central station and antenna gimbal leveling problems, and a deep core that was difficult to extract. After properly documenting the lunar seismic profile experiment geophones and taking stereo panoramic pictures at the central station, the balance of the lunar surface experiment package photographs were postponed until the end of the third extravehicular activity. The Lunar Module Pilot then returned the three deep core sections to the lunar module and retrieved the surface electrical properties transmitter.

Due to the timeline deficit following the lunar surface experiment package deployment, station 1 was relocated to the rim of Steno crater in lieu of the premission station 1 at Emory crater, and the time reduced to 30 minutes. Some difficulty in visual navigation resulted in the crew's coming up about 200 meters short of their revised station 1 objective. The one-pound explosive package (6) was deployed at this point.

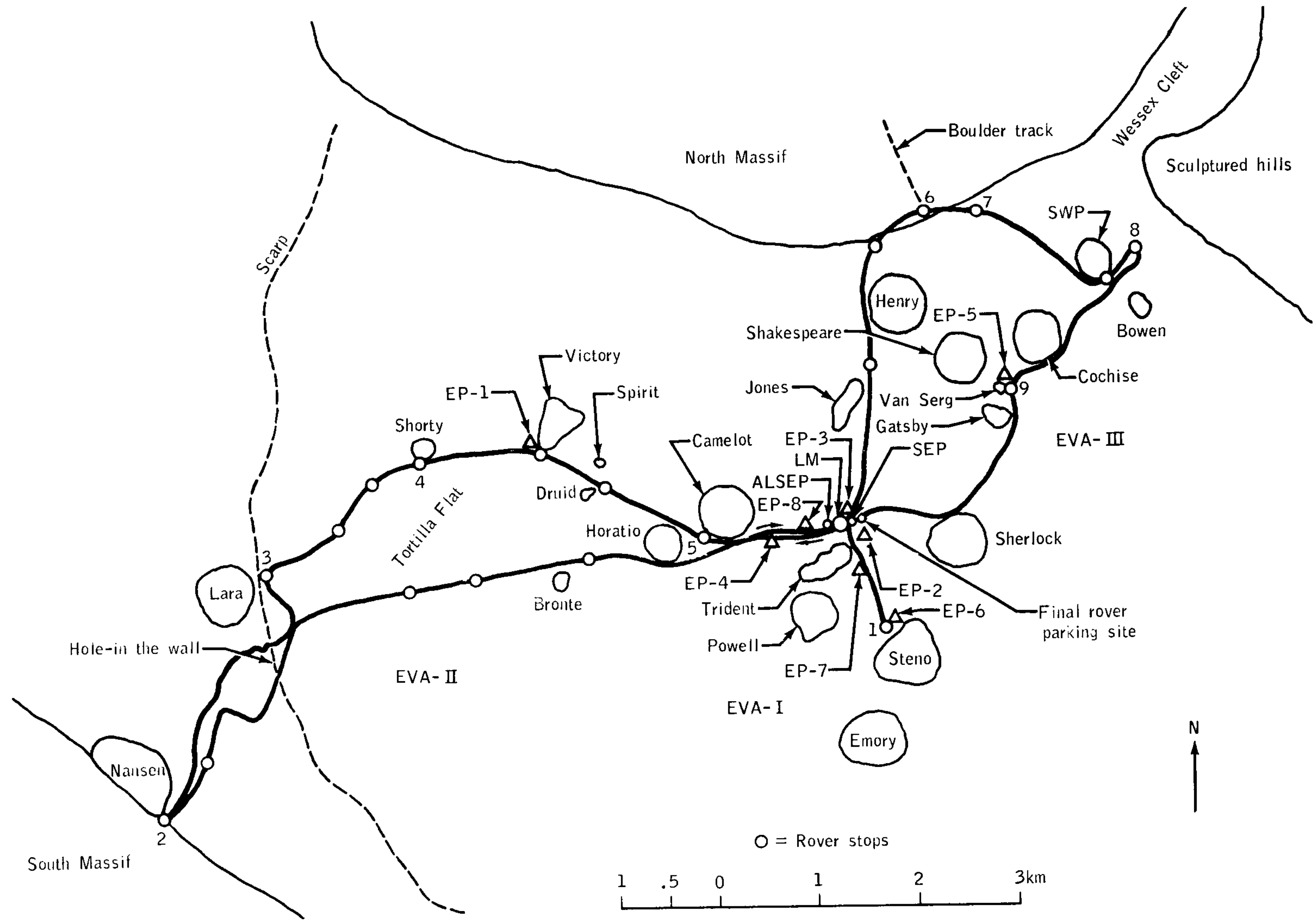

Figure 2.- Extravehicular activity traverses.

Two geologic units were sampled during the first extravehicular activity: a fine-grained unconsolidated surficial material (dark mantle unit); and a coarser blocky material that presumably represents at least the uppcr part of the subfloor materials. The one-half pound explosive package (7) was deployed enroute to the lunar module from station 1. The rover's right rear fender extension, previously knocked off and taped in place, fell off and was lost, thus resulting in a spray of dust inundating the crew and equipment. The surface electrical properties receiver temperature was normal at closeout. A total of six gravity measurements and one bias measurement were taken.

The extravehicular activity was terminated at 121:34 after 7 hours and 12 minutes. The weight of the samples collected on the first extravehicular activity was 25 pounds.

SECOND LUNAR SURFACE EXTRAVEHICULAR ACTIVITY

The second extravehicular activity began at 137:55 for a planned duration of 7 hours. Prior to depressurization, the Commander and Lunar Module Pilot had constructed a right rear rover fender extension using four sheets of chronopaque maps from the flight data file, gray tape, and two clamps for the cabin utility lights. This was installed and worked well for the ramainder of the mission. The temperature of the surface electrical properties receiver began at 80° F and climbed to 112° F during the course of the second extravehicular activity, but then dropped to 108° F during the last half hour of the extravehicular activity.

The second extravehicular activity timeline had been revised to add time at the beginning for repairing the fender, allow time during closeout for the Lunar Module Pilot to reposition the lunar surface gravimeter at the lunar surface experiment package site, and to leave more time for the crewman to clean the extravehicular mobility unit.

The traverse was conducted with real-time modifications to station stop times as a result of geologic interests. At station 4, the crew discovered the first evidence, in the form of orange soil, of volcanic activity on the lunar surface. Five surface samples and a double core sample, the lower tube of which was preserved in the core sample vacuum container, were taken at this site. In addition to visiting all the planned station sites, explosive packages 4, 1, and 8 were deployed. Seven traverse gravimeter gravity measurements were taken during the second extravehicular activity, one each at stations 2, 3, 4 and 5, one between stations 2 and 3, and two at the lunar module landing site.

