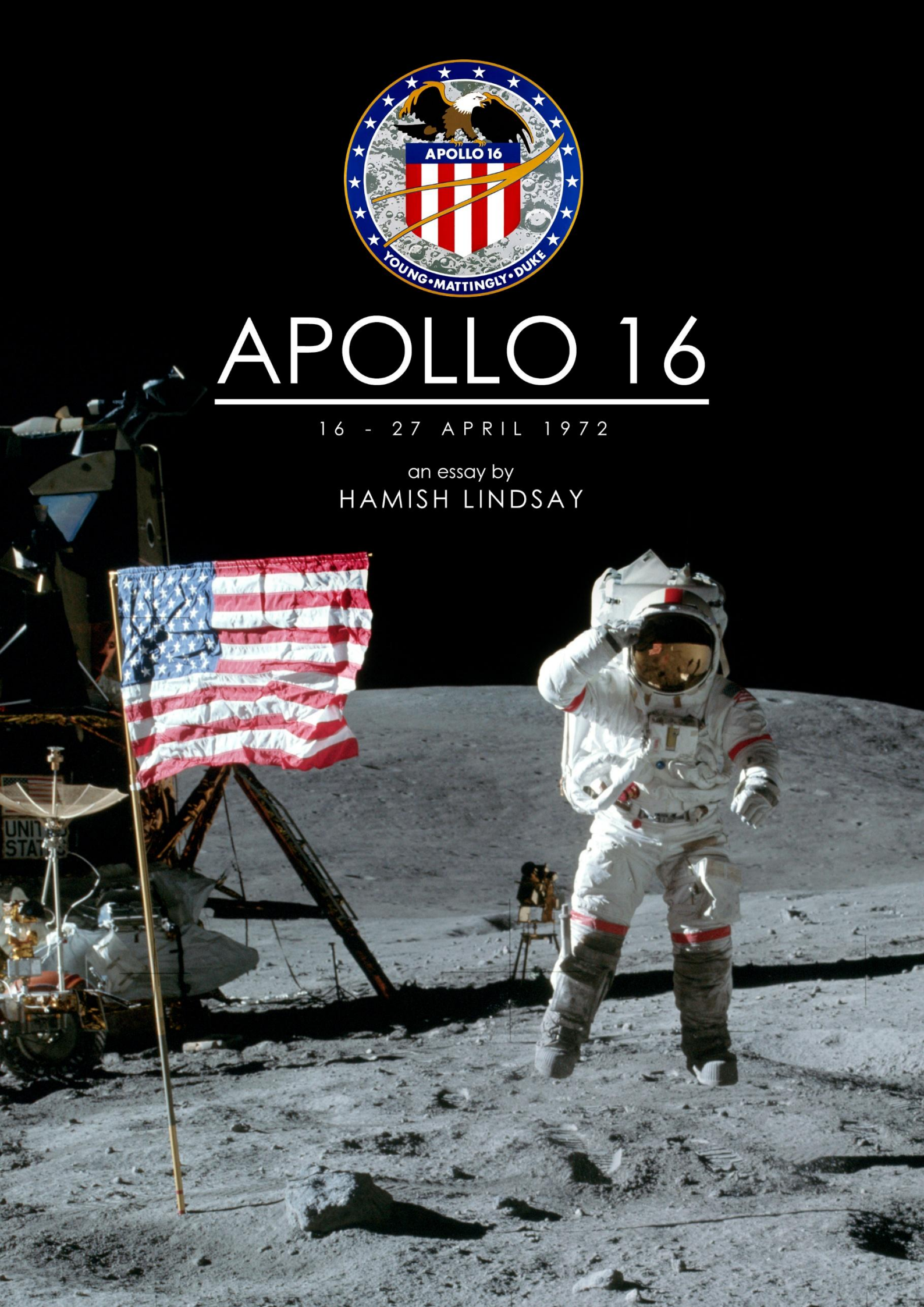


APOLLO 16

16 - 27 APRIL 1972

an essay by

HAMISH LINDSAY

“There you are, mysterious and unknown Descartes.
Highland plains. Apollo 16 is gonna change your image.
I'm sure glad they got ol' Brer Rabbit here,
back in the briar patch where he belongs.”

John W. Young

APOLLO 16

16 – 27 APRIL 1972

an essay by
HAMISH LINDSAY

Extracted from content available on the
Honeysuckle Creek Tracking Station
website, developed by Colin Mackellar

www.honeysucklecreek.net

EDITORIAL NOTES

This description of the Apollo 16 mission includes tables listing key activities and times, plus tracking times, duration, and handovers at Honeysuckle, Tidbinbilla and Parkes.

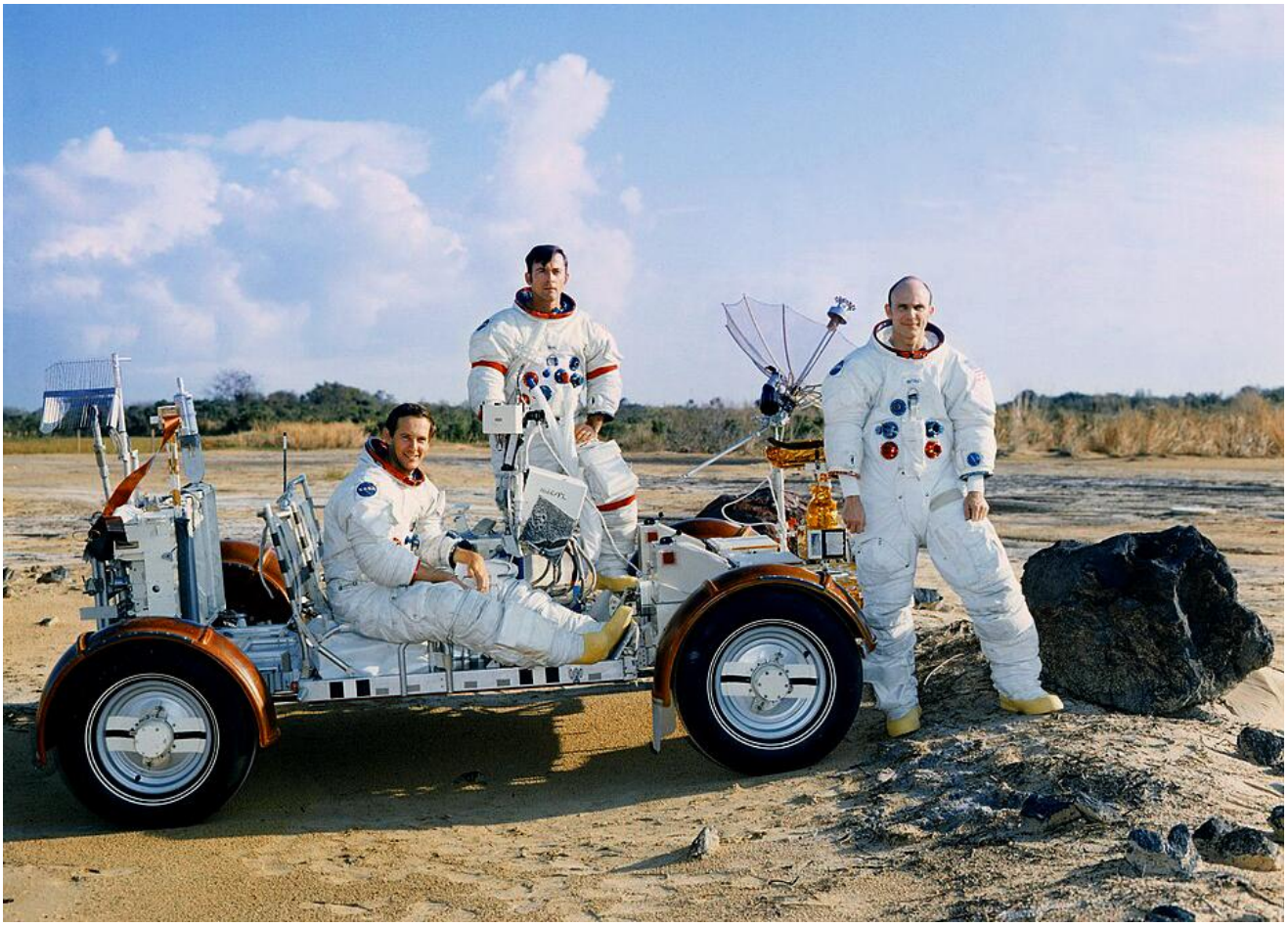
Ground Elapsed Time (GET) is included for a quick sequential reference and to relate it directly to NASA's Apollo Flight Journal and Apollo Lunar Surface Journal.

Unless otherwise indicated, all times are Australian Eastern Standard Time (AEST, GMT +10), refer to the time of events in relation to the Honeysuckle Creek Tracking Station (HSK), near Canberra, Australia. Change of day is midnight HSK time.

Indented and italicised text are either excerpts from interviews by Hamish Lindsay with astronauts and NASA personnel, air-to-ground conversations, or other relevant commentary and quotes.

The honeysucklecreek.net website is regularly updated with new content, which also includes additions to the subject matter of this essay.

THE APOLLO 16 CREW



Charles M. Duke Jr., John W. Young, and Thomas K. Mattingly II
Image: NASA/JSC

AS-511 / CSM-113 / LM-11 J-2 mission NCG 741

PRIME CREW

Commander: John W. Young
Command Module: Thomas K. Mattingly II
Lunar Module Pilot: Charles M. Duke Jr

BACK-UP CREW

Commander: Fred W. Haise Jr
CM Pilot: Stuart A. Roosa
LM Pilot: Edgar D. Mitchell

SPACECRAFT

Command Module: **CASPER** CSM-113
Lunar Module: **ORION** LM-11
Saturn V: SA-511

Note: The indented text in *italics* in this essay are excerpts from interviews by Hamish Lindsay with NASA astronauts and personnel, along with other comments, including air-to-ground conversations.

Mission Fact Box

Launch
Launch Complex – 39A, Cape Kennedy
Sunday, 16 April 1972
1254:00 US EST / 1754:00 UTC
[Monday, 17 April 1972, 0354:00 AEST]

Mission duration
11 days, 1 hours, 51 minutes, 05 seconds

Lunar orbit insertion
19 April 1972, 2022:27 UTC

Lunar orbital data
Lunar orbit (elliptical) – 315.6 x 107.7 kms
Lunar orbit (circular) – 122 x 100 kilometres
Orbits – 64

Landing data
Landing site – Descartes Highlands
8.97301°S 15.50019°E
Landing – 21 April 1972, 0223:34 UTC

Extra Vehicular Activities (EVAs)
Total EVAs – 3 on lunar surface; 1 in space
First EVA – 7h 11m 2s
Second EVA – 7 h 23m 9s
Third EVA – 5h 40m 3s
Lunar rover distance: 26.7 kilometres
Samples collected: 95.71 kilograms
Cislunar EVA: 1h 23m 42s

Lunar Module ascent, docking and undocking
Launch – 24 April 1972, 0125:47 UTC
Docking – 24 April 1972, 0335:18 UTC
Undocking – 24 April 1972, 2054:12 UTC

Lunar orbit departure
CSM – 25 April 1972, 0215:33 UTC

Splashdown
CM – 27 April 1972, 1945:05 UTC
South Pacific Ocean, 0°43'S 156°13'W
Recovery ship: USS Ticonderoga

ONLINE CONTENT – AUDIO, VIDEO, WEB

Click the icons or scan the QR code using your phone or tablet. **An internet connection is required.**

LISTEN WATCH WEBSITE	Click these icons for a direct link to the audio or video files, website or webpage content.
	Scan the QR icon with your phone or tablet for audio or video files, website or webpage content.

The Apollo 16 crew – Mattingly, Young, and Duke. Image: NASA/JSC

Apollo 16

After such an exciting and successful Apollo 15 mission, we looked forward to more of the same.

By now these missions were routine for us (at the tracking stations), though we still had our in-house simulations as well as the airborne Goddard Sim Team.

The additional complexities of the Lunar Rover and the Particle and Fields Sub Satellite held no fears, as we were now very confident of our equipment and mission procedures.

We knew our job.

Commander,
John W. Young, US Navy

Young was born on 24 September 1930 in San Francisco, California. He graduated from Orlando High School, Florida, before receiving his BS degree in Aeronautical Engineering from Georgia Institute of Technology in 1952. After his graduation, he joined the U. S. Navy and began flight training a year later. He graduated from the U. S. Navy Test Pilot School in 1959, logging more than 5,400 hours flying time, 4,400 in jets.

Young was selected as a member of the second group of pilot-astronauts in 1962 and was the first of the group to be assigned a mission. He flew with Gus Grissom on Gemini 3 and later as Commander of Gemini 10 with Michael Collins. He then served as Command Module Pilot on the Apollo 10 lunar mission under Tom Stafford, and backup Commander on Apollo 13 before joining the Apollo 16 mission. He is the first man to go into lunar orbit twice.

Lieutenant-Commander,
Thomas K. Mattingly II, US Navy

Mattingly was born on 17 March 1936 in Chicago, Illinois. He graduated from Edison High School in Miami, Florida, and left it to train as an aeronautical engineer at Auburn University, receiving his Bachelor's Degree in 1958. He had logged more than 4,000 hours flying time, 2,200 in jets.

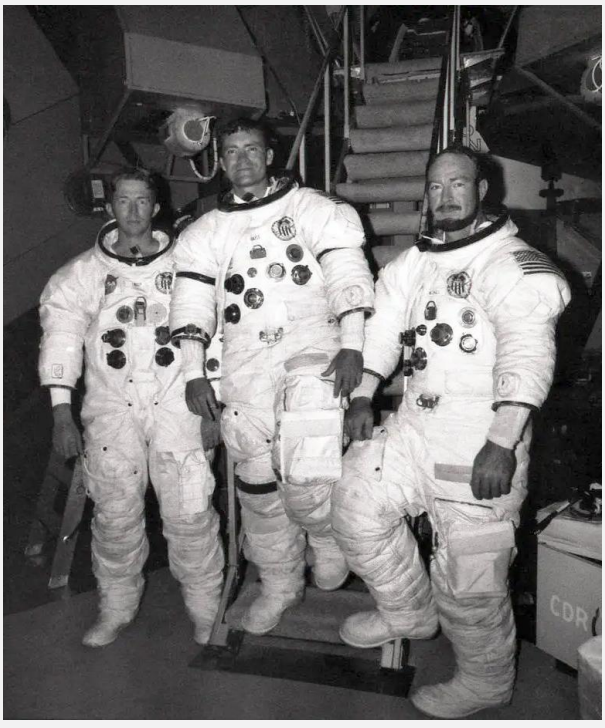
At the time of his selection as a member of the fifth group of astronauts in 1966, Mattingly was a student at the USAF Aerospace Research Pilot School at Edwards AFB. He played an important role in the development of the Apollo spacesuit and backpack. He was selected as Command Module Pilot for Apollo 13 but was removed from the crew three days prior to launch because of exposure to German measles. The backup CMP, Jack Swigert, took his place to release him from the agony of the Apollo 13 drama. Mattingly subsequently rotated into the Apollo 16 crew.

Lieutenant-Colonel,
Charles M. Duke, Jr., US Air Force

Duke was born in Charlotte, North Carolina, on 3 October 1935. He attended the Lancaster High School, South Carolina, then graduated from the Admiral Farragut Academy in St Petersburg, Florida. He gained a BS degree in naval science

from the U.S. Naval Academy in 1957, before moving on to the U.S. Air Force. After completion of flight training, he served as a fighter interceptor pilot in Germany, and then attended the Massachusetts Institute of Technology, receiving a Master's Degree in Aeronautics in 1964. He logged over 2,900 hours flying time, 2,500 in jets. The following year he graduated from the Air Force Aerospace Research Pilot School and was serving as an instructor when, in April 1966, he was one of 19 pilots selected in the fifth group of astronauts.

Neil Armstrong specially requested Duke to be the Capcom for the Apollo 11 landing. He was then chosen as Lunar Module Pilot with Young on the backup crew for Apollo 13 before joining the Apollo 16 crew. Duke, at 36, was the youngest Apollo astronaut to walk on the Moon's surface. Duke and Young worked well together as a team on the lunar surface – Young, though giving the impression of being a rather laid-back country boy, kept the big picture of the mission in his sights, while Duke attended to the finer details.



Apollo 16 backup crew: Roosa, Haise, and Mitchell. Image: NASA

Back-up Crew

The back-up crew for Apollo 16 were Fred W. Haise, Commander, Edgar D. Mitchell, Lunar Module Pilot, and Stuart A. Roosa, Command Module Pilot.

CASPER and ORION

Over in America before the mission Ken Mattingly overheard some youngsters say that the astronauts in their suits looked like Casper, the friendly ghost, so decided to call the Command Module Casper for a touch of humour and so that kids could identify with the mission.

Charlie Duke explained the Lunar Module's name: *"We had considered names like sailing ships or explorers, but nothing really struck our fancy. We then decided we would like a constellation for a name, and Orion was short and easy to pronounce, so chose Orion."*

"Probably one of the few constellations we knew about," added Young.