In order to preserve any volatiles that may exist in the volcanic-type samples and to maximize the contents of sample return container 2, the two double core samples (including the core sample vacuum container) were placed in the sample return container and all samples from the Lunar Module Pilot's sample collection bag were placed in sample return container 2. The remaining volume was filled from the Commander's sample collection bag. The total closeout activity, including the Lunar Module Pilot's visit back to the lunar surface experiment package site took approximately 97 minutes, resulting in a total extravehicular activity time of 7 hours 37 minutes. Seventy-seven pounds of samples were gathered on the second extravehicular activity.

THIRD LUNAR SURFACE EXTRAVEHICULAR ACTIVITY

The third extravehicular activity began at 160:53, for a planned duration of 7 hours. Replanning between the second and third extravehicular activities concentrated on obtaining an extra 20 minutes for closeout to accomodate finishing the lunar surface experiment package site photographs which were omitted on the first extravehicular activity, trying some fixes on the ailing lunar surface gravimeter, and extra time needed for cleaning the extravehicular mobility unit. Times at stations 6 and 7 were reduced by 10 minutes each to make up for the lengthened closeout.

The crew spent 72 minutes at station 6 on a very steep incline (approximately 15°) which necessitated taking the traverse gravimeter experiment off the rover for leveling and a measurement. In addition, the surface electrical properties receiver was turned off in an attempt to achieve sufficient cooldown for tape recorder safety and the rover battery covers were opened. The specific objectives for boulder sampling were accomplished at stations 6 and 7 among some 3- to 4-meter-diameter boulders. At stations 8 and 9, a traverse gravimeter measurement was taken on the rover and on the lunar surface. At the lunar module, an additional traverse gravimeter "bias" mode measurement was made.

The surface electrical properties receiver temperature continued to approach the point where damage to the data tape could occur. Therefore, the crew removed the tape recorder at station 9.

Explosive package 5 was deployed at station 9, when it became apparent that insufficient time remained for a visit to station 10. This charge was originally planned for deployment at station 1.

Polarimetry photographs were omitted and a double core sample scheduled for station 10 was also omitted. The rover's aft pallet swung open on the drive back to the lunar module, resulting in the loss of both the scoop and rake with the extension handles attached. After unloading the rover, the crew paid tribute to the aerospace team and the objectives of the Apollo Program, picked up a breccia rock symbolic of the cohesiveness, yet individuality of mankind, and dedicated pieces of the rock to nations represented by a group of students visiting the Manned Spacecraft Center at the time. Then a plaque commemorating the last Apollo landing was unveiled.

The crew then separated, the Commander to reposition the rover and the Lunar Module Pilot to recover the neutron flux experiment at the lunar surface experiment site. The Lunar Module Pilot took only the essential lunar surface experiment package photographs, employed several different methods of shaking the lunar surface gravimeter in an unsuccessful attempt to make it operational, and removed the neutron flux experiment from the core sample hole.

The Commander placed the rover at the final parking position not far from the surface electrical properties experiment transmitter. The communication television system and the rover batteries were dusted, and the lunar communications relay unit was left powered by the rover batteries. The last explosive package (3) was deployed at the west end of the surface electrical properties transmitter antenna, as planned, and the surface electrical properties transmitter was turned off.

The crew completed sample transfers to the ascent stage, and ingressed the spacecraft at 168:08 accumulating an extravehicular activity time of 7 hours and 15 minutes. One-hundred fifty-five pounds of samples were obtained on the third extravehicular activity for a grand total of 257 pounds for the mission.

TRANSEARTH EXTRAVEHICULAR ACTIVITY

All objectives of the transearth extravehicular activity were accomplished with the successful retrieval of the lunar sounder, panoramic camera, and mapping camera cassettes.

Cabin preparations for the Apollo command module extravehicular activity started at 250:32. The cabin and equipment preparations and systems operations were performed with only one minor equipment problem (see command and service module performance section). The cabin was depressurized and the Command Module Pilot egressed at 255:01 to begin the televised extravehicular activity. The experiment equipment bay was inspected during the extravehicular activity and found to be in good condition. The film cassettes from the lunar sounder, the panoramic camera, and the mapping camera were successfully retrieved by the Comand Module Pilot during the extravehicular activity that lasted 1 hour and 6 minutes. The cabin repressurization was accomplished and the crew performed the post-extravehicular activity cabin equipment reconfiguration and stowage operations.

LUNAR SURFACE SCIENCE

The Apollo lunar surface experiments package consists of a radioisotope thermoelectric generator power source, five scientific experiments, and a central station. Figure 3 shows the arrangement of the experiments on the lunar surface. Other lunar surface experiments include, lunar neutron probe, traverse gravimeter, surface electrical properties, cosmic ray, soil mechanics, and geological investigation.

The lunar surface experiments package and associated equipment were deployed on the lunar surface during the first extravehicular activity. The deployment site is gently rolling with shallow craters and a very fine grained dark mantle. With the exception of the lunar surface gravimeter, the activated experiments are operating satisfactorily. Efforts to null the mass suspension of the lunar surface gravimeter in the proper operating location have been unsuccessful.

CENTRAL STATION

The central station was deployed about 155 meters west-northwest of the lunar module (at a bearing of 290 degrees from the lunar module). The power output of the radioisotope thermoelectric generator stabilized at 75.44 watts, about 2 watts higher than any other Apollo lunar science experiments package. The downlink signal strength, varying from -137 dBm to -138 dBm, depending upon the receiving site, is slightly higher than nominal. Sinusoidal fluctuations up to ±1.5 dBm which have appeared in the downlink signal are within the allowable limits of the system and cause no loss of data.

HEAT FLOW EXPERIMENT

The lunar heat flow experiment was deployed. Each borestem required about 4 minutes of drilling to penetrate 2.4 meters into the regolith. The probes and electronics box were positioned as planned relative to the lunar surface experiments package central station. The heat flow electronics box is 8 to 9 meters north of the central station, probe 1 is 5 to 6 meters east of the electronics box and probe 2 is 5 to 6 meters west-northwest of the electronics box. The tops of both probes are at 1.3 meters and extend to 2.3 meters below the surface.

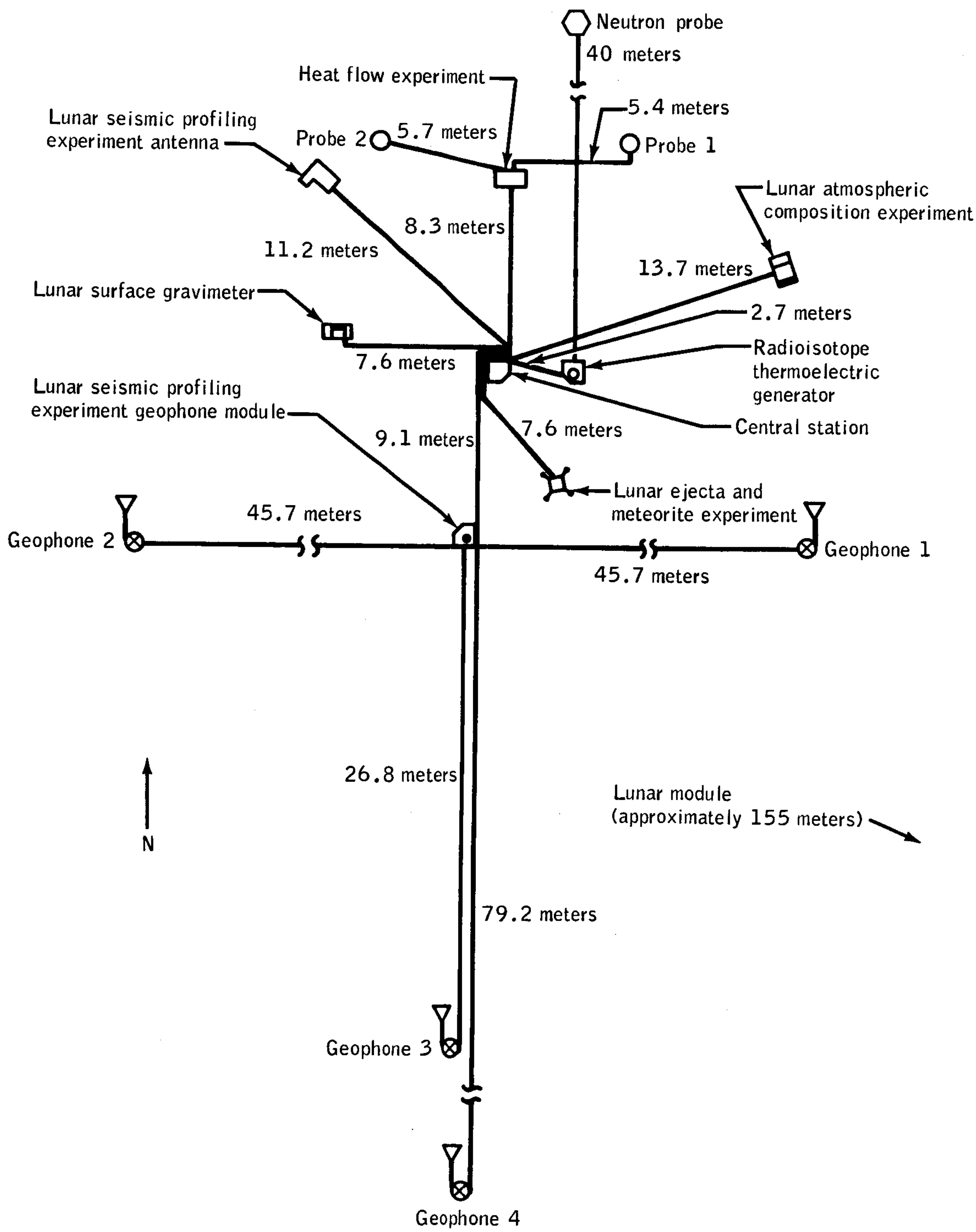

Figure 3.- Apollo lunar surface experiments package deployment.

The experiment was turned on at 117:30. Valid temperature data are being received from all sensors. At emplacement, the probe temperature was about 300° K. In the subsequent 3 days, temperatures have cooled to between 225° and 257° K as they continue to stabilize with the surrounding lunar soil.

LUNAR SEISMIC PROFILING EXPERIMENT

The lunar seismic profiling experiment was deployed in the proper configuration at the Apollo 17 site. Seismic signals were recorded on the geophone array from the thrust of the lunar module ascent engine and the lunar module impact approximately 9 kilometers southwest of the landing site. The eight explosive charges shown in figure 2 were detonated at the scheduled times. All four geophones responded to the energy produced by each charge. Dust from the detonation of the second charge was viewed on television.

LUNAR SURFACE GRAVIMETER

The lunar surface gravimeter was deployed and turned on. The sensor beam would not adjust from the upper stop; however, motion of the instrument was detected. During the second extravehicular activity period, the level and sunshade tilt were rechecked. On the third extravehicular period, the crew rapped, rocked, repositioned, and releveled the gravimeter, but no significant changes in the performance resulted.

Analysis is being made to gain an understanding of the failure. The gravimeter does appear to be working as a seismometer. Further study of its characteristics will be required to determine its usefulness.

LUNAR ATMOSPHERIC COMPOSITION EXPERIMENT

The lunar atmospheric composition experiment was deployed approximately 14 meters east of the central station. The instrument was commanded on for a low voltage circuit check at 118:56. The mirror covers were removed at 262:47 and the 9-hour bakeout sequence was initiated at 274:56. Application of high-voltage awaits lunar sunset (December 25), when both the analyzer and the site have had time to outgas.

LUNAR EJECTA AND METEORITES

The lunar ejecta and meteorites instrument was turned on for 2 hours and responded properly to calibrate commands. An early ground station data printout problem based on an improper frame synchronization was corrected.

SURFACE ELECTRICAL PROPERTIES EXPERIMENT

The surface electrical properties experiment transmitter and antenna were deployed nominally approximately 100 meters east of the lunar module. Temperature problems with the experiment receiver unit caused some operational limitation and a slight degradation of the data is possible. Indications are that good data were obtained along the traverse from the transmitter antenna site to station 2 during the second extravehicular activity period and from the transmitter antenna site to station 6 during the third extravehicular activity period.

A 16-megahertz transmission from this experiment was received for about 80 seconds by the lunar sounder experiment aboard the orbiting command and service module. The strength of the signal received was within predicted values.

LUNAR NEUTRON PROBE EXPERIMENT

The deployment of the lunar neutron probe experiment on the lunar surface was normal. The deep core site appears to be about 40 meters from the radioisotope thermoelectric generator. Some shielding was provided by a boulder between the core site and the generator and by a small depression in which the core hole was drilled.

TRAVERSE GRAVIMETER EXPERIMENT

The traverse gravimeter observations were successful. The earth-moon gravity transfer indicates a value of 162 694 ±5 milligals at the landing site in Taurus Littrow. This value will be used to obtain a revised value for the radius of the moon at this landing site. Seven gravity measurements were made on each of three extravehicular traverses for a total of twenty-one. A bias measurement was made during the first and last extravehicular periods.

The gravity measurements made show a large negative anomaly of about -38 milligals at the base of the South Massif (station 2) and a similar negative anomaly of about -25 milligals at the base of the North Massiff (stations 6 and 8). Preliminary conclusions of the gravity measurements indicate that the material under the floor of Taurus Littrow is much denser than that of the North and South Massifs.

The traverse gravimeter functioned perfectly through all traverses. The temperature control was better than 0.005° K through all extravehicular activity. The bias gravity readings agreed well with a total mission drift of about 2 milligals.