The Landing Site

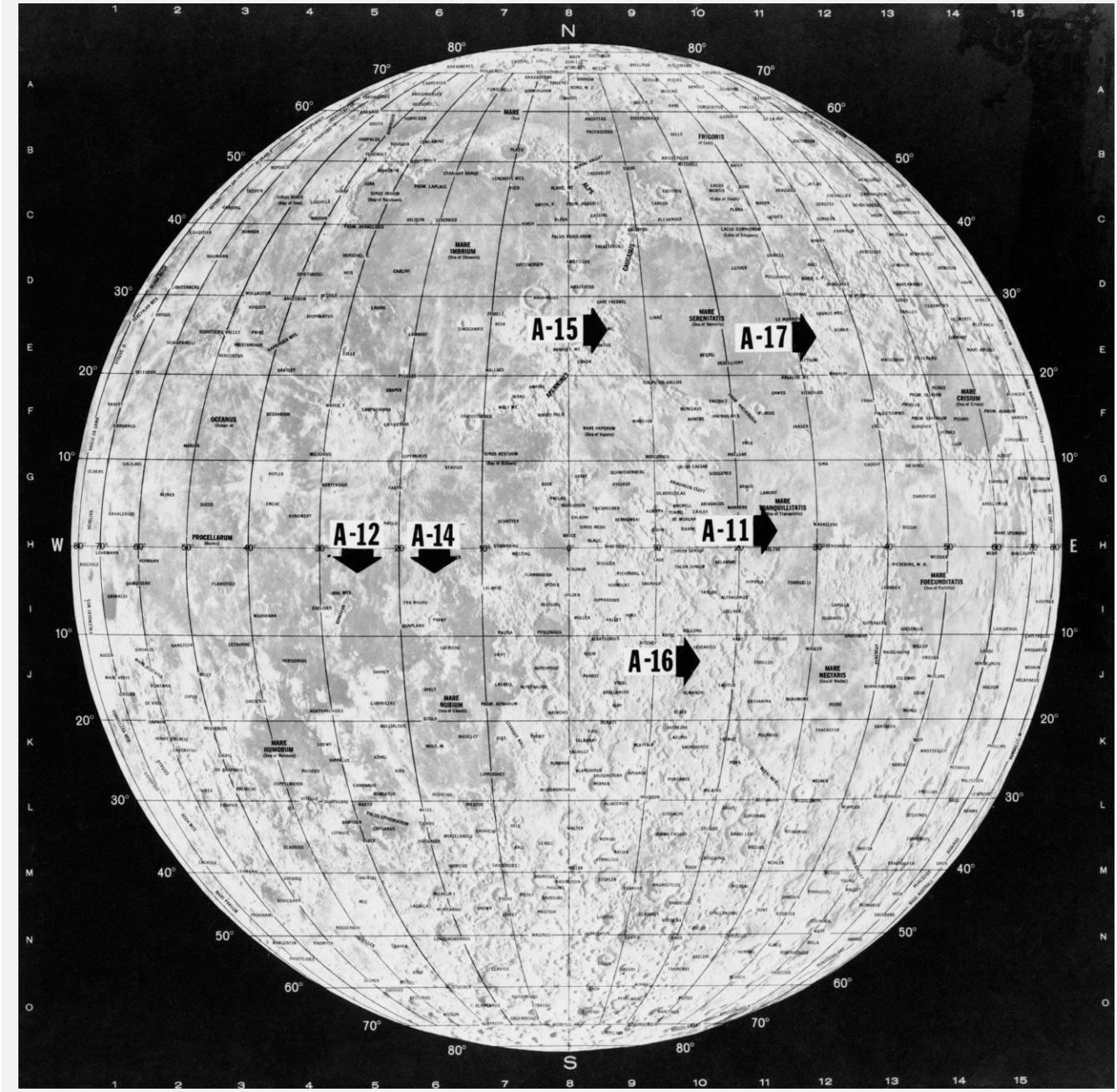
Scientists had considered Tycho, the freshest crater in the southern highlands, but were finally convinced it would be too risky for the astronauts due to the apparently rough lurain and its distance from the equator. So, the Descartes region was selected, with the hope of finding signs of volcanism, absent from the samples brought back so far.

Pictures of the area from orbit seemed to show evidence of volcanism, which would give the geologists new insights into the life of the Moon. They were convinced the Cayley Plains between the mountains were volcanic deposits. As an added bonus, the Descartes region was thought to be beyond the influence of the mighty Imbrium Crater. The Descartes site is almost 2,450 metres higher than the Apollo 11 site.

"We kinda think of it as landing on the top of the Andes Mountains," Young said before they left.

The landing site itself is 75 kilometres north of the ancient crater Descartes on the hilly, grooved, and furrowed western edge of the Kant Plateau in the central highlands among some of the loftiest parts of the Moon that face Earth. The crater was named after the sixteenth century French mathematician and philosopher Rene Descartes. It is in the Caley Formation, or Plain, of the Descartes highlands. Bounding the site are hills that rise 400 to 500 metres above the Plain.

Rollout of the Apollo 16 rocket from the Vehicular Assembly Building. Image: NASA/KSC



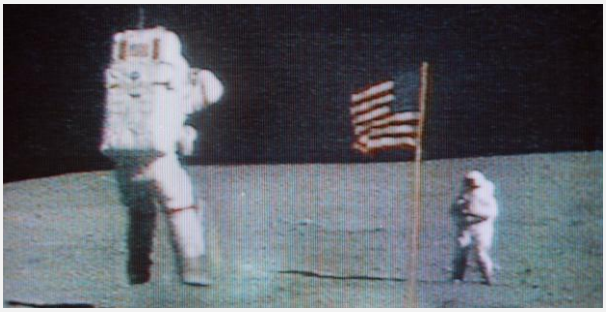
Some large craters of more recent origin abound in the area.

This mission was originally planned for a March 17 launch, but because of a docking ring jettison malfunction had to be re-scheduled for April.

Parkes was not called up for this mission but was on standby in case of emergencies. As it turned out, it was called up for a while when there were some problems in lunar orbit.

As a contrast to Apollo 15, in Apollo 16 Honeysuckle Creek missed nearly all of the action, mainly tracking during astronaut sleep periods. The Minister for the Department of Supply, Mr R.V. Garland, made an official statement in a press release to this effect:

"Because most activities to be televised will occur outside the viewing period of the ACT complex, the amount of TV coverage of this mission received in Australia will not be as great as during Apollo 15."



ACRONYMS

The following tables use these official acronyms:

AEST Australian Eastern Standard Time

ALSEP Apollo Lunar Scientific Experiments Package - *equipment left on the Moon to measure its physical characteristics*

ACN Ascension Island Tracking Station *- in the south east Atlantic Ocean*

AOS Acquisition of Signal *- from the spacecraft (the downlink)*

Capcom Capsule Communicator *- an astronaut in Mission Control*

CRO Carnarvon Tracking Station *- Western Australia*

CSM Command and Service Module

CYI Canary Island - *tracking station*

GDS Goldstone Tracking Station *- California, USA*

GET Ground Elapsed Time - *since launch*

GWM Guam Tracking Station - *NW Pacific*

HSK Honeysuckle Creek Tracking Station *- Canberra, Australia*

HSKX Tidbinbilla Tracking Station *- also called the Wing, Canberra*

IU Instrumentation Unit *- electronic system part of the Saturn IVB rocket*

LCRU Lunar Communications Relay Unit *- mounted on the Rover*

LM Lunar Module

LOS Loss of Signal *- from the spacecraft (the downlink)*

LRV Lunar Roving Vehicle

MAD Madrid Tracking Station - *Spain*

MESA Modular Equipment Stowage Assembly *- part of the LM*

P&FS Particle and Fields Sub Satellite *- dropped from the CSM*

S-IVB Saturn IV(4) B - *third stage booster*

SIM Scientific Instrument Module

TEC Trans Earth Coast *- the voyage back to Earth*

TEI Trans Earth Injection *- engine burn to the Earth*

TEX Texas Tracking Station *- at Corpus Christi, Texas, USA*

TLC Trans Lunar Coast *- the voyage out to the Moon*

TLI Trans Lunar Injection *- engine burn to the Moon*

HSK MISSION DAY 1
MONDAY, 17 APRIL 1972
LAUNCH and TLC – DAY 1

Times: AEST (HSK local time)

EVENT	GET	AEST
Apollo 16 launch	00:00:00	0354:00
Entered Earth orbit	00:11:56	0405:56
TLI burn	02:33:00	0627:37
CSM/LM docking	03:05:00	0715:53
LM fluid leak checkout [1]	33:00:00 34:54:00	1254:00 1448:00

[1] The leak check showed no anomalies
Note: Tests at Grummam showed there would be no thermal problems for the LM's flaking paint.

Prime HSK	Track Duration	AOS LOS
CSM Orbit	0h 3m 00s	0455:00 0458:30
CSM TLC-1	8h 22m 00s	1250:00 2112:00

Handovers	AEST
2-way from GDS	1354:00
2-way to MAD – 6h 30m 00s	2024:00

Wing HSKX	Track Duration	AOS LOS
IU	8h 27m 00s	1252:00 2119:00

Handovers	AEST
IU 2-way from GDS – 8h 27m 00s	1454:00
IU 2-way to MAD – 6h 00m 00s	2054:00

The launch of Apollo 16. Image: NASA/KSC

As the clocks in the Kennedy Space Center reached 0600, the Flight Surgeon hammered on the sleeping astronauts' doors and called out *"Okay, guys – it's time to go."*

The three astronauts bound for the Moon needed no second call – they were eager to get under way before anything could go wrong to delay their departure. They headed for the traditional breakfast of steak and eggs, before suiting up and purging their blood streams for the next three hours to rid their systems of all nitrogen. John Young climbed into the Command Module first and settled down in the left seat, followed by Charlie Duke heading for the right seat and Ken Mattingly dropped into the centre seat.

After delays due to problems with LM batteries, experiments, space suits, and Charlie Duke going down with a severe case of double pneumonia, Apollo 16 was launched on Monday 17 April 1972 at 0354 AEST. Gene Kranz and his White team were manning the Mission Control consoles in Houston, and Vice President Spiro Agnew turned up to watch the launch from the Firing Room. The weather at the Cape was fine, with scattered cumulus clouds. The temperature was 31°C with a visibility 16 kilometres.

Apollo 16 entered a 177 by 174 kilometre Earth orbit at 0406 AEST, reaching Carnarvon at 0446 on the first time around.

A number of minor problems were noted during the time in orbit; within minutes the crew had to check the settings on the CSM's Environment Control System as telemetry indicated a potential leak in the primary coolant loop. While the spacecraft was over Australia on its first orbit, other problems developed with the S-IVB stage's attitude control modules. First, the APS (Auxiliary Propulsion System) #2 Module, that would cause them to pitch away from Earth, experienced a failure of the helium regulator causing gas to vent overboard continuously. Then another helium leak was detected in the APS #1 Module.

In a further fault the IU (Instrument Unit) between the Spacecraft Launcher Adaptor (SLA) and S-IVB stage leaked gaseous nitrogen from a bottle supporting a temperature control system. If the S-IVB could not hold its orientation, then the crew could not carry out the docking manoeuvre to allow them to extract the LM from the booster.

Apollo 16 reached Honeysuckle Creek at 0456 where Capcom Gordon Fullerton gave the spacecraft crew a run down on their troubles. As these problems could be overcome, and had nothing to do with TLI, the mission continued.

Apollo 16 was boosted into Trans Lunar Injection (TLI) with a 5 minute 40.6 second burn beginning at 0627 over Australia and streaked through the dawn to complete the CSM/SIVB separation and LM docking at 0716.

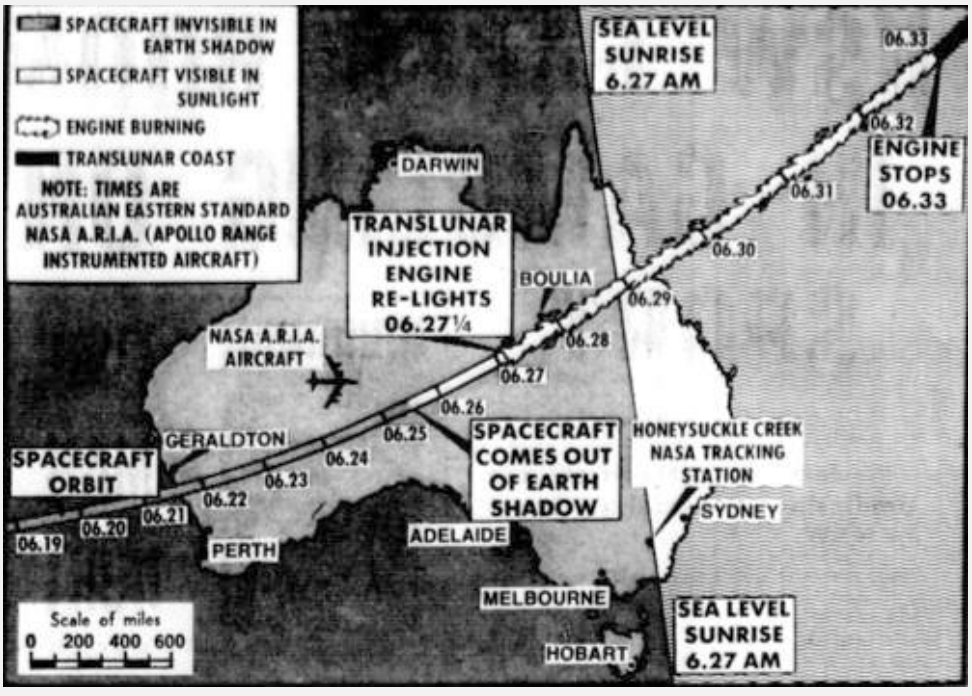


Diagram of Apollo 16's TLI burn over Australia, was drawn by Qantas pilot Captain Frank Brown. Sydney's Daily Telegraph on Sunday, 16 April 1972. Scan by Colin Mackellar.

WEBSITE

Daily Telegraph article

At 4:26 GET, and at a distance of 29,000 km from Earth,
this photo shows much of North and Central America. Image: NASA

After the manoeuvre Duke was looking out of his window at the LM when he stiffened – it looked as though there were thousands of particles escaping from the upper part of the spacecraft, *"Gordo, we must have a zillion particles along with us."* It looked like a fuel leak in the LM, which would immediately abort the mission. They were advised to dock with the LM, power up and check all the liquids. A thorough check showed nothing abnormal, so the mission continued. It was later they found it was paint flaking off.

At a distance of 29,000 kilometres Mattingly called the other two over to see the whole Earth from his window.

> He couldn't resist calling Fullerton, *"Gordy, I can't get over the view of that Earth. None of the pictures do it justice. Absolutely beautiful!"*

Towards the end of our track the astronauts turned in for their first sleep period. Young settled down in the lower equipment bay, Mattingly hovered between his seat and the instrument panel, and Duke hooked himself to the underside of his seat.

He missed his pillow but wrote, *"In zero gravity you simply stretch out your legs, close your eyes, fold your arms, and go to sleep. The head doesn't nod, limbs don't go to sleep, and you wake up feeling perfectly refreshed."*

Once they were settled down all the voice channels from the spacecraft went quiet for the rest of our track.

HSK MISSION DAY 2
TUESDAY, 18 APRIL 1972
TLC – DAY 2

Times: AEST (HSK local time)

Prime HSK	Track Duration	AOS LOS
CSM	8h 48m 00s	1309:00 2157:00

Wing HSKX	Track Duration	AOS LOS
CSM	6h 02m 00s	

Handovers	AEST
CSM 2-way from GDS	1522:00
CSM 2-way to MAD	2124:00

At 0257 AEST Houston woke the astronauts, and first up Duke gave a status of the crew.

For Young he stated, *"The Commander ate a sandwich and his orange juice that was in his suit, and all his meal for day 1, and his* PRD (Personal radiation dosimeter) *is 22,028, and he had 7 hours of sleep. Best ever in spaceflight! No medication. Three voids – 34, 20, 18. Fluid intake: total 21 ounces. Over."*

While Goldstone and Madrid were tracking, the IU signal disappeared for good at 1100 AEST due to a transponder failure.

HSK MISSION DAY 3
WEDNESDAY, 19 APRIL 1972
TLC – DAY 3

Times: AEST (HSK local time)

EVENT	AEST
Apollo 16 enters influence of lunar gravity	1515:00
HSK initiated commands due to MSC computer fault	1917:00

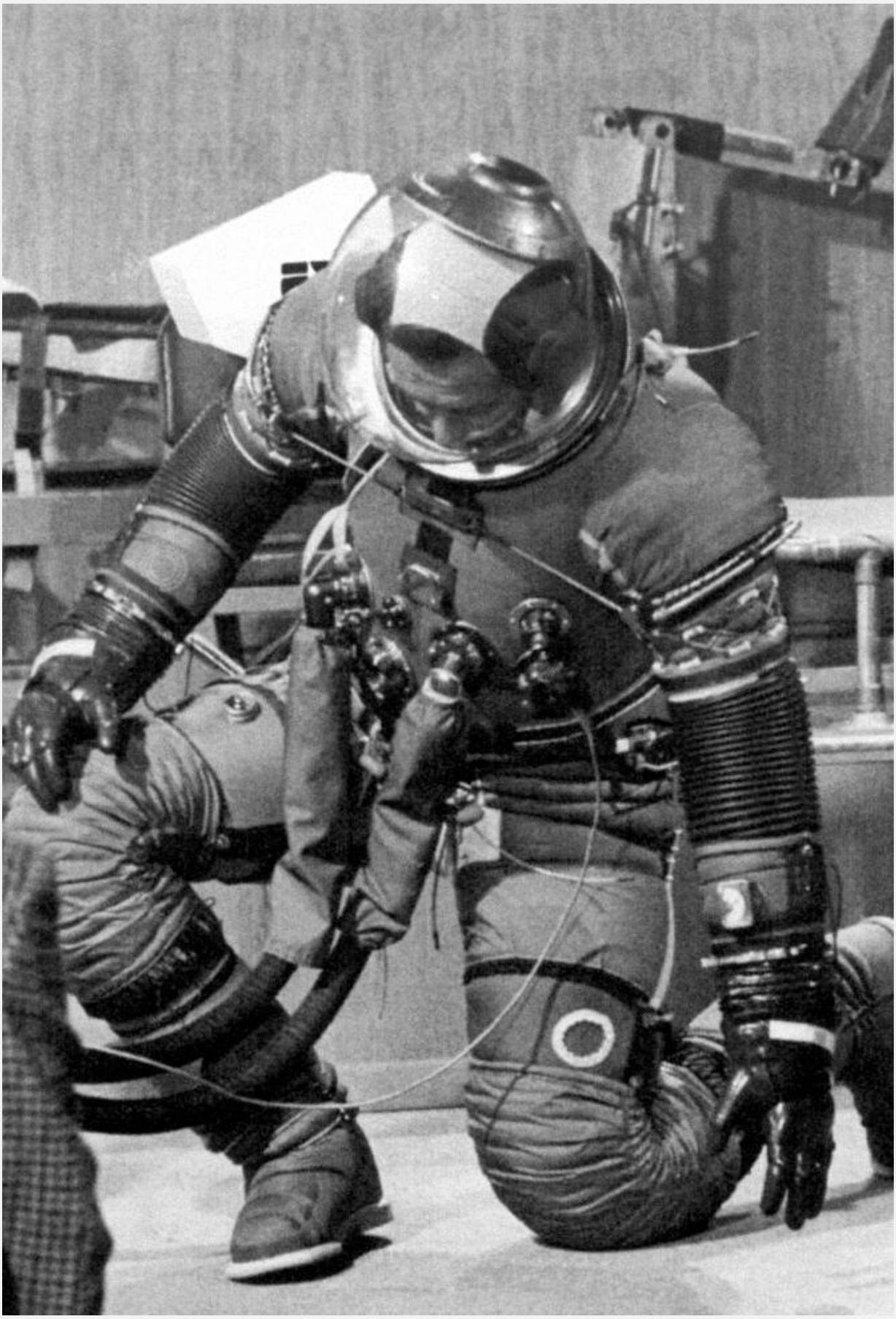
Prime HSK	Track Duration	AOS LOS
CSM	8h 27m 00s	1317:00 2215:00
ALSEP 1 and 4	2h 14m 00s	1955:00 2146:00

Handovers	AEST
CSM 2-way from GDS	1454:00
CSM 2-way to HSKX	1932:00
To CYI (Canary Islands)	2146:00

Wing HSKX	Track Duration	AOS LOS
CSM	11h 51m 40s^	

Handovers	AEST
CSM 2-way to CYI (Canary Islands)	2146:00

At around 1038 [54:44 GET] the astronauts rehearsed some of the upcoming flight procedures such as separation of the CM and LM. As they were putting on their spacesuits Duke found he could put his pants on two legs at a time in zero gravity, but proceedings came to a halt when Young couldn't pull Duke's back zipper across.



Charlie Duke tries the flexibility of the International Latex Corporation Industries' A7L-B lunar surface spacesuit.

Shown here is the pressure garment assembly, worn under the white thermal and micrometeorite protective suit so familiar in the astronauts' pictures on the lunar surface. A cable restraint across the chest and back helps keep the shape of the suit and assists shoulder movements. This type of suit was first worn on the Apollo 15 mission.

Duke wrote, *"I was really concerned. If it didn't work, we were in serious trouble as far as the lunar landing went. I needed this spacesuit to be able to walk on the Moon; a multimillion dollar mission couldn't fail because of a tiny zipper."*

Eventually Young clamped a pair of pliers to the zipper handle and braced his knee against Duke's back. While Duke held on to the sides of the spacecraft, Young gave an almighty yank and the zipper slammed shut. The problem was caused by zero gravity allowing Duke's muscles to relax and his spine stretched 1.3 centimetres, making his suit a tighter fit.

Shown here is the pressure garment assembly, worn under the white thermal and micrometeorite protective suit so familiar in the astronauts' pictures on the lunar surface. A cable restraint across the chest and back helps keep the shape of the suit and assists shoulder movements. This type of suit was first worn on the Apollo 15 mission.

By 2210 they were 35,750 kilometres from the Moon and barrelling in at 4,000 kilometres per hour. The crew woke up, looking forward to entering lunar orbit. As they ate their breakfast, the view out the windows was a rapidly growing crescent Moon shining in sunlight. The rest was in shadow, bathed in the light of earthshine.

Duke commented, *"This gave the Moon a softness and yet an eeriness as the shadows tended to meld together into the dark grey of the lunar surface."*

HSK MISSION DAY 4
THURSDAY, 20 APRIL 1972
INTO LUNAR ORBIT – DAY 4

Times: AEST (HSK local time)

EVENT	GET	AEST
SIM door jettisoned	69:59:00	0153:00
LOS behind the Moon	74:17:00	0611:00
LOI achieved [2]	74:28:28	0622:28
S-IVB impact on Moon [3]	75:08:00	0702:00
Astronaut 9-hour sleep period commences		1450:00

[2] 107.7 x 315.6 kilometres orbit achieved with a 374.3 second SPS burn
[3] Latitude 1.3N Longitude 23.8W

Prime HSK	Track Duration	AOS LOS
CSM - Lunar orbits 4-9	9h 46m 00s	1316:00 2302:30

Handovers	AEST
CSM 2-way from GDS	1646:00

Note: HSK PA #2 [LM back up Power Amplifier] was red at 1635 AEST with an intermittent over-current alarm due to an Italian moth in the power supply spark gap.

Wing HSKX	Track Duration	AOS LOS
CSM	9h 53m 00s	1316:00 2309:00

Apollo 16 arrived at the Moon and went behind the rim at 0611. As they homed in to the LOI [Lunar Orbit Insertion] burn they saw their first lunar sunset – no spectacular colours or cloud effects – the Sun suddenly just vanished behind the airless Moon and they were in darkness. A 6-minute 14-second burn thrust them safely into orbit at 0622 AEST.

As they came into sunlight again the two newcomers were almost speechless at the incredible sight of the backside of the Moon 97 kilometres below, but Young was able to point out features he had seen on his previous visit in May 1969.

Duke noted, *"Our photographs pick up the barrenness and the craters and the hills, but they just don't capture the emotion that you have in real time."*

When they emerged from behind the Moon Young announced, *"Hello Houston, Sweet 16 has arrived."*

As they approached the terminator the shadows lengthened until there were just the peaks tipped with sunlight. Moments later they were looking at the pale blue surface of the Moon in earthshine. Then they had Earthset, and the lurain below went black, and they couldn't see any more features, but they did begin to see the stars and could make out Scorpio and The Big Dipper. In the darkness they never saw the landing site on the first orbit, as the sun did not rise on Descartes until 0954.

During the second orbit the terminator had moved enough to reveal Descartes quite clearly. Mattingly had studied the orbital maps and thought he could make out Palmetto and Gator Craters. As they approached the end of the second orbit they had to reduce their orbit to 15 kilometres and executed a 24 second SPS burn. Out of sight of the tracking stations on Earth this DOI [Descent Orbit Insertion] burn was very critical, as the engine performance had to be nominal. It only had to be 2 seconds too long and they would smash into the lunar surface. That engine had everyone's attention – both Duke and Young had stop watches, the computer had a clock, and there was a cabin clock, all cross-checking each other.

The burn went fine and put them in a 19.8 by 109.3 kilometre orbit.

Mattingly called Capcom Henry Hartsfield, *"Henry, it feels like we're clipping the tops of the trees." Duke described his impressions: "It did feel like we were right down in the valleys. I couldn't believe how close we were to the surface.... we were rocketing across the surface at about 3,000 miles per hour in this low orbit, with mountain and valley whizzing by. The mountain peaks and craters went by so fast; it gave you the same impression as looking out your car window at fence posts while travelling at 70 miles per hour (112 kph)."*

After dinner they checked Duke's suit zipper reluctance with Houston to find they thought that it would be okay in the one-sixth lunar gravity. Duke wasn't convinced and told Houston he wasn't going to wear all his undergarments on the Moon to help keep his bulk down. With that cleared they turned in for a sleep as they approached their fourth orbit.

The next spacecraft day the LM's signal had already gone over our horizon when Capcom Don Peterson called through Madrid at 2318 to find the astronauts already up. There was a lot to do, and the crew were going to try and get ahead of schedule. Unfortunately, it wasn't one of those friendly days – there were to be many setbacks.

"How are you down there this morning, Houston?" Mattingly's reply tossed the ball back to Mission Control.

As soon as they had finished their breakfast they began preparing to transfer to the LM. During orbit 9 Young and Duke climbed into the LM to prepare for separation and the trip down to the lunar surface. In Mission Control Gerry Griffin's Gold Team took over the consoles to cover the descent and landing.

Young and Duke were very relieved when the zipper zipped shut without any trouble and they were able to keep ahead of schedule – but this wasn't to last. At this point they had four hours to prepare for descent.

HSK MISSION DAY 5
FRIDAY, 21 APRIL 1972
LUNAR LANDING – DAY 5

Times: AEST (HSK local time)

EVENT	GET	AEST
CSM Lunar orbits 16 – 21		
Astronauts enter LM [4]	93:30:00	0124:00
CSM/LM separation	96:13:31	0407:31
PDI commences [5]	104:17:25	1211:25
LM touchdown [6]	104:29:35	1223:35

Note: A CSM circularisation burn was not executed on time due to a problem in one channel of the SPS yaw gimbal actuator. Following appraisal of the problem back on Earth, a lunar landing was approved at 1045 AEST on orbit 15, and a circular burn executed at 1116 AEST.

[4] 11 minutes earlier than scheduled

[5] During orbit 16

[6] Latitude 8° 59′ 29″ S Longitude 15° 30′ 52″ E

Prime HSK	Track Duration	AOS LOS
LM [7]	10h 9m 00s	1351:00 2400:00

Handovers	AEST
LM 2-way from GDS	1735:00
LM 2-way to MAD	2321:00

[7] LM touchdown was 1h 27m 25s before HSK AOS at 1351. Goldstone was the only 26 metre station monitoring the landing. At HSK we were still doing our pre-pass calibrations.

HSK MISSION DAY 5
FRIDAY, 21 APRIL 1972
LUNAR LANDING – DAY 5

Times: AEST (HSK local time)

Wing HSKX	Track Duration	AOS / LOS
CSM	9h 15m 00s	1445:00 2400:00

Handovers	AEST
CSM 2-way from GDS	1726:00
CSM 2-way to MAD – 5h 46m	2321:00

Parkes	Track Duration	AOS LOS
LM		1654:00

Note: SI 087 NCG 741 requested Parkes support from 1654, as loss of LM steerable antenna required a 64-metre antenna for LM high bit rate data for possible emergency LM ascent.

The first problem of the day was the LM's high-gain steerable antenna would not slew in the yaw axis. This was a problem for the tracking network as well as the astronauts, as it meant we could not get our full signal strength all the time. The astronauts could hear Houston clearly, but Mission Control received a weak and noisy signal.

The astronauts tried to overcome the problem by talking up louder. This weak and noisy signal from the spacecraft meant commands could not be sent automatically, and had to be voiced up, copied down by hand, and keyed into the computer manually. This put the pressure on, as it had to be done before the next LOS thirty minutes away, followed by undocking out of sight of Earth.

Then to compound their problems, when Young tried to activate the RCS [Reaction Control System to control their attitude in space] there was a double failure in the pressurisation system. The RCS system consisted of a pair of identical systems of tanks, valves, regulators, and piping.

Casper after undocking. Image: NASA

When he opened the valves, Young noted that the pressure in RCS A climbed above the planned value of 1,268 kilopascals, inferring there was a leak in the regulator assembly.

This would over pressurise the system and blow the release valve, which would scrub the landing.

Only an hour into their checkout and they had two major malfunctions.

> *"This is the worst jam I was ever in,"* gritted John Young.

They weren't able to fix the RCS regulators, but by venting the excess pressure into the ascent fuel tank the pressure could be kept down to 1,241 kilopascals, and the mission could proceed. Things were reaching breaking point, but the rigorous training before the mission now began to pay off. Before they had LOS behind the Moon, Jim Irwin in Houston was able to send the welcome message,

> *"Assuming you get the P52 complete, you have a GO for undocking. Over."*
>
> Undocking went to plan at 0408 AEST, and Duke wrote, *"After making a small separation burn from the Command Module we turned so we could see Casper out our front windows. It was a beautiful sight. The spacecraft was silhouetted against the lunar surface, rushing by beneath it."*

As Orion reappeared from behind the Moon and communication was re-established, Duke reported,
"Okay, Jim. It was a little rushed, but we got it done. The only thing bad is that I got a packful of orange juice."

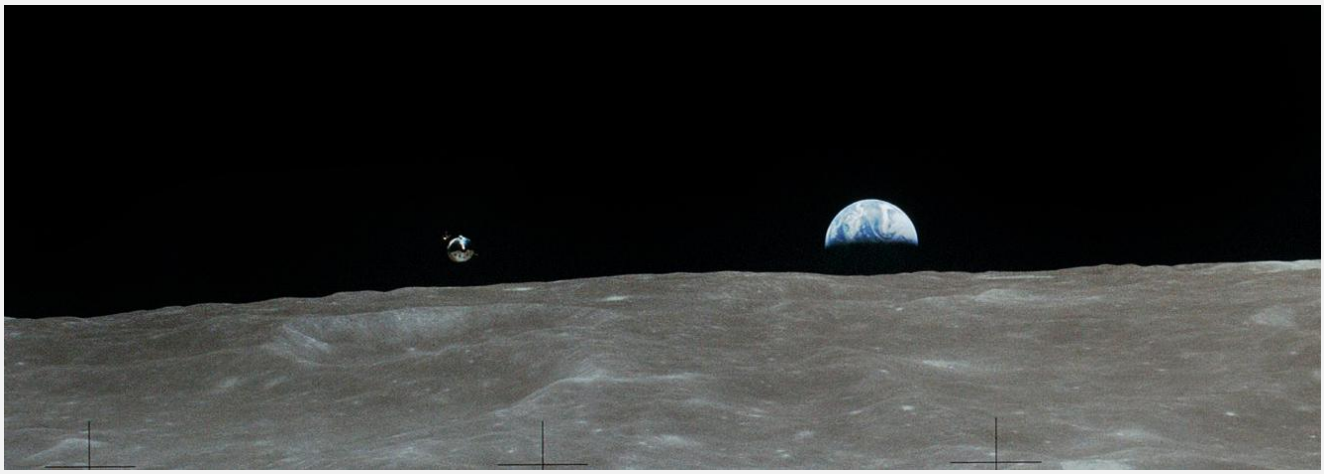
As soon as Duke had locked his helmet down when dressing, his drink bag began to leak orange juice into the space suit. Every time he breathed out, small drops of juice would leak from the plastic valve beside his mouth. It became more of a problem when it began to smear his vision.

> Duke described the experience, *"I couldn't suck them; I couldn't reach them with my tongue. I could only watch cross-eyed as they floated out in front of my face. Eventually some of the drops would hit me on the tip of the nose and slowly migrate up into my hair, giving me a sticky orange juice shampoo. It was really frustrating not being able to wipe the stuff off, as it touched and tickled my nose."*

So, Orion appeared to be in good shape as they went behind the Moon and prepared for PDI, or Power Descent Initiation.

Sailing over them in Casper, looking like a little star about 1.6 kilometres ahead, Mattingly had to make an orbit change to a 111 kilometre circular orbit to conduct experiments and be on standby in case of a landing abort. When he set the thumbwheels to turn on the secondary control system associated with the yaw axis in the main engine to check it, the spacecraft began to vibrate. He watched the 8-ball indicator wobbling back and forth and wondered if it was anything he had done, though he had carefully checked every move. He tried twice more with the same result. He called the LM.

> *"There is something wrong with the secondary control system in the engine. When I turn it on, it feels as though it is shaking the spacecraft to pieces."*



Casper and the Earth as viewed from Orion.