COSMIC RAY DETECTOR (SHEETS)

The cosmic ray detector experiment was deployed at approximately 115:57 and was retrieved at the beginning of the third extravehicular activity at approximately 162:22. The experiment was terminated earlier than planned because of an apparent increase in the flux of low-energy particles thought to be caused by an interplanetary sector boundary in the earth-moon region. Since the experiment had been completely successful, the experiment was terminated with a slight loss of statistical data rather than risk the chance of losing the data already acquired.

LUNAR GEOLOGY INVESTIGATION

The traverse region (fig. 2) was hummocky and pocked with craters. The fine-grained unconsolidated dark mantle is between 5 and 10 meters thick east of the light mantle and thins to the north as the North Massif is approached. It partly covers even the youngest crater materials (Van Serg).

The subfloor basalts (gabbro) retain their distinctive textural characteristics over the entire traverse area, but represent more than one unit. A tan-gray, coarsely vesicular basalt is the most common type and it appers to be overlain in the northern traverse region (Henry Crater) by a darker gray, non-vesicular basalt.

North Massif material consists of breccias similar to those of the South Massif. Blue-gray and tan-gray types are present. On both massifs, aligned block concentrations suggest layers.

The breccias sampled and described at station 2 are mostly of the blue-gray type with a fine-grained matrix enclosing 10 percent or more clasts of fine-grained crystalline rock; dark, very fine-grained dense rock; and blocks, to 1/2 meters in size, of porphyritic feldspathic gabbro. The dark matrix breccia apparently gives way within a single boulder to breccia with dark clasts in a white matrix. This indicates more than one episode of brecciation. Many blocks in or near the crater Nansen have tracks leading to the blue-gray outcrops.

Boulders encountered at station 6 and 7 include a vesicular "anorthositic gabbro" which contained small clasts of white rock and small to very large inclusions of recrystallized blue-gray breccia. The blue-gray breccia was, for the most part, non-vesicular and itself encloses and veins subrounded finely crystalline white clasts up to 1 meter across. One boulder was foliated as shown by flattened vesicles. Other smaller rocks include tan "anorthositic gabbro" and the blue-gray, finely recrystallized breccia. These may prove to correspond to the principal rock types found also at South Massif and distinguished there by similar colors.

The Sculptured Hills unit, where visited, had few boulders. All of those examined on the lower slopes at station 8 are thought to be subfloor basalts. A larger boulder much higher on the slope proved to be coarsely crystalline, and consisted of about equal amounts of plagioclase and a light yellow mineral. This boulder was glass coated, and may or may not be indigenous Sculptured Hills material. A very friable white fragment was collected from a small crater at station 8. Considering the general absence of boulders and the morphologic characteristics of the Sculptured Hills, the friable rock and soil samples are perhaps more likely to be representative of the Sculptured Hills unit than the one boulder sampled.

The light mantle apparently is composed of the same types of breccia as South Massif, but contains a high proportion of unconsolidated fine debris. No change in surface characteristics or lithology of the mantle was observed where the crew traversed the scarp.

Small craters (1 meter size) in the dark mantle have glass-coated pits. Slightly larger bright-haloed craters, that are not blocky with fragments derived from the subfloor, have abundant "instant rock" clods on their rims.

The rocks sampled on the dark-haloed crater Shorty resemble those of the subfloor. Bright orange and red bands on the south rim and extending from the crater interior upward to the west rim resemble alteration haloes which occur around many terrestrial volcanic vents.

More than 2100 photographs were taken on the lunar surface and approximately 115 kilograms of samples (net weight) were collected of materials representing the dark mantle, light mantle, subfloor, North and South Massifs, and Sculptured Hills. Samples were as follows:

	First Extravehicular Activity	Second Extravehicular Activity	Third Extravehicular Activity
Loose rocks	3	1	7
Bagged rocks	7	30	31
Rake fragments (bags)	2	2	2
Soil	5	23	19
Drive tubes	0	4*	4**

*Two double cores, bottom tube from station 3 in the core sample vacuum container.

**Two single cores, 1 double.

Special samples include a soil from an east-west split; top and bottom chips of a boulder; soil from beneath the boulder; and a skim soil from the top of a boulder.

SOIL MECHANICS

Little dust was generated during the final phase of the lunar module descent. Surface texture, dust generation, cohesiveness, and average footprint depths as observed from television coverage indicate soil properties at the surface comparable to those at other Apollo sites. Detection of any differences at greater depths must await detailed analysis of returned core samples and photographs.

The lunar drill core hole remained open for insertion of the neutron flux probe. Resistances to drilling and core tube driving were within previously established ranges and indicated no unusual mechanical properties. Variations in drilling and core tube driving resistance indicate considerable local variability in mechanical properties as has been observed at previous landing sites.

ORBITAL SCIENCE

Orbital science activities were performed during translunar flight, lunar orbit, and transearth flight. The equipment for these activities was located in the scientific instrument module and in the command module.

LASER ALTIMETER

The laser altimeter performed well throughout the mission. As a result, 10 additional hours of data were obtained by operating the altimeter throughout the sleep period that commenced at 217:50. The laser fired approximately 4140 times as compared to the mission requirement of 2308. The laser altimeter was operated according to the flight plan except on revolution 62 when the altimeter was turned off about 38 minutes to allow an attitude maneuver for the ultraviolet spectrometer.

MAPPING CAMERA

The mapping camera performed normally with vertical photography being obtained during twelve lunar revolutions and after transearth injection. Oblique photography was obtained during four revolutions. All planned metric photography was obtained except 15 minutes of north oblique photographs on revolution 65. This loss occurred because the proper go - no go indication was not obtained when the camera was activated while on the back side.

The second camera deployment was slower than expected. To circumvent the possibility of a mechanical failure, the camera was left in the deployed position between several photographic passes and the revolution 49 deployment was deleted.

PANORAMIC CAMERA

The panoramic camera operated satisfactorily except for an 8-minute period at the end of the planned coverage. Panoramic photography was obtained on 8 revolutions and after transearth injection. Camera operations began during revolutions 1 and 2 with the velocity/altitude sensor manually overridden in accordance with the flight plan. Subsequent operation in revolutions 13 and 14 was performed with the sensor in the automatic mode. Subsequent indications of erratic operation of the sensor prompted switching back to the manual mode for the remainder of the mission.

About 8 minutes prior to completion of the final photographic pass in lunar orbit, the stereo drive motor failed. The effect was loss of stereo photography and some degradation of the resultant monographic photography.

INFRARED SCANNING RADIOMETER

The infrared scanning radiometer operated normally throughout the mission and attained all objectives. In nearly 100 hours of operation, the infrared scanning radiometer measured the full range of lunar temperatures (80° K to 400° K) to an accuracy of one degree.

Real-time data samples of approximately 2 percent of the total data show that several thousand night-time thermal anomalies have been detected. Night-time hot spots are generally associated with boulder fields or exposed bedrock near fresh impact features. Cold spots indicate the existence of areas covered by material with exceptionally low values of density and thermal conductivity.