Young, the decision-maker behind the Moon, thought hard, and though he hated to say it, ordered: *"Don't make the burn. We will delay that manoeuvre."*

When they were in contact with Earth again, Duke reported, *"No CIRC. No CIRC."*

Irwin responded, *"Okay, copy. No CIRC. Anticipate a waive-off for this one. We will set you up for the next one* [orbit]*."*

There was a fault with the TVC-2, the Thrust Vector Control system gimbals that kept the spacecraft oriented during a burn. When one of the two parallel systems was used to control the engine, its electric motors appeared to shudder. Although one of the control systems was functioning perfectly, there was no back up available. Correct operation of the SPS motor would be critical if the LM could not rendezvous with the CSM. If this happened, Ken Mattingly would have to use the SPS to rendezvous with the LM. Moreover, before a landing attempt, the LM descent engine provided an alternative means of return to Earth but if the SPS failed to function later, all three astronauts could be stranded in lunar orbit. Under mission rules, such a fault meant that a lunar landing could not be attempted. While Mission Control reviewed the results of tests of the SPS gimbal motors, Young and Duke waited impatiently.

Their hearts had sunk down to their boots two and a half years of training and only 13 kilometres from their target (they could even see it) and now it looked like they would have to abort and return back to Earth. Mattingly felt cheated – first he was taken off Apollo 13 and now it looked as though this mission was going to end in failure with no Moon landing.

At 0754 the LM returned to Casper and the two spacecraft circled the Moon in company … anxiously waiting for an answer from Houston.

Duke: *"We knew in our minds it was very grim. It looked as if we had two chances to land – slim and none. We were dejected."*

Down in Mission Control the engineers, led by Larry Canin, had set up a test rig and found that the problem was an open circuit (probably a broken wire) in the TVC control system and worked a way around it by using the drive clutch to hold the nozzle stable during the burn. After extensive discussions in Houston and at the Rockwell plant in California, Canin approached Flight Director Gerry Griffin and suggested the mission go ahead and land on the Moon. Mattingly admitted afterwards he probably would not have made that decision.

"It was a cliff hanger of a mission from where we were sittin' in the cockpit," Young told me, "The secondary vector control system on the SPS motor wasn't workin' right and if they didn't work right the mission rules said it was no go. The people on the ground did studies at MIT and Rockwell and in the end it worked out just fine."

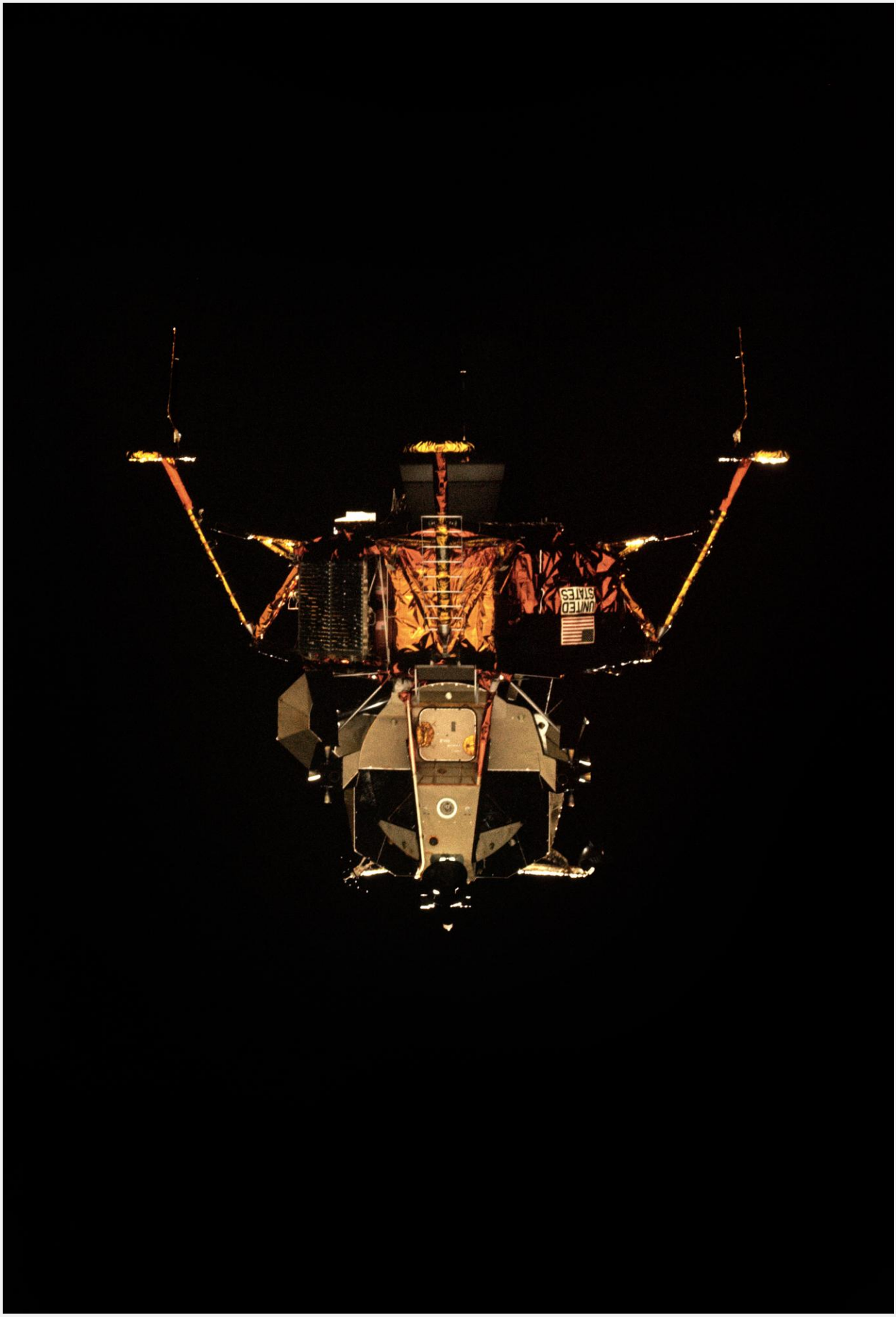
Then at 0954 it was a great relief when Jim Irwin called, *"You do have a GO for another try here at PDI on REV 16."*

As Kranz said, *"Happiness reigned in both spacecraft and Mission Control."*

It wasn't so happy for his White Team, though, they were on standby by for an emergency lift-off within two hours. If a controller could not get from his home to the MCC in 30 minutes, he had to stay in the Center's sleeping quarters. As the management and flight controllers wanted to scrub the third moonwalk, the geologists also suffered a sleepless night as they prepared a case to keep it in the flight plan.

Now six hours behind schedule, Kranz's team had to rapidly reorganise the mission with only two and a half days on the surface. They decided to continue with a three EVA mission and fixed the LM lift-off for CSM revolution 52. The delay meant that the descent would now begin from a greater height than any previous mission, 20.1 kilometres, and 4.8 kilometres south of the planned ground track.

At 1211 AEST the PDI burn went according to plan on Orbit 16, and Orion headed down for the Cayley Plains, closely tracked down by the Goldstone complex.



Mattingly took this picture of the LM Orion ready to descend to the surface. Image: NASA

Listen to the descent and landing

John Young and Charlie Duke descend towards Descartes – as recorded from Net 1 and Net 2 at Honeysuckle (Goldstone was prime).

From a compact cassette recording made at Honeysuckle during Apollo 16 by Bryan Sullivan, digitised by Colin Mackellar.

LISTEN

560kb mp3 file – 4m 33s
Audio starts at about 104:26:40GET
and finishes just after landing.

"At five minutes – coming in like gangbusters!"

Duke was on his back looking out into space, excited and relieved to be actually coming in to land after all their frights.

After pitchover at 1220 at an altitude of 2,200 metres, Duke momentarily looked up from his job of calling the LPD [Landing Point Designator] readings and values of altitude, descent rate, and forward velocity to glance out of his window for a few seconds and immediately recognised North Ray, Gator, Palmetto and Dot Craters.....

"Pitchover. Hey, there it is. Gator, Lonestar. Right on!"

He was very pleased to see that the lurain to North Ray was going to be navigable by the Rover. Because of suspected rough lurain and boulders, the geologists had some doubt they would reach the rim of North Ray.

Young also looked out at the landing site and the first feature he spotted was South Ray Crater with its ray pattern radiating out. He immediately decided they were going to land long, a bit too far north and west, and applied corrections to their trajectory. As they headed towards the terminator, the surface shadows began to lengthen.

At 119 metres altitude Young took over manual control to choose a suitable landing area.

Although Orion raised a lot of dust from about 24 metres above the lurain, it never obscured their view of the surface to the extent of the previous missions. Due to their six hour delay the Sun was 3° higher than originally planned and may have had less effect on the rising dust particles. Young hovered at 12 metres, saw a dangerous looking 15 metre wide crater and skipped over it to land about three metres beyond.

When the blue contact light lit up Duke called *"CONTACT – STOP!"*

Young counted a second and shut the motor off at a metre above the lurain. The LM dropped like a stone to land hard, but safely, at 1223 AEST.

They had landed on the only flat piece of lurain in the area – 25 metres in any direction and they would have landed on a slope. Young admitted he could not gauge the angles of slopes from above; it was just luck he picked a flat spot. If they had landed on a slope, it would have made working around the LM very difficult.

Looking out the window he thought they were on a ray from South Ray Crater. He also noticed the lurain was bright and very white and observed,

"Well, we don't have to walk far to pick up rocks, Houston. We're among them!"

Duke added, *"All we got to do is jump out the hatch and we got plenty of rocks."*

Orion had landed on Cayley Plains in a 16 kilometre wide valley with mountains all around. They only missed the original planned landing point by 270 metres to the north and 60 metres to the west. Duke launched straight into an excited description of the view through the windows and had to be interrupted by Young,

"Wait a minute, Charlie – we gonna stay Houston?"

The view through the window after landing. Image: NASA

"Everything's looking okay up to this point, John. We'll give you a final word here shortly."

Looking around the astronauts saw a range of mountains, including Stone Mountain (named for Stone Mountain in Georgia because it was also smooth and rounded), 8 kilometres to the south. To the southwest lay South Ray Crater, about 11 kilometres away. It was white in colour, with distinct black streaks down its side. Then 8 kilometres to the north was a range of mountains rising 305 metres above the valley floor they had called the Smoky Mountains because of their grey colour.

Both astronauts were highly excited and desperately wanted to get out of the LM and begin exploring. As the crew had been up for almost 20 hours, Houston decided to change the Flight Plan and go straight into a sleep period. The crew agreed a good sleep first was the wisest move.

Young looked longingly out of the window, *"Man, it's really tempting though. It really looks nice out there."*

Since there would be few reserves left if the mission continued for its originally planned 12 days, Houston decided that Apollo 16 would spend one day less in orbit around the Moon after the surface exploration had been completed. The delay also cost a lot of effort in changes to the Flight Plan, and for a while threatened to scrub the third excursion in the lunar Rover to North Ray Crater because of the shortage of consumables. Endless changes were voiced up from Houston.

Duke: *"I began to write, and I wrote and wrote and wrote. It seemed like I was about to run out of pencil lead because of the hundreds of changes – changes in our time lines and changes in our procedures."*

The astronauts began their first sleep on the lunar surface at 1543. They both had nylon hammocks, Duke's stretched across a few centimetres above

the floor, Young's fore and aft above Duke. Although Young was in his hammock, he found he was actually sleeping on a mattress of pressure suits stacked under him.

While they slept, we settled back in our recliner chairs and kept an eye on our equipment as it tracked a silent LM. Young said that the rest period was very cold in the cabin. He began the first night in the nude, but woke up to find his feet freezing cold, so he swapped his head for his feet and put the Interim Stowage Assembly over his feet and slept soundly for the rest of the sleep period. The other two sleep periods he slept in his Liquid Cooled Garment without the cooling water flowing. Duke said he slept really well during all three sleep periods.

First Morning on the Moon's Surface

At Honeysuckle Creek we were coming to the end of our tracking period when the astronauts' day began at 2343 AEST (our LOS due to the Moon setting was at midnight). Duke was the first to call Tony England in Mission Control, and then queried, *"Nice to hear you guys. We're up. Did you guys have a site handover about 20 minutes ago?"*

England: *"Hold on, I'll check ... Okay, yes, I guess we did. Why, did you get keying there?"*

Duke: *"Okay, you..... well, you dropped the uplink in a big blast of static."*

He was dead right – Honeysuckle Creek handed the uplink over to Madrid at 2321 AEST, or 23 minutes earlier. Both stations were near their

Honeysuckle's antenna at night. Photo: Lindsay

HSK MISSION DAY 6
SATURDAY, 22 APRIL 1972
LUNAR SURFACE – EVA-1

Times: AEST (HSK local time)

EVENT	GET	AEST
CSM Lunar orbits 29 – 34		
EVA-1 [8] - hatch open to close	119:00:02 126:06:58	0254:02 1000:58
Rover [9] – first excursion - start to end	122:58:00 125:09:00	0652:00 0903:00
ALSEP – return to site	124:54:00	0848:00
Rover – 'Grand Prix'	124:56:51 124:59:20	0850:51 0903:20
Sleep period - sleep to wake-up	131:24:00 139:07:43	1518:00 2301:43

[8] MAD's 26-metre antenna was the only station tracking as the astronauts climbed down the ladder.
[9] Rover excursion time: 2h 11m.
Distance travelled: 4.2 kilometres

Note: HSK lost Net 1, the incoming astronaut talk line from Houston, for 5 minutes at 2335 due to an outage in the USA. The line was restored back to normal at 2340 AEST.

Prime HSK	Track Duration	AOS/LOS
LM	10h 46m 00s	1418:00 23/0104:00

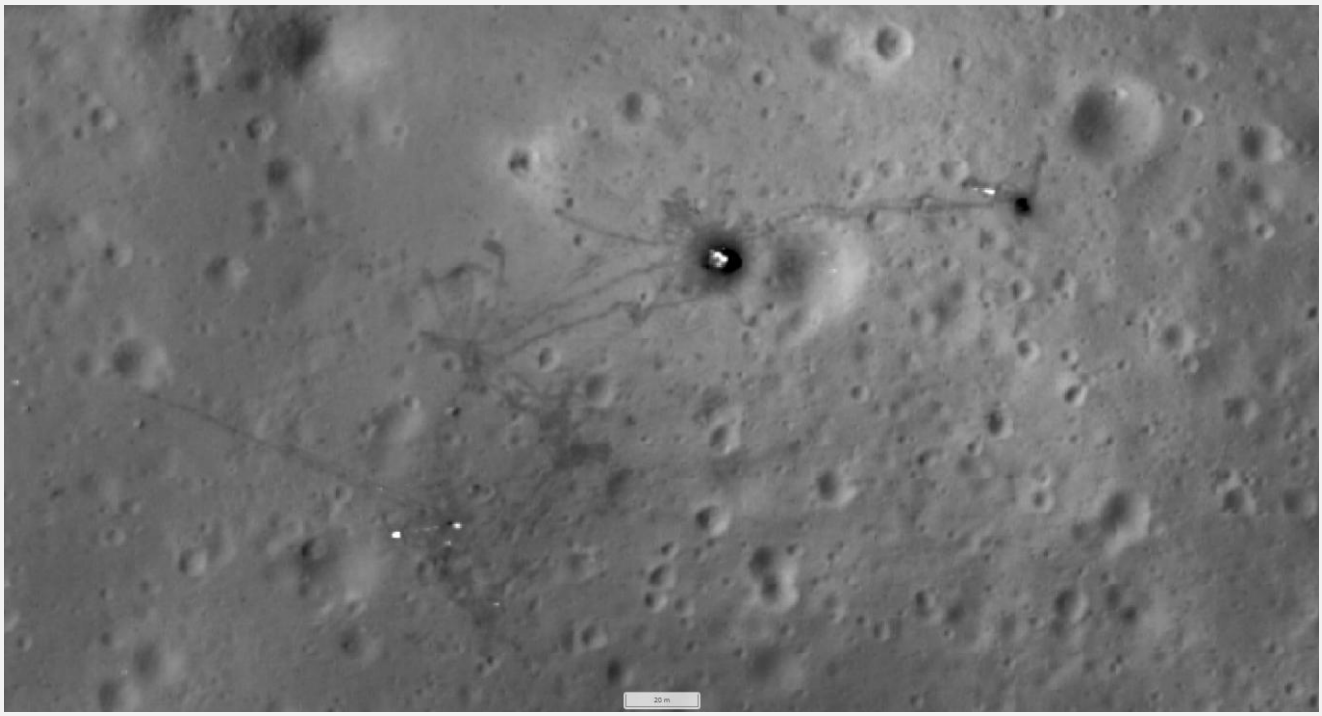
Handovers	AEST
LM 2-way from GDS [10]	1803:00
LM 2-way to MAD – 6h 46m 00s	0204:00

[10] Handover from GDS delayed 22 minutes due to loss of Net 2, Net 3 and telemetry data to MCC.

Wing HSKX	Track Duration	AOS/LOS
CSM	9h 15m 40s^	1512:00 23/0027:00

Handovers	AEST
CSM 2-way from GDS	1723:00
CSM 2-way to MAD – 7h 32m	23/0055:00

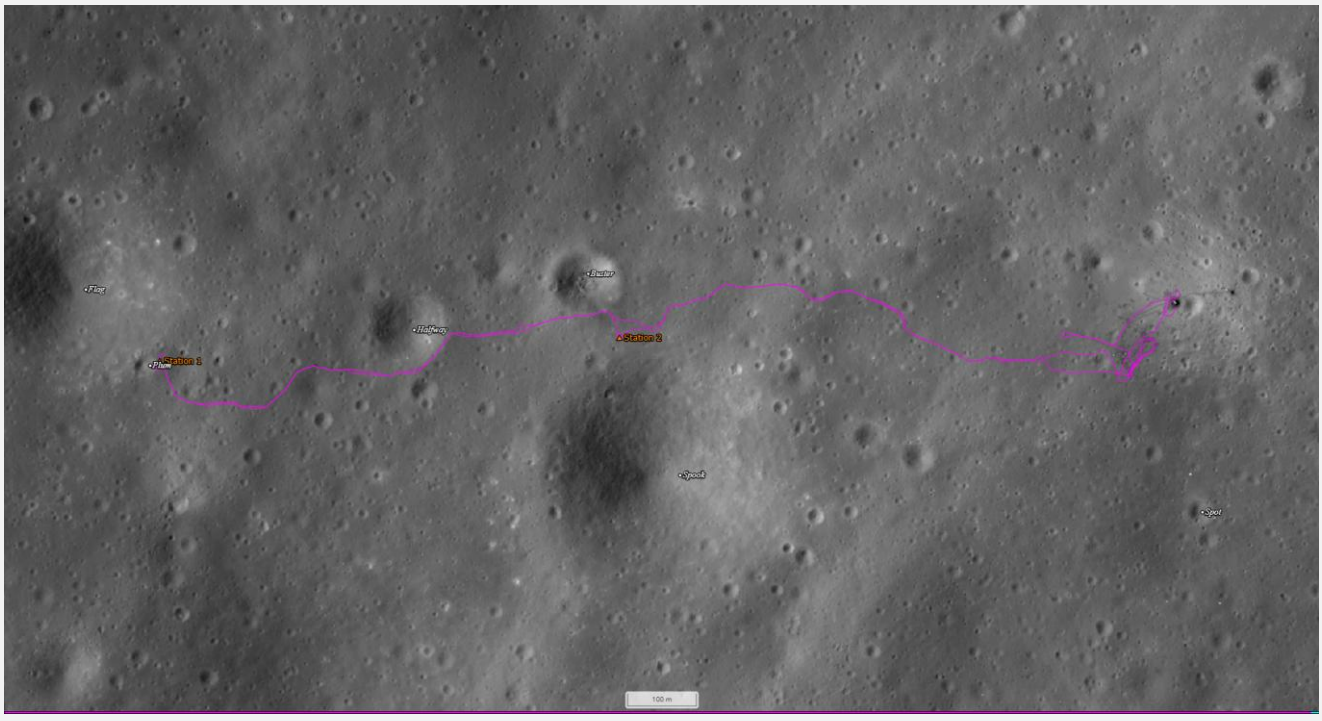
Parkes	Track Duration	AOS/LOS
LM	5h 47m 00s	1657:00 2244:00



Above: A close-up of the Apollo 16 landing site. *NB: Gray bar equals 20 metres.*
The Lunar Module 'Orion' is the object above the centre of the image.
The Lunar Rover is parked to the upper right. The ALSEP parts laid out towards the lower left.
The marks left by the wheels of the rover the footprints of the astronauts are visible.

Images: NASA/Lunar Reconnaissance Orbiter Camera

Below: The purple line marks the first EVA traverse from the LM landing site on the right,
to Plum Crater (Station 1), a smaller crater next to the larger Flag Crater on the far left,
and Buster Crater (Station 2) in the centre, sits above the larger crater called Spook.
Nearest the LM is the oval-shaped course of the "Grand Prix". *NB: Gray bar equals 100 metres*



respective horizons on handover, which may explain the glitch the LM experienced.

Duke: *"We were as excited as two little five year olds on Christmas morning. Imagine the best Christmas, the best birthday, the best visit to an amusement park – all rolled into one instant of time – that is the feeling we had as we tried to describe what we were seeing."*

After a breakfast of peaches, cold scrambled eggs, cinnamon toast cubes and a lemon food bar, the two astronauts dressed in their suits, finding the task very difficult in the cramped conditions. It took them 2 hours to prepare for egress through the hatch at 0256 AEST.

"Hey, John, hurry up!" Duke, watching from inside the LM, was getting impatient.

"I'm hurrying ... okay," Young was also keen to get out, and stepped on the Moon's surface, raised his arms in salutation, and spoke to the world, *"There you are: Mysterious and Unknown Descartes. Highland plains. Apollo 16 is gonna change your image. I'm sure glad they got ol' Brer Rabbit here, back in the briar patch where he belongs."*

This last comment was a reference to Young, as Brer Rabbit in the Joel Harris story, back exploring in space, where he felt he belonged.

Duke climbed down the ladder after Young, and commented to Tony England, their Capcom for the EVAs:

"Fantastic. That's the first foot on the lunar surface. It's super, Tony."

Duke, at 36, the youngest astronaut to walk on the moon, then joined Young to help unload the Rover and excursion equipment. When they turned around they were startled to see they had landed Orion only 3 metres away from a crater 7.5 metres deep.

Young: *"It would have been bad if we had landed in that crater, I saw it for a little while when comin' down, but where we landed it was perfectly flat, in the bottom of this 75 metre wide crater."*

If they had landed on the rim of the deep crater they could have toppled over the edge, and that would mean they probably couldn't lift off – they would have been marooned on the Moon forever. They frequently talked about the close encounter with that crater.

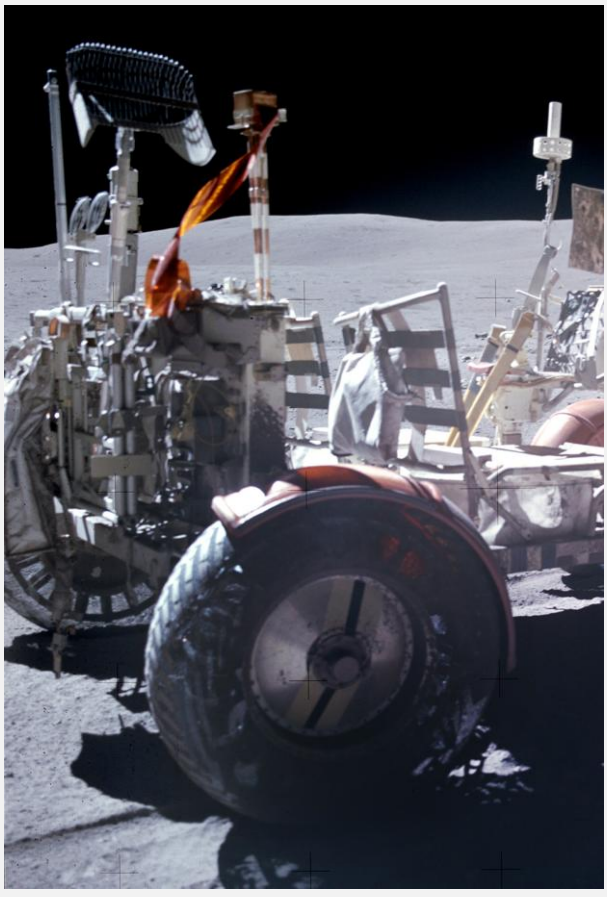
Young: *"I can't believe that big hole back there."*

Duke: *"John, you picked the exact bottom of this old crater."*

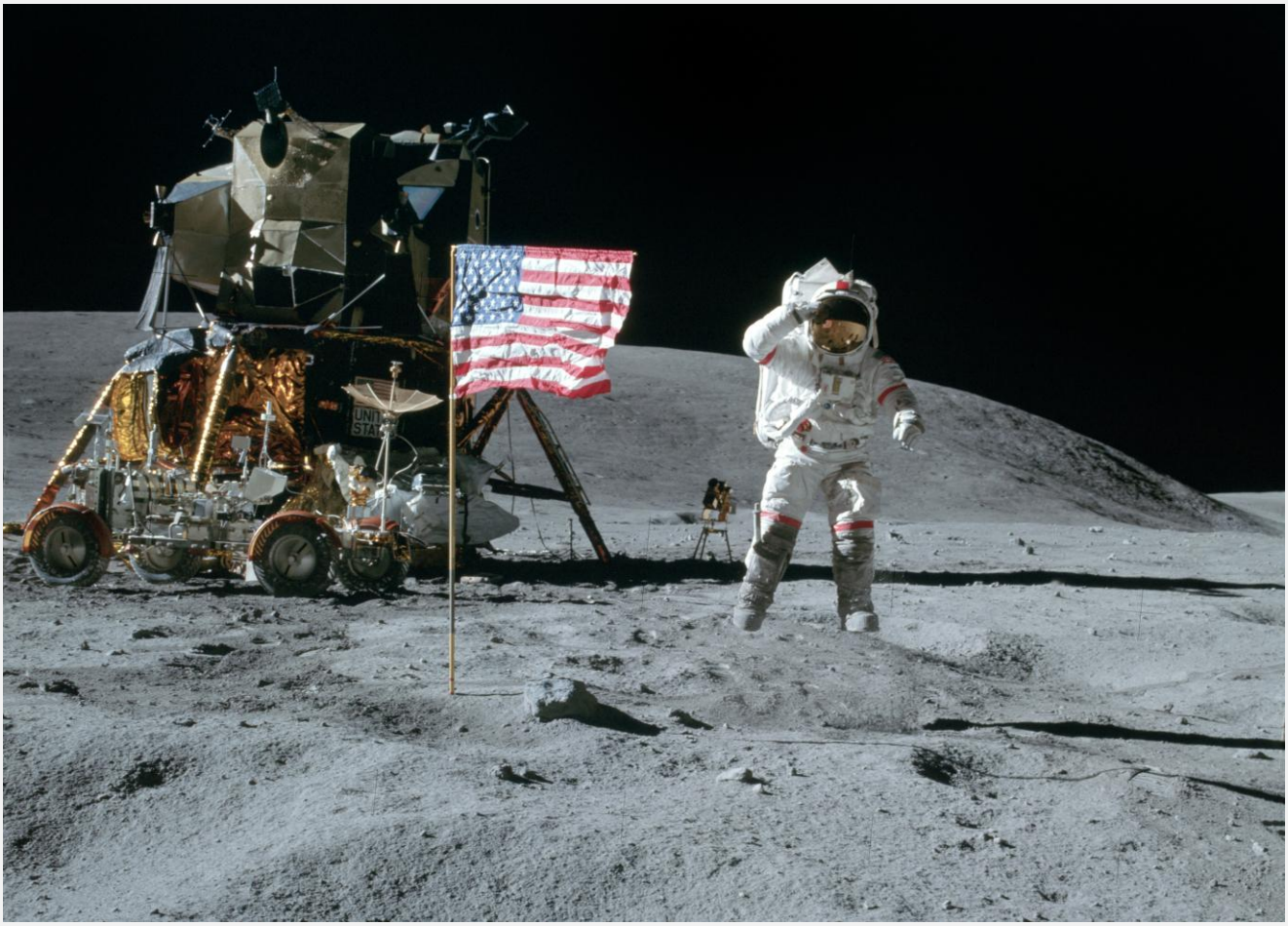
Young: *"There weren't any flat places around here, Charlie."*

Duke: *"Yes, but anywhere else we would have been on a great big slope."*

The Rover was deployed without any difficulty by 0334, but when Young tried to drive it he found the rear steering wasn't working. Passing the problem over to Houston, next they rigged the TV camera before planting the Stars and Stripes in the lurain. Each saluted it, Young leaping an exuberant metre above the dust while saluting, before setting up the ALSEP experiments at 0427. The experiments are detailed in the essay on the ALSEP. While parking the Rover for the TV to



Rear wheel issues on the rover. Image: NASA



Above: John Young leaps while saluting the flag.

Images: NASA

Below: Charlie Duke salutes the flag.

watch the ALSEP installation, the Rover's rear steering suddenly began working. The reason for the failure was never discovered.

For six years geophysicist Mark Langseth had been studying how much heat was being conducted out of the moon's interior. His first experiment had burned up in Apollo 13's Aquarius; then Dave Scott wasn't able to drill down the required 3 metres in Apollo 15. Now he was watching Duke drilling and inserting the thermometer for the Cayley Plains experiment and thought that at last he would be getting his data. Then to his horror he saw Young had a cable caught around his boot and as he watched the cable tautened and snapped off at the connector.

Duke: *"Uh-oh!"*

Young: *"What is that? What line is it?"*

Duke: *"That's the heat flow. You've pulled it off."*

Young: *"I don't know how it happened ... Pulled loose from there?"*

Duke: *"Yeah."*

Young: *"God almighty!"*

"Well, I'm wasting my time." Duke was drilling the hole for the second thermometer.

Young dropped to his knees at the back of the Central Station and examined the connector.

Young: *"I'm sorry. I didn't even know ... I didn't even know it … aargh; it's sure gone!"*

Now the Apollo 16 heat flow experiment was a dead loss. Langseth couldn't believe it. Both astronauts were devastated, as they had trained so hard to make this experiment a success. Although Mission Control looked at repairing the broken connector, it was decided that it would have taken too long to re-terminate the 48 wires, even if it was a feasible task for astronauts to try on the surface of the Moon.

After deploying the ALSEP, the astronauts ran around collecting samples. When Duke fell down, he found it was much easier to get back on his feet by crawling to a nearby crater, putting his feet in it, then rocking back to get his centre of mass back enough to get back on his feet. The craters were about ten metres in diameter and about two to three meters deep.

First Excursion

They began the first Rover excursion at 0652 AEST and drove off on a bearing of 274°. Young had his hands full keeping the Rover under control, out of steep craters, and avoiding rocks and boulders. He was afraid of driving more than 4 to 5 kilometres per hour because with the Sun behind them he couldn't see the rocks or craters ahead due to their shadows being hidden. A couple of

Orion viewed from the ALSEP site. Note the top of the flag just visible at left. Image: NASA

times they dropped unexpectedly through craters when Young missed seeing them. He also had trouble identifying ridges and how steep they were. Duke took over the role of navigator, photographer, and travel guide. He commented his tourists were 240,000 miles away in Mission Control in Houston!

As they set off they noticed South Ray Crater about 11 kilometres away to the south west. It was a 450 metre wide crater flanked by large boulders, with a great amount of smaller rocks forming black and white rays extending all around for great distances.

Bouncing across the lurain they both became confused with their bearings, as everything looked the same. Because they weren't sure of the LM's exact landing location, which the Rover's navigation systems used as a reference point, they could not rely on it for getting them to Plum Crater.

As they were driving along about half a kilometre from the LM, on a heading of 270°, or due west, Young became a bit annoyed when Duke was trying to take pictures and kept bumping his arm, unexpectedly knocking the Rover off course to the left.

"Quit hitting my arm," growled Young.

At 0701 they passed by Spook Crater on their left and Buster Crater on their right. These were the biggest craters they had seen so far, at least 46 metres diameter, containing some pretty big rocks, they estimated to be up to 4 metres across. As they neared Flag Crater they found the hilly lurain was covered with angular rocks thrown out of South Ray Crater.

Station 1 – Plum Crater

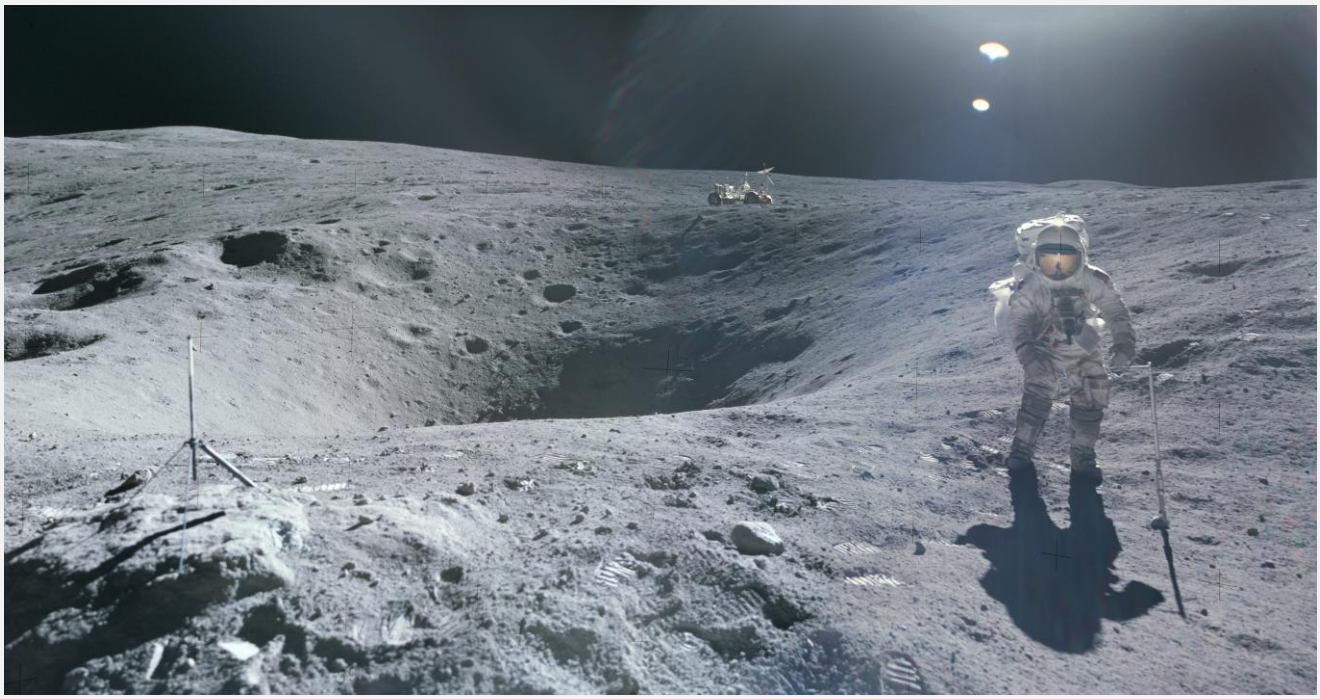
At 0717 they stopped on the rim of what they believed was Plum Crater, 1.4 kilometres from the LM, although the speedo was indicating they had actually driven a distance of 2 kilometres. Plum Crater is a 36 metre wide hole on the rim of 290 metre wide Flag Crater. The scientists thought that Flag Crater was big enough to penetrate deep into the regolith to the Cayley Formation [original material] and Plum Crater would provide good samples of Flag.