Compared with observations using large earth-based telescopes, the infrared scanning radiometer results are more sensitive and of a higher accuracy. They have yielded spatial, thermal, and temporal resolutions vastly greater than can be obtained by other methods.

ULTRAVIOLET SPECTROMETER

The ultraviolet spectrometer performance was normal throughout the lunar orbit period and during transearth coast. All planned observations were accomplished including lunar atmospheric composition and density, lunar ultraviolet albedo, solar system Lyman-alpha (1216 angstroms), ultraviolet zodiacal light, earth ultraviolet spectra, and ultraviolet spectra of several stars and extragalactic sources.

Unexpectedly high background counts were observed: 22 counts/sec in lunar orbit, and 27 counts/sec in deep space and at five earth radii. The background count did not degrade the accuracy with which Lyman-alpha could be measured, but did reduce the instrument's sensitivity to weak obscure ultraviolet sources. For example, the preflight-predicted minimum level of detection for atomic oxygen was about 25 atoms/cc; whereas, the background count increased this limit to 100 atoms/cc at the surface.

Approximately 18 hours prior to completion of instrument operation, both internal (motor and electronics) temperature measurements failed, but had no effect on the science data.

S-BAND TRANSPONDER

Useful data were obtained of the prime areas from tracking of the command and service module and the lunar module. The prime areas were Mare Serenitatis, Mare Crisium, and the Taurus-Littrow site. The data, taken on eight revolutions at low altitude will enhance results obtained from the Apollo 15 spacecraft and subsatellite.

LUNAR SOUNDER

The degree to which objectives were met in active sounding will be determined from the video signals recorded on film. However, the average return power along the ground track profile was telemetered and correlates very well with the lunar features. For example, the highlands show a low-frequency structure and the data are well correlated with surface topography. The mare show a high-frequency characteristic in the data which is consistent with the presence of subsurface structure. The amplitude of this structure is highest in the 5-megahertz band and lowest in the VHF band, which is also consistent with the presence of subsurface structure.

In the passive mode, the front side of the moon exhibited a much higher noise level than expected in the 15 megahertz band. The absence of this on the lunar back side, as well as a correlation of antenna orientation with noise level, indicated that the noise is of terrestrial origin. The back side passive data is undergoing examination to establish whether it represents the true cosmic noise background.

The terrestrial noise was monitored during transearth coast to gain a better understanding of the noise sources as well as to calibrate the antenna patterns.

PHOTOGRAPHIC TASKS AND EQUIPMENT

Astronomical Photography

Solar corona photography in white light was scheduled twice in the mission. The first, accomplished according to plan on revolution 25, was a presunrise series consisting of seven data frames from 10 seconds to 1/60 second duration. The imaged corona extended eastward beyond the lunar limb as the sun moved from 3 1/2 degrees to 1/2 degree below the limb. The brightness of the portion of corona just above the limb increased three orders of magnitude during the 65 seconds over which these data frames were made. The Command Module Pilot used the 70-mm electric camera with 80-mm lens set at f/2.8 for this work. The film type for this task, as well as for all of the other astronomical tasks, was type 2485, very-high-speed, black-and-white, recording emulsion.

The second series of solar corona photographs, to be run in reverse order just after sunset, could not be carried out because of lengthened sleep periods and the improper attitude required for its performance.

The other phenomenon scheduled to be photographed on this mission was the zodiacal light from 50 degrees eastward of the sun, down to the solar corona region mentioned previously. This photography was carried out very successfully three separate times; first, in red light on revolution 23 (approximately 600-700 miles), again in blue light on revolution 38 (approximately 420-520 miles), and finally in plane-polarized white light on revolution 49. Both color series occurred exactly on schedule. The Command Module Pilot noted that the second photography in red light, a planned 60-second exposure, was underexposed because of inadvertent, early shutter closure.

The zodiacal light series utilized the 35-mm camera with 55-mm lens set to f/1.2. All filters were situated immediately ahead of the objective lens.

Lunar Surface Photography

All objectives of the photography of the lunar surface from the command module were accomplished. To supplement scientific instrument module photography, ten photographic strips were taken with the 70-mm camera and color exterior film; five of the strips on the nearside and five on the farside.

Under near-terminator conditions, eight targets were photographed using the 70-mm camera and very-high-speed, black-and-white film. Two of the targets were on the far side, and the remaining six on the near side.

In addition to the scheduled photography, the crew took photographs of lunar surface features to document visual observations. The crew took photographs over the Apollo 17 landing site using the polaroid, red, and blue filters.

Visual Observation from Orbit

Visual observations from lunar orbit were successfully accomplished. The ten targets planned for visual study were observed and excellent comments were made by the crew. These comments will help solve geologic problems that are hard to solve by other means. Among the salient findings are the following:

1. Only relatively young craters on the far side are filled with mare material. Domes in the floor of the crater Aitken are probably extrusive calcite domes.

2. Orange-colored ejecta blankets of craters were spotted in Mare Crisium, in the landing site area and on Western Mare Serenitatis.

3. The actual colors of lunar surface units were characterized, especially in the lunar maria. This will help in the extrapolation of ground truth and remotely-sensed data.

4. The extensive nature of the rings of the basin Arabia were verified. The swirls in and west of the basin have no topographic expression associated with them.

5. Several volcanic craters were discovered under the ground tracks that had not been characterized previously.

All onboard items carried in support of this task were found to be adequate, including the 10X binoculars. The color wheel was not used because its colors did not correspond to the actual lunar colors.

MEDICAL EXPERIMENTS AND INFLIGHT DEMONSTRATIONS

BIOSTACK

The biostack experiment container was exposed to the space vacuum during the transearth extravehicular activity. The canister was retrieved after recovery for post-mission analysis.

BIOLOGICAL COSMIC RADIATION EXPERIMENT

The experiment container remained stowed in its designated location during the mission. This stowage position permitted it to be exposed to space vacuum during the transearth extravehicular activity. Four of the mice contained in the canister survived the mission. The mice are being subjected to further examination.

APOLLO LIGHT FLASH INVESTIGATION

The visual light flash investigation during translunar coast was completed. The test began at 65:35 and continued for 64 minutes. The Apollo light flash moving emulsion detector was worn by the Command Module Pilot during this test period. The Commander wore only the eye shield. The Lunar Module Pilot served as recorder for the events observed by the other crewmen. The events occurred at random intervals and a total of 28 events was reported. This total is significantly lower than the 70 events reported for this period on Apollo 16; however, the number of events is sufficient for a statistically reliable analysis.

The second observation period lasted 55 minutes and was executed during transearth coast beginning at 277:14. Both the Commander and Command Module Pilot wore eyeshields. No light flashes were observed during this observation period. No explanation is available at this time.

HEAT FLOW AND CONVECTION DEMONSTRATION

The Apollo 17 heat flow and convection demonstration obtained data on the types and amounts of convection that occur in the near weightless environment of space flight. Although normal convection is suppressed for the most part in near weightlessness, convective fluid flows can occur in space by mechanisms other than gravity, such as by surface tension and artificial accelerations.

The demonstration contained three independent test cells that detect convection either directly or through the measurement of heat flow rates in the fluids. The data were recorded by the onboard 16-mm data camera. The heat flow rates were visibly displayed through the use of temperature/color strips made from liquid crystals.

The radial and linear cell operation was reported to be normal and the flow-pattern cell demonstration was successfully performed. The liquid in the flow pattern cell was convex (thicker in the center of the cell), and the liquid contained an unexpected bubble in the center. Convection patterns were reported after a few minutes heating on both runs. A steady-state condition was reported after 7 minutes on the first run. The baffle configuration contained the fluid very well, representing a significant improvement over Apollo 14 performance.

HYPOTENSIVE PROTECTIVE GARMENT

The garment was donned by the Command Module Pilot before earth entry. The garment was pressurized just after landing and before standing up. The pressure was held at 130 mm Hg above ambient until the Command Module Pilot was under the care of a physician onboard the recovery ship.

COMMAND AND SERVICE MODULE PERFORMANCE

STRUCTURES AND MECHANICAL SYSTEMS

All of the Apollo 17 structures and mechanical systems performed satisfactorily. During the transposition docking sequence, docking ring latch switch 9 did not open as evidenced by a barberpole indication. Examination of the latch verified that the latch hook was properly engaged and subsequent manual actuation of the latch resulted in proper latching and switch operation. Also, the handles for latches 7 and 10 did not lock automatically, requiring manual engagement. Later in the mission, docking ring latch 4 was found in the half-cocked position. The latch was recocked and all latches operated normally for the lunar orbit docking.

Following command and service module/lunar module undocking, an extend/retract test was conducted for the lunar sounder HF antennas. The antennas were partially extended, then retracted but a retract indication was not received for antenna 1. The antennas were then fully extended in preparation for the lunar sounder experiments. Subsequent antenna retract verification was based on motor stall currents.

The crew reported both drogue parachutes to be functioning properly. Drogue parachute disconnect and pilot parachute mortar fire were reported at 11 000 feet by the crew. The command module was observed on television during the descent on the three main parachutes. All three main parachutes were retrieved.

COMMUNICATIONS

Performance of the communications equipment was normal except for a 2-minute dropout of several pulse code modulation telemetry channels which occurred at 191:40.

FUEL CELLS AND CRYOGENICS

The fuel cell and cryogenic system performance was acceptable throughout the flight. Prior to lift-off, the fuel cells were configured with fuel cells 1 and 2 on main bus A and fuel cell 3 on main bus B. Bus voltage was maintained between 27.3 and 29.7 volts. The fuel cells consumed 61 pounds of hydrogen and 484 pounds of oxygen while delivering 700 kilowatt-hours of energy and producing 545 pounds of potable water. Total oxygen consumed by fuel cells and for life support was 600 pounds. Hydrogen and oxygen usage were both within 3 percent of preflight estimate.

The automatic pressure switch operating deadband for the hydrogen-tank 2 heaters decreased early in the mission. Tank 2 heaters had been automatically switching on at 247 psia and off at 261 psia. Following the change, the pressure switch was actuating the heaters on at 249 psia and off at 252 psia. This condition continued for about 14 1/2 hours; therefore, a manual mode of operation was selected for the remainder of the mission. Tank fans were used for maintaining pressurization control of tank 2. Tank 1 was also operated in this mode because the pressure switches for both tanks 1 and 2 operate in series. Operation thereafter was normal throughout the mission.

ELECTRICAL POWER SYSTEM

The electrical power system performed satisfactorily. Entry batteries were maintained above the minimum capacity of 85 ampere hours throughout the mission. Entry batteries A and B were used with the fuel cells to supply the main bus requirements during launch and the service propulsion maneuvers. Preparatory to entry, batteries A and B were fully charged and batteries A, B, and C provided the command module with the total electrical power requirements from service module separation through recovery. Pyrotechnic batteries A and B performed all required functions.

SERVICE PROPULSION SYSTEM

The service propulsion system was fired six times for a total firing duration of 584 seconds. System performance was normal during all maneuvers. Propellant management was effected by the crew, resulting in an indicated propellant unbalance of 30 pounds at the end of the transearth injection maneuver. The propellant utilization valve was utilized in the DECREASE position during the lunar orbit plane change and the transearth injection firing. Propellants remaining after transearth injection were 2.8 percent of the oxidizer and 2.9 percent of the fuel.

REACTION CONTROL SYSTEM

The service module and command module reaction control systems performed normal during all phases of the mission. Propellant utilization was within predicted limits.

ENVIRONMENTAL CONTROL SYSTEM

The environmental control system performed satisfactorily throughout the mission, providing an acceptable environment for the crew and adequate temperature control of the spacecraft equipment. System performance during the transearth extravehicular activity of approximately one hour duration was also satisfactory.

During four early lunar-orbit revolutions, the water/glycol temperature control valve failed to open properly with decreasing radiator outlet temperature. The mixed coolant temperature momentarily fell as much as 4° F below the specification control band during mixing startup. Initiation of mixing was proper during all subsequent lunar orbits and during transearth coast.

The radiator flow proportioning valve automatically switched over to the backup system at about 274:28. The crew reset the system to the primary auto position about 4 hours later and operation was satisfactory.

CREW EQUIPMENT

All crew equipment functioned properly during the flight with the exception of one communication carrier. While donning the pressure garment assembly for the transearth coast extravehicular activity, the Command Module Pilot did not receive a low-pressure warning tone. The Command Module Pilot exchanged his communication carrier with the Lunar Module Pilot and received the tone during a subsequent check. Later, the Command Module Pilot removed the cover from his communication carrier and found two broken wires. For reentry, the Lunar Module Pilot used the electronic components of the lightweight headset secured to the communications carrier.

INSTRUMENTATION AND DISPLAYS

The instrumentation and displays performed satisfactorily during the mission. One measurement, the fuel interface pressure, fluctuated for a period of about 10 hours twice during the mission. The oscillations followed the lunar orbit insertion and the transearth injection firings.

Shortly after earth orbit insertion, on several occasions, spurious master alarms occurred. The nature of the alarms indicates a possible intermittent short circuit on panel 2.

Also, at 1:58, the mission timer in the lower equipment bay was noted to be 15 seconds slow. The timer was reset and it operated properly for the remainder of the mission.

GUIDANCE AND CONTROL

Performance of the primary guidance, navigation and control system and the stabilization control system was normal. No system abnormalities or procedural problems occurred during the mission.

The entry monitor system accelerometer bias varied excessively about the time of the second midcourse correction. Entry procedures were revised to assure starting the scroll at 0.05g.