"Yeow.. is that some crater, Tony. Whooo ... it's a smooth crater, very subdued, but it's really steep. I can't even see the bottom right where we are," Duke called out.

"That is spectacular," agreed Young.

"Charlie, don't fall in that thing," warned England.

"I'm not gonna fall in it," Duke said with feeling.



Charlie Duke and the Rover at Plum crater. Images: NASA
This is a composite of photos AS16-114-18421, 18422 and 18423.

Trying to look over the edge without getting too close, the two astronauts could see the steep sides and powdery dust could trap anyone trying to climb out, and with no ropes they realised there would be little chance of rescue if one of them did fall in.

As well as taking photographs, they pulled out their tools and began tasks of collecting samples, conducted geological experiments, and a magnetometer experiment. They found that as they rollicked around they became very dirty, but to their surprise when they stirred up the regolith it was white, completely white, about two centimetres under the grey surface.

At 0759 England called them to finish their exploring, *"Okay, it's time to go back and pack up."*

As they were loping back to the Rover, England passed on a request from the scientists in the back room. Astronaut Jim Lovell was the verbal link between the scientists and the spacecraft crew, and they had to convince him their request was important before he would pass it on.

This request passed: *"As you come around there, there is a rock in the near field on this rim that has some white on the top of it. We'd like you to pick it up as a grab sample."*

After finding and confirming the rock was the one they wanted, Young was dubious, *"Are you sure you want a rock that big, Houston?"*

"Yeah, let's go ahead and get it."

At 11.7 kilograms, this gray-matrix white-clast breccia ended up being the biggest sample brought back by Apollo, surpassing Apollo 15's *"Great Scott*" 9.6 kilogram chunk of basalt. It was dubbed *"Big Muley"* after Bill Meulhberger, their geology principal investigator, who initiated the request, not being aware of its size from the television images. Duke fell to his knees and digging the football sized rock out of the dust rolled it up his leg to carry it to the Rover. It had to go on the floor of the Rover, as it was too big to go into any of their bags.

After a 50½ minute stay at Station 1, they retraced their tracks heading for Buster Crater. Duke was full of enthusiasm for the lunar Rover,

"You are making great time, John. We are doing 11 clicks (kilometres per hour)*."*

England: *"Outstanding!"*

Duke: *"Super!"*

England: *"The Grand Prix driver is at it again."*

Duke: *"Barney Oldfield."* (Early 20th century American car racing driver)

Young: *"I can follow a road."* referring to the tracks made by the Rover on its way out to Flag Crater.

Station 2 – Buster Crater

After some confusion which crater was Spook and Buster, they arrived on the rim of Buster at 0815 and Duke began taking photographs of South Ray Crater and Stone Mountain, while Young set up a magnetic field experiment using the Portable Magnetometer (see ALSEP essay for details of the LPM).

Duke noticed he could clearly see the LM's orange/gold descent stage gleaming in the Sun about 1.6 kilometres to the east. He flew around picking up samples, careful not to come too close to the edges of the crater – it was like Plum Crater, if he fell in he would never get out.

Young commented, *"Buster is really an impressive crater, Houston. The walls are so darn steep, and the blocks are all over it."*

The two astronauts were still not finding the hoped-for volcanic material. The back-room geologists were beginning to reconsider their pre-mission volcanic hypothesis. Could they have been wrong? The Buster stop was shortened to 27 minutes as Duke's cooling water supply was running low, so the Rover set off for home at 0842. Back at the ALSEP site at by 0848, Young felt a moment of ardour for their home,

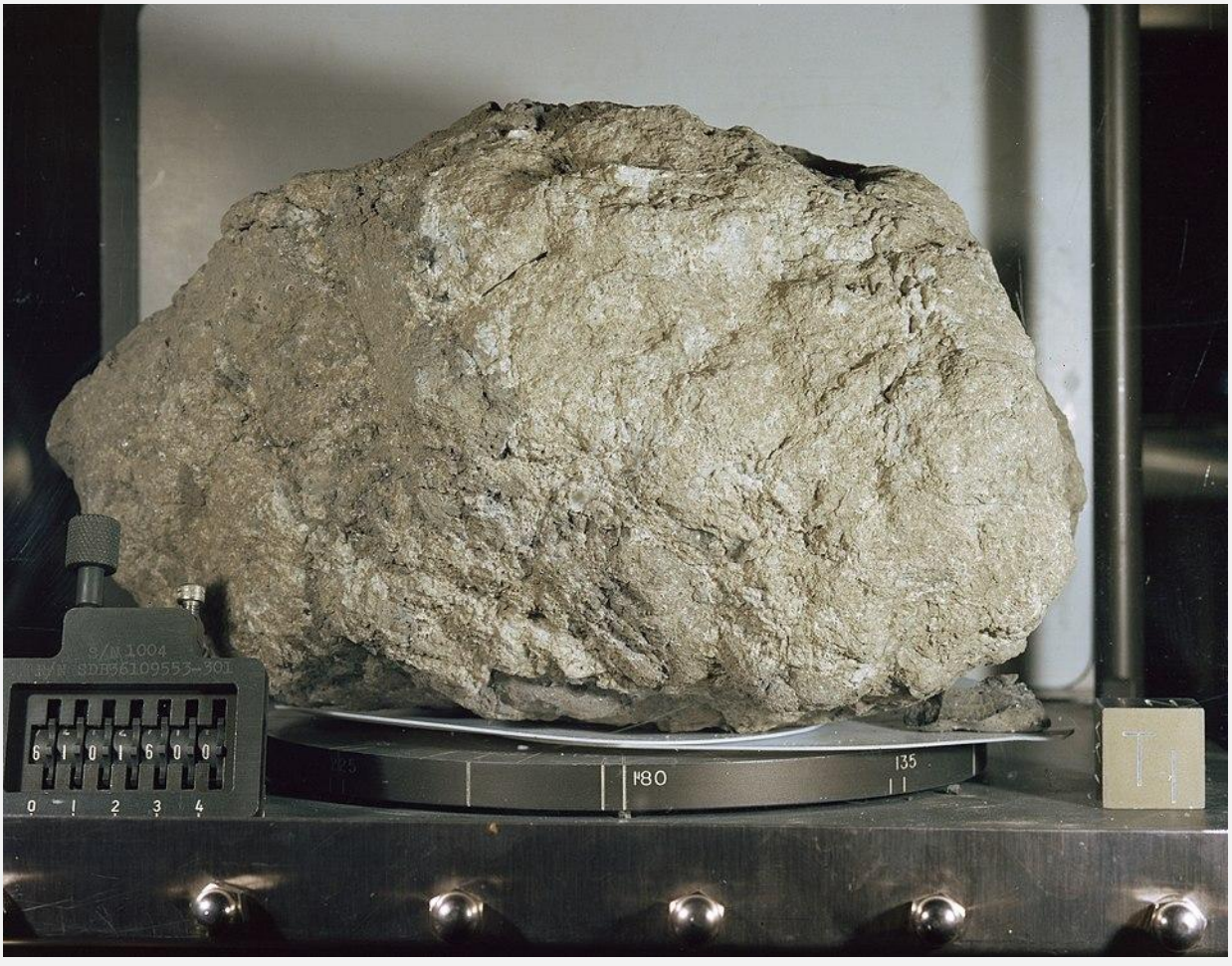
"Hey, that LM makes a nice looking house."

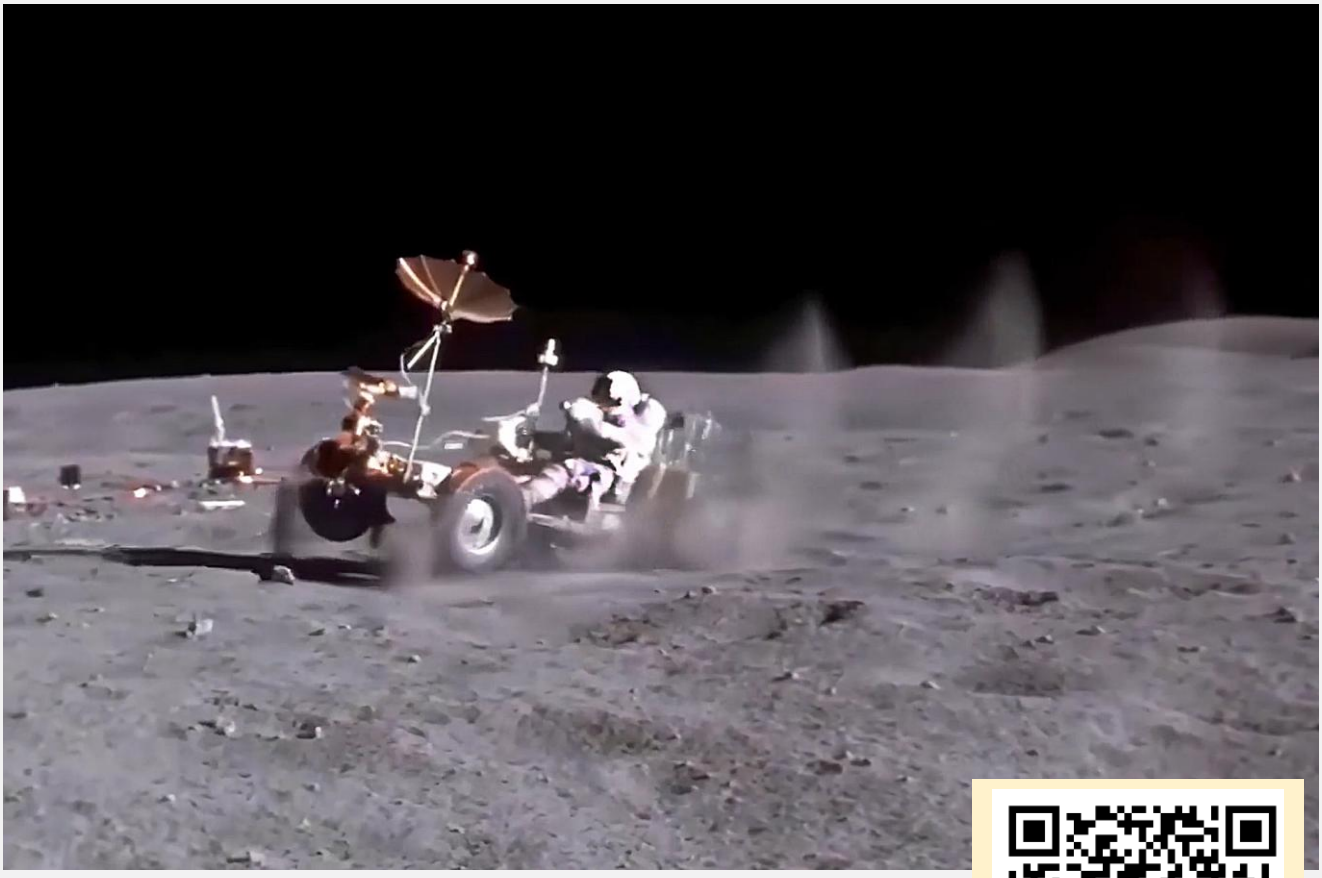
"Especially since it's about the only one there!" noted Duke dryly.

Above: Charlie Duke prepares to pick-up “Big Muley”. John Young is on the left.

Images: NASA

Below: The 11.7 kilogram of white-clast breccia in the Lunar Receiving Laboratory at JSC.





A frame from the 16mm movie film taken by Charlie Duke. Image: NASA

WATCH

Image stabilised video of the 'Grand Prix' on the Apollo Flight Journal's YouTube channel. *Internet connection required.*

The Grand Prix

Although Dave Scott had performed a Grand Prix in Apollo 15, the 16mm movie camera had failed to produce any usable pictures, so the Flight Plan called for another demonstration drive in front of their 16mm movie camera.

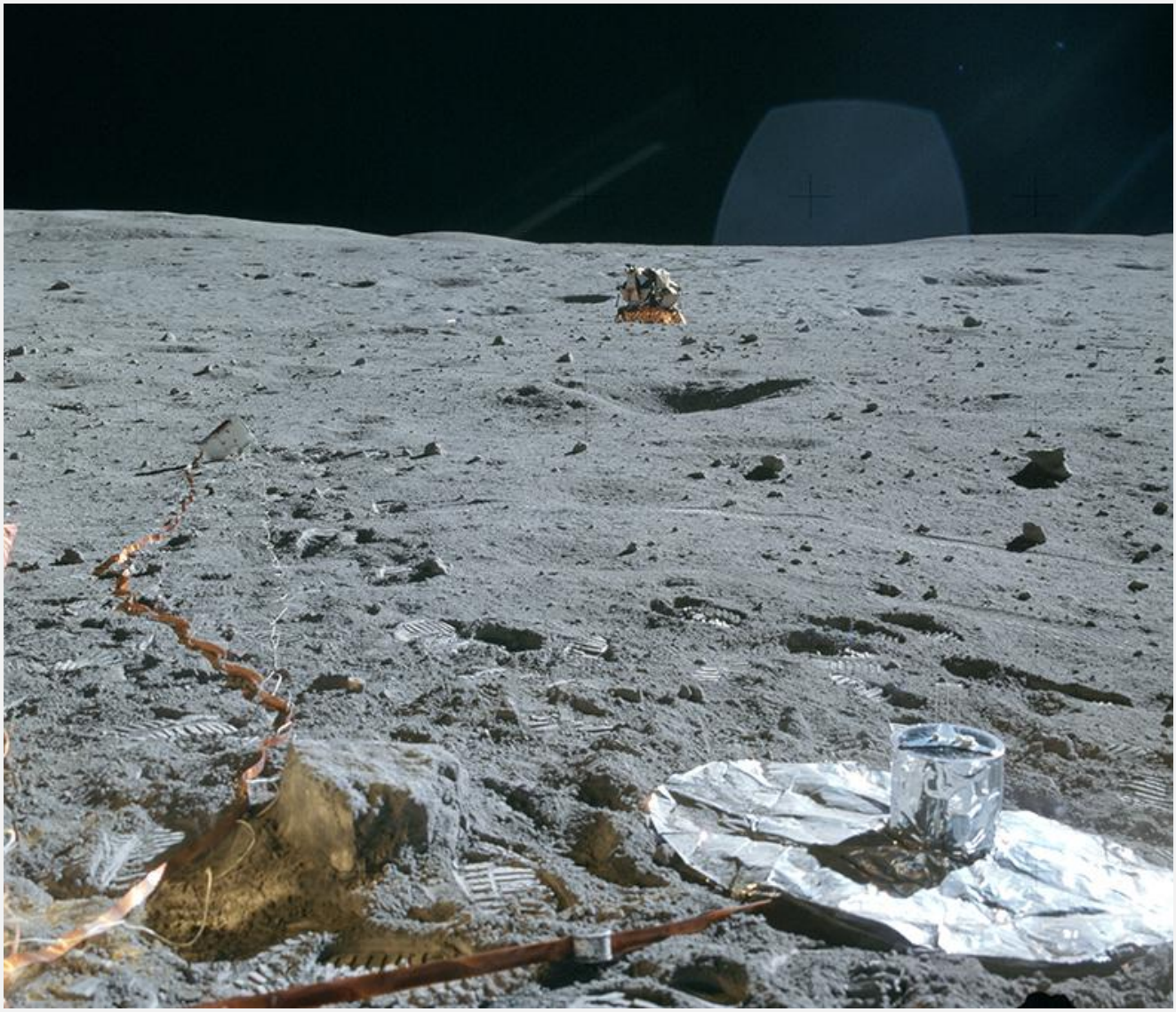
Duke jumped off the Rover, gave Young the thumbs up, set his camera about 50 metres from the action, and described the scene as Young put the Rover through its paces at 0850,

"He's got about two wheels on the ground. There's a big rooster tail out of all four wheels. And as he turns, he skids. The back end breaks loose just like on snow. Come on back, John. Man, I'll tell you, Indy's never seen a driver like this (referring to the Indianapolis 500). Okay, when he hits the craters and starts bouncing is when he gets his rooster tail. He makes sharp turns. Hey, that was a good stop. Those wheels just locked."