LUNAR MODULE PERFORMANCE

THERMAL, STRUCTURES AND MECHANICAL SYSTEMS

Lunar module temperatures were maintained within acceptable limits. The only temperatures that exceeded preflight predictions were on the rendezvous radar and the S-band steerable antenna.

The lunar module velocities at touchdown were within the structural design limits. Postlanding, the vehicle was pitched up approximately 5.3 degrees and rolled left about 2.6 degrees. The crew reported that the descent rate at probe contact was 2 ft/sec. A visual examination indicated that there was some forward velocity at touchdown and that the minus Z primary landing gear strut had stroked.

COMMUNICATIONS

All functions of the communication system were acceptable during each phase of the mission. The S-band steerable antenna lost lock several times. Real-time telemetry displays indicated that each loss was caused by the antenna tracking into vehicle blockage or into gimbal limits. Acquisition was difficult when the vehicle came from behind the moon on the 12th and 13th lunar orbits. However, once automatic track was definitely established, the antenna performance was satisfactory for the remainder of each revolution.

Lunar module voice transmission to the command module was initially intermittent, during VHF activation on the fifth day of the mission. Shortly thereafter, however, satisfactory two-way voice communications were established and were normal for the remainder of the mission, as was lunar module/extravehicular activity voice and all data transmissions.

RADAR

Landing radar performance was normal during powered descent. Velocity acquisition was obtained at an estimated altitude of 42 000 feet, prior to changing the lunar module yaw attitude from 70 to 20 degrees. Range acquisition was obtained during the yaw maneuver, at an altitude of approximately 39 000 feet. Antenna position and range scale change occurred at the predicted time and tracking was continuous to lunar touchdown. There was no lock-up on moving dust or debris near the lunar surface.

The rendezvous radar performance was normal for all mission phases including self-test, rendezvous radar/transponder checkout, and rendezvous tracking.

ELECTRICAL POWER

The descent, ascent, and pyrotechnic battery performance was normal. The descent stage batteries delivered 1585 ampere-hours from a specification total capacity of 2075 ampere-hours. The ascent stage batteries had delivered 306 ampere-hours of a rated 592 ampere-hour capacity at lunar module jettisoning. The dc bus voltage was maintained above 28.8 volts and the maximum observed current was 71 amperes, which occurred during powered descent. Both inverters performed as expected.

DESCENT PROPULSION

Firing duration for the powered descent was 727 seconds. All parameters appeared normal during the firing. At touchdown, fuel tank 2 showed the least propellant remaining. After landing, the fuel residual was about 449 pounds and the oxidizer remaining was about 790 pounds. The estimated hover time from the remaining propellants was 120 seconds.

ASCENT PROPULSION

Normal ascent propulsion performance was observed during the ascent maneuver. The firing duration was approximately 444 seconds. At termination of the maneuver, the fuel residual was about 117 pounds and the oxidizer remaining was about 155 pounds.

REACTION CONTROL SYSTEM

Performance of the reaction control system was normal. Propellants consumed were 282 pounds compared to the predicted usage of 273 pounds.

ENVIRONMENTAL CONTROL SYSTEM

Performance of the environmental control system was satisfactory. The primary water sublimator started at activation and the rejected heat loads were within the anticipated range. All system components functioned normally except for a rise in pressure in the unmanned atmospheric revitalization section during preparation for the third extravehicular activity. Demand regulator A was placed in the closed position and the pressure rise stopped. Rather than perturbate the extravehicular activity or mission timeline, the regulator was not checked out and was left closed for the remainder of the lunar module operations.

Cabin leak rate was expected to be 0.025 pound/hour, from prelaunch data. Flight data indicates that the actual value was approximately 0.030 pound/hour. The cabin temperature was maintained between 60° and 80° F.

Predicted descent stage water usage was 359 pounds compared to the actual usage of approximately 399 pounds. All other consumables were within the predicted values.

INSTRUMENTATION AND DISPLAYS

All instrumentation and displays operated satisfactorily. A discrepancy was noted at acquisition of data on the twelfth lunar revolution. Battery 4 voltage had shifted approximately 1/2-volt down from a previous normal value of 30.5 volts.

GUIDANCE AND CONTROL SYSTEM

Both the primary guidance and navigation system and the abort guidance system provided satisfactory operation throughout the mission. Powered descent, braking phase termination and approach phase were accomplished as expected. Manual control of vehicle attitude and descent rate was initiated at an altitude of 250 feet.

Powered ascent and all direct rendezvous maneuvers were successfully targeted and executed. Resultant velocity residuals were within expected deviations. One inflight and two lunar surface abort guidance system calibrations were performed normally.

EXTRAVEHICULAR SYSTEMS PERFORMANCE

EXTRAVEHICULAR MOBILITY UNIT

First Extravehicular Activity

The Commander's and Lunar Module Pilot's suit integrity checks were acceptable, and the checkout of the portable life support system indicated normal performance. All extravehicular mobility unit systems performed normally throughout the extravehicular activity with no abnormal flags or warning tones. Crew comfort was maintained satisfactorily throughout the extravehicular activity, with the crewmen adjusting their diverter valves periodically to control cooling. Both crewmen received feed water warning tones for depletion of primary feed water and switched on auxiliary feed water.

Second Extravehicular Activity

All extravehicular mobility unit systems performed normally throughout the second extravehicular activity, including preparation and checkout activities. Because a questionable portable life support system water recharge was indicated, the Lunar Module Pilot's water tanks were topped off prior to the extravehicular preparations to insure that they were fully charged. Both crewmen used their cover gloves (provided for drilling operations) throughout the first two extravehicular activities and they became extremely worn. The crewmen removed and discarded their cover gloves at the beginning of the third extravehicular activity. Both crewmen periodically adjusted their diverter valves to control cooling; however, most of the second extravehicular activity was performed with the valves in the minimum cooling position.

Third Extravehicular Activity

Preparation for the third extravehicular activity proceeded normally. The crew commented that it was noticeably warmer on the lunar surface than it had been during the previous extravehicular activities when the sun angle was lower; however, cooling was again periodically adjusted and no thermal problems were experienced. Both crewmen operated periodically with their gold outer sun visors partially up. During the post-extravehicular pressure regulation check of the Lunar Module Pilot's oxygen purge system, the regulation pressure was slightly above the specification value. This was attributed to a slight regulator leakage.

LUNAR COMMUNICATIONS RELAY UNIT AND GROUND COMMANDED TELEVISION ASSEMBLY

The voice, data, and transmitted television video quality from the lunar communications relay unit were good. The ground-commanded television assembly provided quality pictures at all times during extravehicular operations. The system operated a total of 15 hours and 30 minutes. Subsequently, the system failed to respond to uplink turn-on command approxmately 36 hours after lunar module lift-off. This was anticipated because of heating due to the high sun angle.

LUNAR ROVING VEHICLE

The lunar roving vehicle performed well throughout the three extravehicular activities except for the failure of the battery 2 temperature gage prior to the initiation of the third extravehicular activity.