Young explained to me:

"We drove it to see how it worked. We had to go up the side of a mountain with slopes more than 20°, and I think we did that because we bottomed out the pitch meter. We wanted to see how the vehicle handled. We had the camera there to document it too, which nobody else had done before.

It was like driving on ice when you cut the thing too sharp at about 5 or 7 kilometres per hour, it would slide out and go backwards. The stuff on the moon is very slippery. You don't hear anything but your suit pumps going when you're drivin' in a vacuum. It was very difficult to get in and out of – the Apollo 17 guys had a scoop to pick up rocks up without even stoppin' the Rover."



The view from the ALSEP back to the LM and flag (as seen in previous close-up). Image: NASA

After completing more tasks at the ALSEP site, the two astronauts arrived back at the LM at 0903 AEST and parked the Rover beside it. By this stage Duke had used all his cooling water and was on his reserve.

Closing the hatch at 1000, making it a 7 hour 6 minute 56 second EVA, the astronauts relaxed in the LM and went through a thirty minute briefing with the scientists in Houston.

Duke told Houston that he was convinced that at the LM and ALSEP sites they were on a ray from South Ray Crater, as the rocks seemed to be predominantly from there, but that at Flag, Spook and Buster Craters they were definitely out of the ray and on the Cayley.

Both astronauts suffered bruised fingers trying to work equipment and pick things up.

Young thought it may have been because he had forgotten to trim his fingernails, a problem suffered by the Apollo 15 astronauts, but as Duke had trimmed his and he also suffered, it seems that it was a hazard of the pressurised spacesuit.

> Duke: *"Working in that spacesuit, squeezing those gloves and pressing the tips of our fingers against the ends, caused our fingers to seem like bloody stumps."*

The astronauts had to exert pressure all the time to keep the fingers bent when holding an object, or the suit pressure would pop the hand open.

Young and Duke both found difficulty drinking the water and orange juice from the suit containers. After more than 7 hours out on the lurain, Young said:

"The first thing I wanted was a drink of water. I could have finished all my drink if I had a mouth behind my left ear. That was my only problem. It got lodged back there and I never could get at it."

In an attempt to overcome the potassium loss suffered by the Apollo 15 astronauts, Young and Duke were encouraged to take as much orange juice as they could.

During the preparations for settling down for a sleep period inside the LM the following conversation took place:

England, *"... but things look pretty good. And your biomed looks great down here. Just keep up the orange juice. Push on it a little bit there and everything will be fine."*

Young was doubtful, *"Push on the orange juice and everything will be fine?"*

England, *"Yeah, push on the orange juice. Rog."*

Young, *"I'm going to turn into a citrus product is what I'm gonna do."*

England, *"Oh, well; it's good for you, John."*

Young, *"Ever hear of acid stomach, Tony?"*

A bit later, as they were eating dinner, Young confided in Duke with one of Apollo's classic passages, suspected to be inadvertently transmitted by a sticking push to talk switch:

"I have the farts, again. I got them again, Charlie. I don't know what the hell gives them to me. Certainly not... I think it's acid stomach. I really do."

Duke: *"It probably is."*

Young: *"I mean, I haven't eaten this much citrus fruit in 20 years! And I'll tell you one thing, in another 12 @#$% days, I ain't never eating any more. And if they offer to supplement me potassium with my breakfast, I'm going to throw up! … I like an occasional orange. Really do. (Laughs) But I'll be durned if I'm going to be buried in oranges."*

They then slung their hammocks for a sleep period. We had only been tracking them for an hour when Young said goodnight to Capcom Stu Roosa at 1517 and fell asleep straight away. Duke, though, was so wound up over the events of the day and the plans for the next day he ended up taking a Seconal sleeping pill.

Sleep Time and the
Second 'Morning' on the Moon

All evening, we tracked the LM and its sleeping astronauts until their second day began at the end of our day with an eager Young calling Houston through Honeysuckle Creek at 2301 –

"Houston, Apollo 16. Over ... Houston, Orion. Over ... Houston; Orion. Over"

"Orion, Houston. How do you read?" replied duty Capcom Don Peterson.

"Rog. What time are we supposed to get up? Over".

They were only 3½ minutes ahead of their scheduled arousal time. Thirteen minutes later Tony England took over from Peterson, and a discussion on plans for the day's activities began. Then right in the middle of the EVA 2 discussion the lines from Honeysuckle Creek to Houston went down at 2335 –

Listen to John Saxon Speak with John Young and Charlie Duke

Recorded at Honeysuckle Creek, John Saxon conversed with the Apollo 16 astronauts on the Moon while the problem with the link to Houston was being sorted out.

Longer and alternate versions on the HoneysuckleCreek.net website

3.6mb mp3 file. Shorter with silences removed.

John Saxon on the Honeysuckle Operations Console. Photo: Hamish Lindsay

Honeysuckle Creek talks to
Apollo 16 on the Moon

Young: *"We were just sittin' there in the LM talkin' to Houston when Honeysuckle called back."*

John Saxon, on the Operations Console at Honeysuckle:

"We lost all the lines to Houston for a considerable period. I was madly trying to reestablish lines to Houston, when the astronauts called Houston, and I had to respond. We had a chat for about five minutes; I guess I am the only person in the Southern Hemisphere that actually got to speak to anyone on the lunar surface. The conversation was mainly about beer."

Saxon: *"Orion this is Honeysuckle. We have a comm outage with Houston at this time. Stand by one, please."*

Young: *"Okay, Honeysuckle nice to talk to you. How are ya'll all doin' down there?"*

Saxon: *"We're doing great. Nice to talk to you."*

Young: *"You sound good."*

Saxon: *"Roger that … We'll be with you shortly, we are just getting some lines reconfigured here."*

Young: *"Have a Swan for us."*

Saxon: *"Say, again, Orion. You're pretty poor quality on this back up."*

Young: *"I said quaff a Swan for us."*

Saxon: *"Ah … I still can't copy you, Orion. Sorry about this, the quality is very poor at the moment."*

Young: *"Okay you're loud and clear."*

Saxon: *"Roger that, I read you a bit better now."*

Duke*: "Honeysuckle, what John was saying was have a Swan for us."*

Saxon: *"Oh, Roger."*

John Saxon calls Houston Comm Tech again on Net 1 – he cannot hear any reply. John's voice is being heard in Houston.

Saxon: *"Orion, this is Honeysuckle – We're still having trouble with the incoming from Houston. We should get it restored very shortly for you. Sorry about the delay."*

Young: *"Roger, thank you."*

Saxon: *"Okay, we're reading you this time for a change."*

Duke: *"Okay you guys are nice to talk to. We don't care about Houston."*

Saxon: *"Thanks very much. Certainly, appreciate it. It's a pleasure working on this mission."*

Young: *"Roger. We'd sure like to come down there and see you folks after this is over too."*

Saxon: *"Right you've got a permanent invite, anytime you like."*

Young: *"That's very kind."*

Saxon: *"We will keep the beer cool for you."*

Young: *"You've just got a couple of fellas going to show up on your lawn here."*

Duke: *"That's the best idea I've heard all day."*

Saxon: *"I think it's a pretty good one down here too."*

Duke: *"You see in my terminology friendly 48 packs, right now that's how I feel. Really love one."*

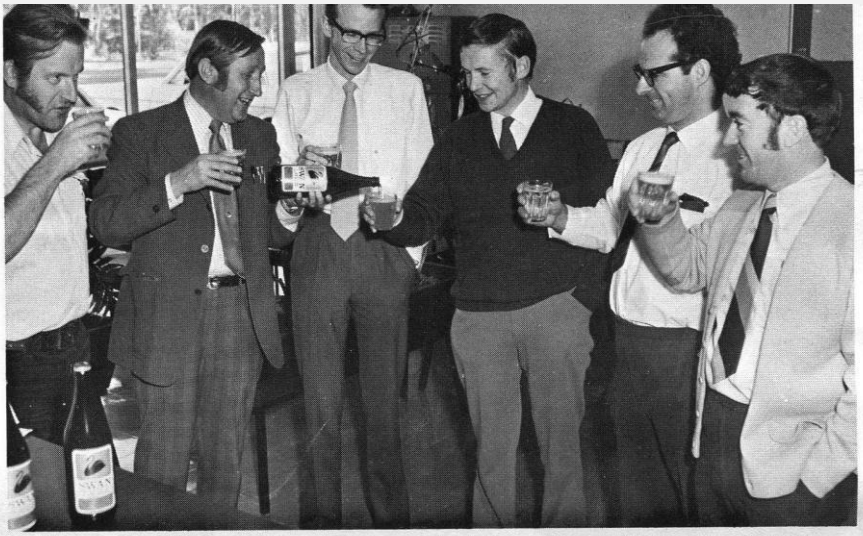
Saxon: *"Roger that. We're still having difficulty with the comm, Orion. Hopefully, very shortly, we will get the net up for you."*

Duke: *"Okay … take your time, don't worry about it … we're eating."*

Saxon: *"Don't worry Orion, we are worrying!"*

The staff at Honeysuckle Creek ground station enjoy a "splashdown" Swan Lager after the Apollo 16 mission.

From left, the men are social club president Jerry Bissicks, Station Director Don Gray, Chief Engineer Geoff Seymour, Operations Supervisor John Saxon, Deputy Station Director Ian Grant and Station Administrative Officer Milton Turner.



The staff at Honeysuckle Creek ground station enjoy a "splashdown" Swan Lager after the Apollo 16 mission. From left, the men are social club president Jerry Bissicks, Station Director Don Gray, Chief Engineer Geoff Seymour, Operations Supervisor John Saxon, Deputy Station Director Ian Grant and Station Administrative Officer Milton Turner.

Flashback: Moon Shot

You will recollect how Swan beer made history during the Apollo 16 mission by becoming the first product to be publicised direct from the moon.

While talking from the moon to the Honeysuckle Creek ground station near Canberra, Astronaut Charles Duke said he would "really love" a Swan Beer.

His moon companion, Astronaut John Young, backed him up with a request to "have a Swan for us".

Twice more the astronauts made the request in their talk with the Honeysuckle Creek station.

To mark the occasion the Group Public Relations Manager, Mr George Geddes, sent some Swan Lager to Honeysuckle Creek for a "splashdown" party.

Recently the station director, Mr D. J. Gray, wrote to thank Mr Geddes for his gesture.

Mr Gray said: "The two photographs enclosed show the station staff enjoying the Swan Lager which you kindly supplied following the Apollo 16 mission.

"Unfortunately, all our efforts to organise a traditional splashdown party have been frustrated by operational commitments.

"For one reason or another the station has been continuously involved in either supporting the scientific experiments left on the moon by the various Apollo missions, or in extensive engineering projects.

"This has meant that at no time has it been possible to hold a function which all members of this station, along with those from our sister station at Tidbinbilla, could attend.

"Rather than let any further time go by which would have detracted from the relevance of the Apollo 16/Swan Lager connection, we decided on a station luncheon. We felt this met the spirit of your generous gesture, although we would have dearly loved to have done it proper justice in a less formal manner.

"I think the photographs portray the enjoyment your product brought us and I would like, on behalf of station staff, to express their appreciation for your Company's contribution to our celebrations.

THE BLACK SWAN

The story was told in "The Black Swan",
the official journal of the Swan Brewery, Perth WA. Issue Vol 9 No 5 dated Sept 1972.

Preserved and scanned by Milton Turner.

Five minutes later, at 2340, the line was restored, and the conversation finished with:

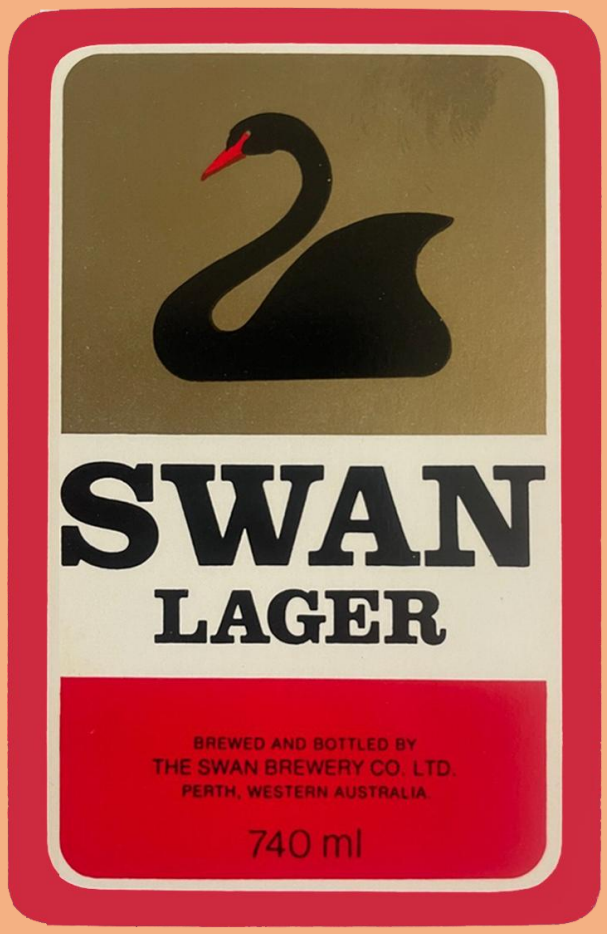
England, *"Orion, Houston."*

Duke, *"Go ahead."*

England, *"Hey, outstanding! You're back!"*

Duke, *"Yeah, you were gone for a little while, and we had a nice chat with Honeysuckle. They're mighty friendly folks down there."*

John Saxon: *"This was picked up by the American press, and they published a few things about astronauts talking to Australia and talkin' about Swan Lager. Swan got hold of this, and thought it was marvellous publicity, so they sent each of the astronauts a crate of beer. We rang them up and said, 'Hey look we're having a party too', so we ended up with 48 crates of Swan beer!"*



"Hey, look we're having a party too, so we ended up with 48 crates of Swan beer!"

HSK MISSION DAY 7
SUNDAY, 23 APRIL 1972
LUNAR SURFACE – EVA-2

Times: AEST (HSK local time)

EVENT	GET	AEST
CSM Lunar orbits 42 – 47		
EVA-2 – hatch opening	142:51:15	0245:15
Rover departure	143:43:00	0334:00
Rover wheel failure Resolved at Station 8	146:48:00 017:14:00	0642:00 0708:00
Rover excursion #2 terminated [11] [12]	148:54:32	0848:32
EVA-2 end [13]	126:11:59	0545:59
Sleep period begins Wake-up	154:43:07 162:38:32	1437:07 2232:32

[11] On arrival at Station 10
[12] Distance travelled – 11.1 kilometres
[13] Excursion elapsed time – 5h 11m 32s

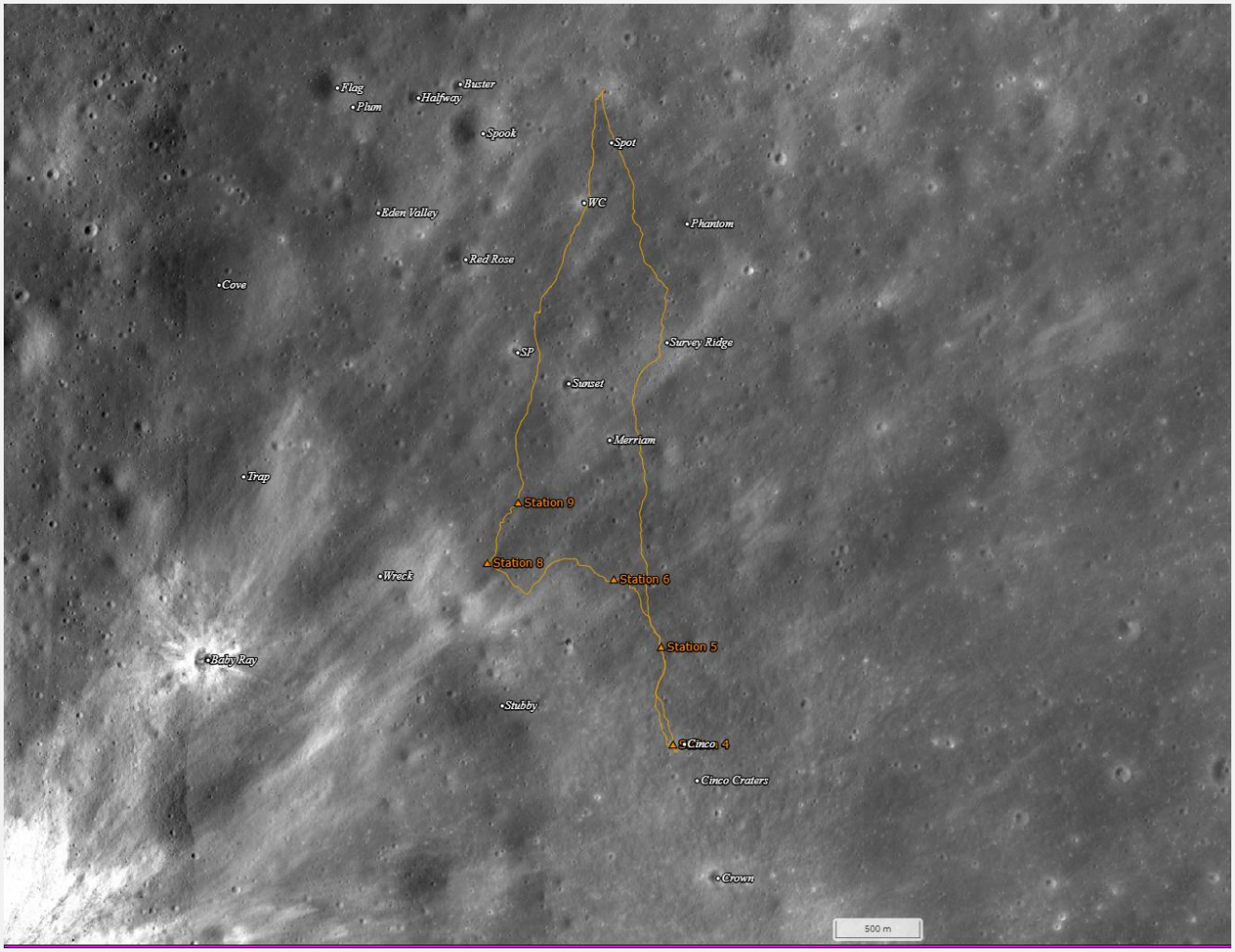
Prime HSK	Track Duration	AOS/ LOS
CSM	10h 48m 00s	1515:00 24/0203:00

Handovers	AEST
CSM 2-way from GDS	1651:00
CSM 2-way to MAD – 7h 53m	24/0044:00

Wing HSKX	Track Duration	AOS LOS
LM	10h 34m 40s	1529:00 24/0203:00

Handovers	AEST
LM 2-way from GDS	1742:00
CLM 2-way to MAD	24/0152:00

Note: HSK and HSKX experienced high winds of up to 52 knots – 96 kilometres per hour. However, tracking was not affected.