The approximate distances driven during the three extravehicular activities were 2.5, 19.1, and 11.6 kilometers for a total of about 33 kilometers. Speeds as high as 18 kilometers per hour were achieved going down hill and again, the lunar roving vehicle demonstrated its ability to climb slopes approaching 20°.

Deployment from the lunar module was nominal except that the battery 2 ampere-hour indicator showed zero (although it appeared to work properly for the remainder of the mission) and both battery temperature gages showed higher-than-predicted temperatures. These temperatures were 95° and 112° F for batteries 1 and 2, respectively, compared to the 80° F predicted.

During the initial loading of the lunar roving vehicle, the crew inadvertently knocked the right rear fender extension off. An improvised fender extension worked very well for the remainder of the mission.

When the lunar roving vehicle was powered up for the third extravehicular activity, the battery 2 temperature gage read off-scale low, indicating a meter failure.

FLIGHT CREW

The launch phase progressed normally and the delayed lift-off had no impact on crew activities. During translunar injection, transposition, docking, and lunar module ejection, the crew reported a variety of fragments, which appeared like insulation, floating outside the spacecraft and photographed the event. The crew reported their observation of earth and weather systems during translunar coast and took many photographs of earth to document their reports. Lunar module checkout was accomplished during translunar coast.

The lunar orbit insertion, descent orbit insertion, and command and service module circularization maneuvers were normal and intervehicular transfer to the lunar module and subsequent lunar module undocking and separation was accomplished in accordance with the flight plan. The landing site was observed from lunar orbit and the crew made continuous observations of lunar features and accomplished required orbital science observations and photography. The lunar module landing was normal in the planned area about 200 meters east of the preferred landing point.

During the first extravehicular activity, some geology was terminated early and lunar surface experiments package photography was postponed to a later extravehicular activity. These changes were necessary because of late starting of the extravehicular activity, the time taken to deploy the lunar surface experiment package, and the attempt to repair the rover fender.

The crew was allowed an extra hour of sleep after a strenuous first extravehicular activity; consequently, the second extravehicular activity started about 1 hour later than planned. The second extravehicular activity was very challenging and all objectives were accomplished with minor exceptions, as discussed in the lunar surface science section.

The third extravehicular activity started about one hour late. Extensive boulder sampling was accomplished and station 8 location was revised. The station 9 stop was shortened and 10 was eliminated. The crew revisited the lunar surface experiment package site where they took the lunar surface experiment package photographs that were missed on the first extravehicular activity and dusted the central station. The entire extravehicular activity operation progressed very smoothly with only minor difficulties.

During the period of lunar surface activity, the Command Module Pilot accomplished the required lunar orbital science experiments.

The crew carefully stowed the large quantity of lunar samples, film, and equipment in the lunar module. Lunar lift-off through docking was accomplished very smoothly and equipment was transferred to the command module and stowed. The last day in lunar orbit prior to transearth injection was filled with orbital science observations and photography as well as normal operational requirements.

Film usage had been high through this phase of the mission; however, there was sufficient film to accomplish the remaining orbital science photography and to allow one magazine of color film for crew option photography. The transearth extravehicular activity was essentially normal with the Command Module Pilot starting a few minutes late but he had returned to the timeline at ingress. Retrieving the three cassettes from the scientific instrument module bay and transferring them to the command module was accomplished with relative ease.

All photographic objectives were accomplished with the exception of the deletion of some surface polarimetric photography and a solar corona pass. The crew accomplished considerable unscheduled photography during translunar coast, in lunar orbit, on the surface, and during transearth coast.

Crew performance was satisfactory throughout the mission.

BIOMEDICAL

All inflight medical objectives were successfully completed on this mission. The health of the Apollo 17 crew was excellent throughout the 12.6 days of flight. All physiological parameters obtained from the crew were within the expected range. No medically significant arrhythmias occurred during the mission.

The metabolic rates observed during the lunar surface extravehicular activity were generally higher than predicted, but well within the range of rates experienced during previous missions. The metabolic rates during the transearth extravehicular activity were estimated by use of heart rates and were within expected limits.

The total inflight radiation dose received by the crew was within expected levels and not medically significant.

The principal medical problem experienced during the flight was the presence of a greater amount of gastrointestinal gas than anticipated. The gas problem was experienced in varying degrees by all three crewmen. The symptoms ranged from mild awareness to discomfort; however, at no time were the symptoms severe enough to interfere with the operational duties of the crew.

MISSION SUPPORT PERFORMANCE

NETWORK

The Mission Control Center and the Spaceflight Tracking and Data Network supported the Apollo 17 mission satisfactorily. Although no network problems caused significant mission impact, the following problems were experienced.

During the terminal countdown, a failure occurred in the television data display system in the Mission Control Center. The failure was isolated to the clock driver module. This was replaced and normal operation was restored.

An antenna on the Vanguard tracking ship began a high frequency oscillation during the launch phase, causing the loss of some spacecraft data. The problem disappeared and tracking was reacquired.

At acquisition of signal on the first lunar orbit, 4 minutes were required to establish two-way communication with the spacecraft. The problem was caused by improper pointing of the prime antenna at Goldstone. A handover was made to the Jet Propulsion Laboratory wing antenna and normal operations were resumed.

On lunar module ascent, two-way lock with the lunar module transponder was lost. This resulted in a 4-minute loss of uplink voice, and tracking data during ascent. It was necessary to have the Command Module Pilot pass comments from the ground to the lunar module crew during this period. The initial loss of lock was attributed to attenuation by lunar module plumes. Communications should have been re-established in less time. A review of data indicates that a normal re-acquisition by Goldstone should have been attempted earlier. Approximately 4 minutes after lunar module lift-off, a normal re-acquisition was accomplished.

RECOVERY

The Apollo 17 command module landed in the Pacific Ocean on December 19, 1972, approximately 0.4 mile from the target point and 4.3 miles from the primary recovery ship, the USS Ticonderoga. The landing point was 17 degrees 52 minutes 24 seconds south latitude, and 166 degrees 9 minutes 24 seconds west longitude as determined by the recovery ship. The onboard computer coordinates of main parachute deployment were 17 degrees 52 minutes 48 seconds south latitude and 166 degrees 6 minutes 36 seconds west longitude. All three of the main parachutes were recovered as well as the forward heat shield. Times of significant recovery events are listed below.

Event	Time, G.m.t., Hr:min
Radar contact (USS Ticonderoga)	19:15
Visual	19:20
Landing, stable one	19:25
Sea anchor attached	19:34
Flotation collar installed/inflated	19:41
Egress raft installed/inflated	19:43
Hatch opened, life preservers passed in	19:48
Crew in raft	19:57
Hatch closed	19:57
Crew in helicopter	20:06
Crew aboard recovery ship	20:17
Command module retrieved, secure on dolly	21:28