Excursion #2 traverse map. Image: NASA/ Lunar Reconnaissance Orbiter Camera

The orange line shows the course the astronauts took across the lunar surface, taking in stops at:
Station 4, Cinco Crater (farthest south), and on the return journey, Stations 5 and 6,
then to the west and Station 8 (nearest the brighter ejecta of South Ray Crater [off photo]).
Last stop was the nearby Station 9, before returning to the Lunar Module. *NB: Gray bar equals 500 metres.*

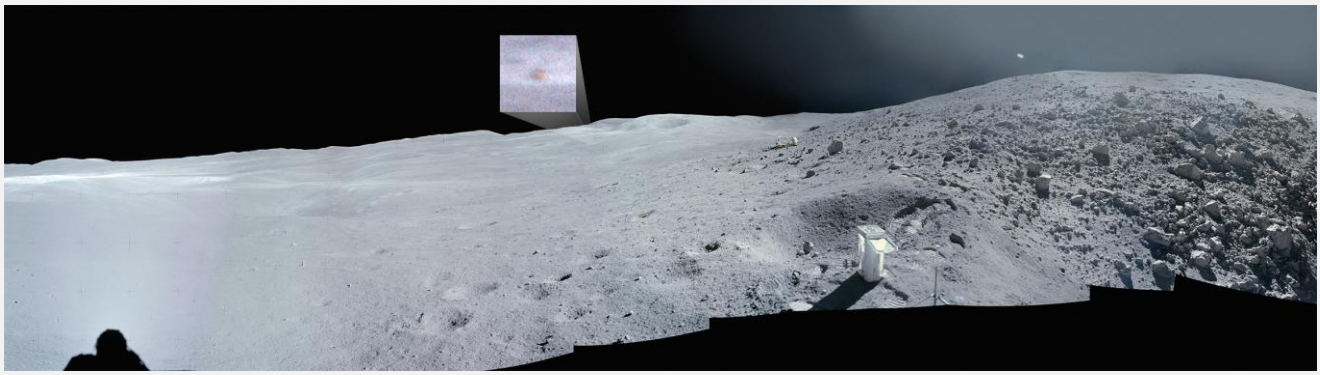
At Honeysuckle Creek the Prime site lost the LM signal with the moon setting behind our Collimation Tower ridge just 30 minutes before the second EVA began at 0233, and Madrid took over the tracking.

The major objective for the second excursion was to visit Stone Mountain and climb a 20° slope almost to the summit to visit Cinco Craters.

After Stone Mountain they were to drive west towards South Ray Crater. The crater itself was 13 kilometres away and out of reach, but they were to stop at a place called Survey Ridge and try and get some dark material thought to have come out of South Ray Crater. Then they were to return to the Lunar Module.

Second Excursion

They left the LM at 0334 AEST. As they were driving across Sun, giving them good visibility, Young set up a fast pace, at times reaching 10 kilometres per hour. The Rover bucked and bounced across the lurain on a course of 162°. As they progressed away from the LM the surface became rougher, with more craters and rocks, some nearly two metres across. At a distance of 2.8 kilometres from the LM, they were pushing hard trying to keep on schedule, having a ball tearing up and down slopes and hitting bumps, though concerned they might hit a big rock and smash the radio and television controls mounted on the Rover's front assembly. Dust was flying everywhere.



Above: This view of the landing site – South Ray at left – to Smoky Mountain in the centre, and the slopes of Stone Mountain - at right - from where this panorama was taken.

The Lunar Module is in the distance (above centre), as seen in the blown-up inset image above, and appearing at **left**.

Assembled from NASA images AS16-107-17468 to 76 – part of a panorama taken by John Young at GET 144:48, as he stood next to a small crater. There's a sample collection box on in the foreground.

"Hey, that was super. That wheel just left the ground." Duke shouted in glee.

"This is the wildest ride I was ever on" agreed an enthusiastic Young.

"I love it. It's great! Eight clicks, Tony. We got up to 12 there, once." Duke was ecstatic.

"Sounds like you're really making money there," an envious England responded from his rock-steady console in Mission Control.

The Rover began to climb the lower slopes of Stone Mountain, and the astronauts noticed they were now surrounded by dark material from South Ray Crater as the five craters came into view.

Station 4

After about 38 minutes driving in a straight-line distance of 3.8 kilometres from the LM, at an average speed of 7.3 kilometres per hour, they arrived at Station 4, the Cinco Craters on Stone Mountain, a few minutes ahead of schedule at 0403. They parked close to the west rim of crater Cinco *b*.

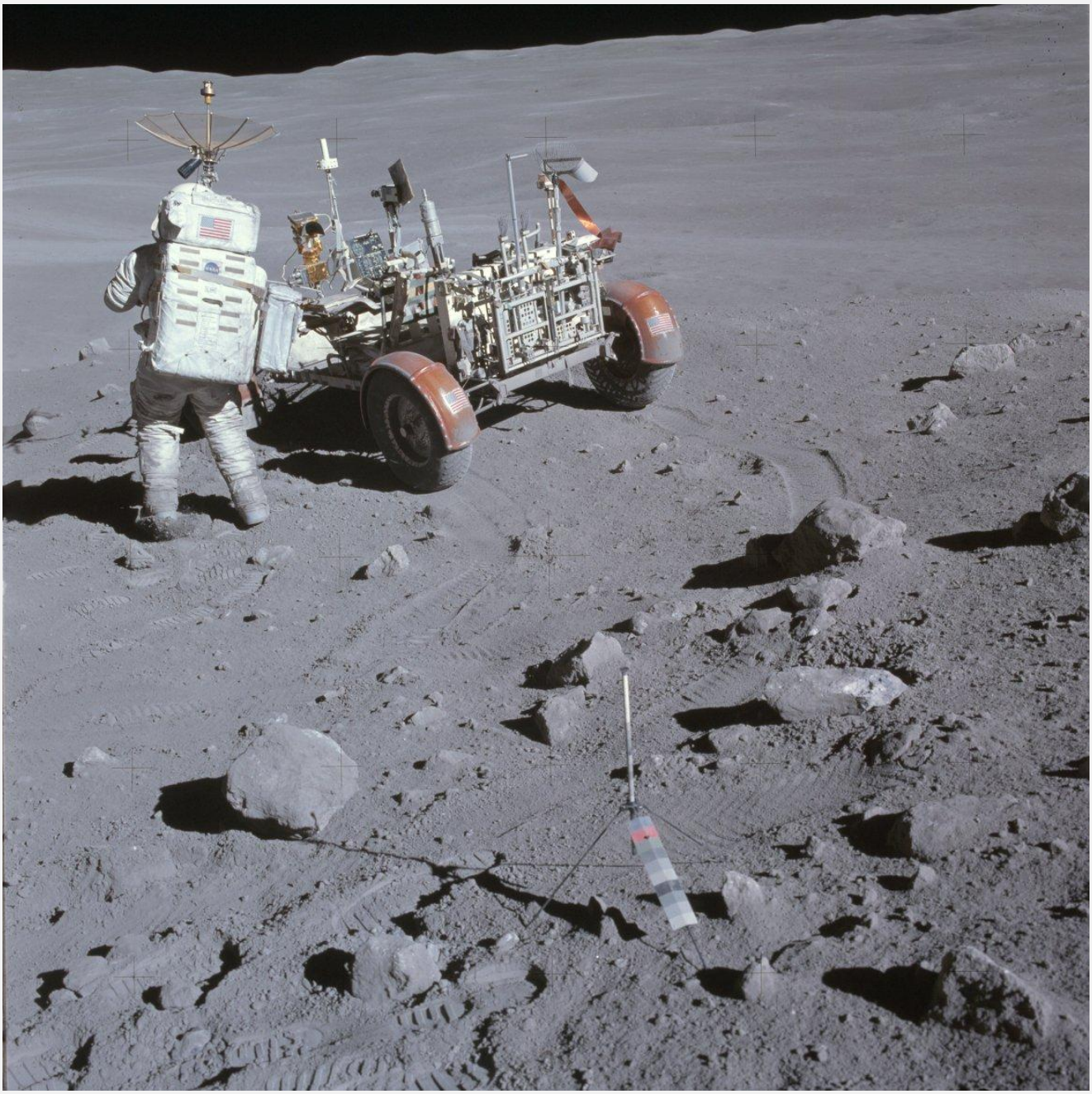
Ken Mattingly, orbiting 111 kilometres above them, saw a momentary flash from Descartes region. Young and Duke felt he must have seen the Sun glinting off their battery of mirrors. It was the only sign Mattingly ever saw of his mates on the surface.

At Stone Mountain they reached a height of 152 metres above the valley floor, the highest elevation above the LM of any of the Apollo excursions. Looking back over a series of steep ridges dropping away from their feet they found the panoramic view across the valley stunning. Duke felt they could go tumbling down the mountainside without stopping. He looked up to see the circular South Ray Crater dominating the valley with its alabaster white rim,

"Tony, you can see the rays of South Ray come out across the landscape, albedo-wise. And it's really predominant. They cross right across.....Go right up Survey (Ridge), and it's definitely ray pattern that we were crossing."

In the middle of the valley was the LM, the only spot of colour in the whole scene:

"Tony, you just can't believe this! You just can't believe this view! You can see the lunar module; you can see North Ray with boulders on the southwest side; and where Station 12 is, there's one huge boulder [to become House Rock] that's going to be just great. It looks like we can get up there, and there's a great ray pattern going up the side of Smoky Mountain from North Ray."



Charlie Duke with the rover at Station 4. Gnomon in the foreground. Image: NASA

A few minutes later Duke couldn't resist another attempt at describing the wonder of the scene and the moment,

"Wow! What a place! What a view, isn't it, John?"

Young, *"It's absolutely unreal!"*

Duke, *"We've really come up here, Tony. It's just spectacular. Gosh, I have never seen ... all I can say is 'spectacular,' and I know you are all are sick of that word, but my vocabulary is so limited."*

England, *"We're darn near speechless down here ..."*

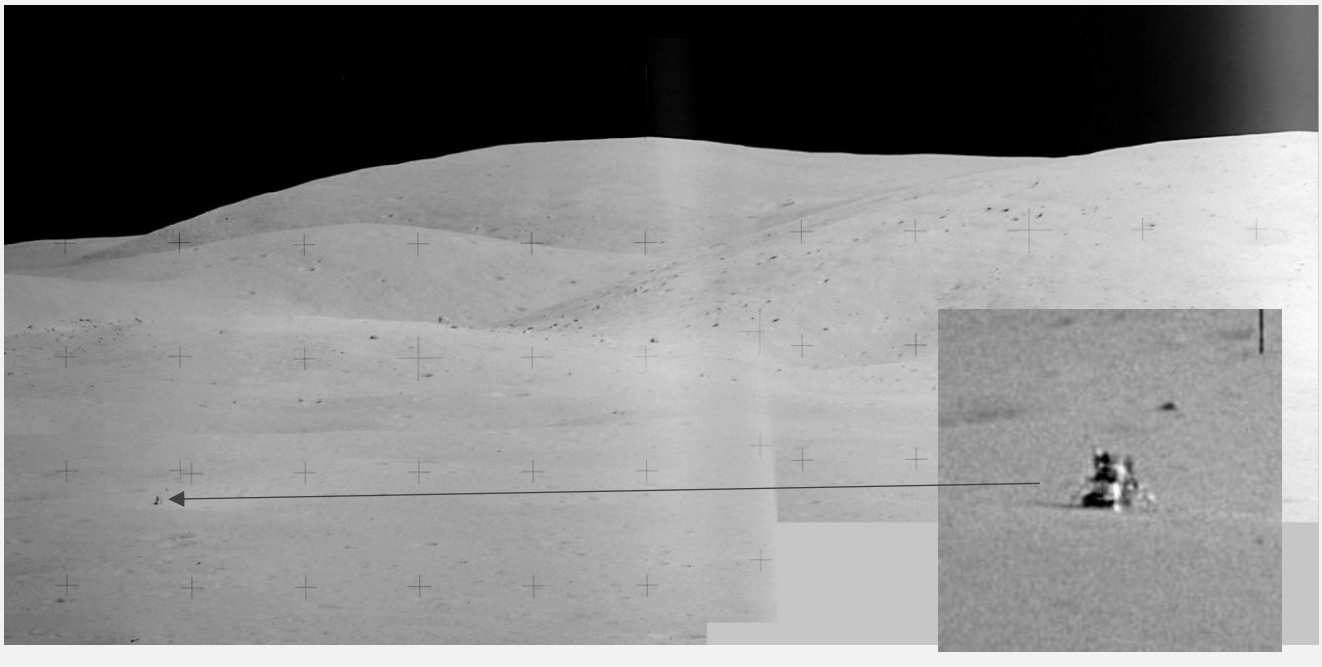
Not quite sure of their exact position the astronauts turned to their scheduled tasks, unaware that Cinco a, the largest of the five craters was less than 80 metres away out of sight behind a ridge to the east. As they floundered around they felt it was like climbing a steep sand dune, the soil was so loose they would slide downhill at each step.

This station had the most difficult working conditions of their whole visit; trying to avoid falling into craters; trying not to glissade down the slope; and the steep lurain tiring them out. Duke had trouble getting core samples, the tube appeared to hit rock about half way, so he had to

Above: This view of South Ray was assembled from images using a 500-mm mini-pan taken by Charlie Duke at 144:14.AS16-112-18245 and AS16-112-18247 to 18252.

Images: NASA

Below: Turning a little to the right, Charlie Duke snapped a panorama of Smoky Mountain. The distant LM (arrowed) is visible in this panorama from Stone Mountain, assembled from images AS16-112-18270, 71, 72, 74 and 75 – taken by Charlie Duke at 144:16.



try again. The hammer didn't fit in his glove very well with the result he dropped it a few times. When he found he couldn't bend enough to pick it up, he had to use other tools to retrieve his hammer from the lurain.

Now on a heading of 354° they pushed on to Station 5, leaving Station 4 at 0457 after a spell of 54 minutes. Still on the slopes of Stone Mountain, it was downhill all the way. At this point they returned to their outbound tracks. Young drove carefully at around 4 to 5 kilometres per hour, increasing to 10 on flat stretches, but coming up to a ridge he slowed up because he wasn't sure what was on the other side.

He commented, *"When you got the Rover up to about 10 clicks going down a hill, it's just like riding a sled on ice. No matter which way you turn the wheel, the thing's going straight. I mean, it'd be sideways, but still going in a straight line downhill."*

As he said to England from the lunar surface, *"Okay. I've got the power off, and we're making 10 kilometres an hour, just falling down our own tracks."*

Tony England watching the action from the CapCom console. Image: NASA/JSC

The digital MET readout above and just to the right of his video monitor reads 144:39:17. Deke Slayton is standing behind Tony; and Fred Haise, the backup Commander, is sitting to his right.

With thanks to J.L. Pickering and Kipp Teague's Apollo Image Gallery.

Station 5

They arrived and parked on the rim of a 20 metre wide crater they called Station 5 at 0503. Rather frustrated by ambiguity of the samples at Station 4, here they were looking for a primary crater not contaminated by South Ray and hoping to find some samples of Descartes of which Stone Mountain is made. Young walked around inside the crater, looking carefully at the sloping side facing away from South Ray, but neither found the rocks that were definitely Descartes, though to this day, according to geologist Don Wilhelms, the Station 5 samples are a reasonable bet to be Descartes, but nobody is really sure of the origin of these samples.

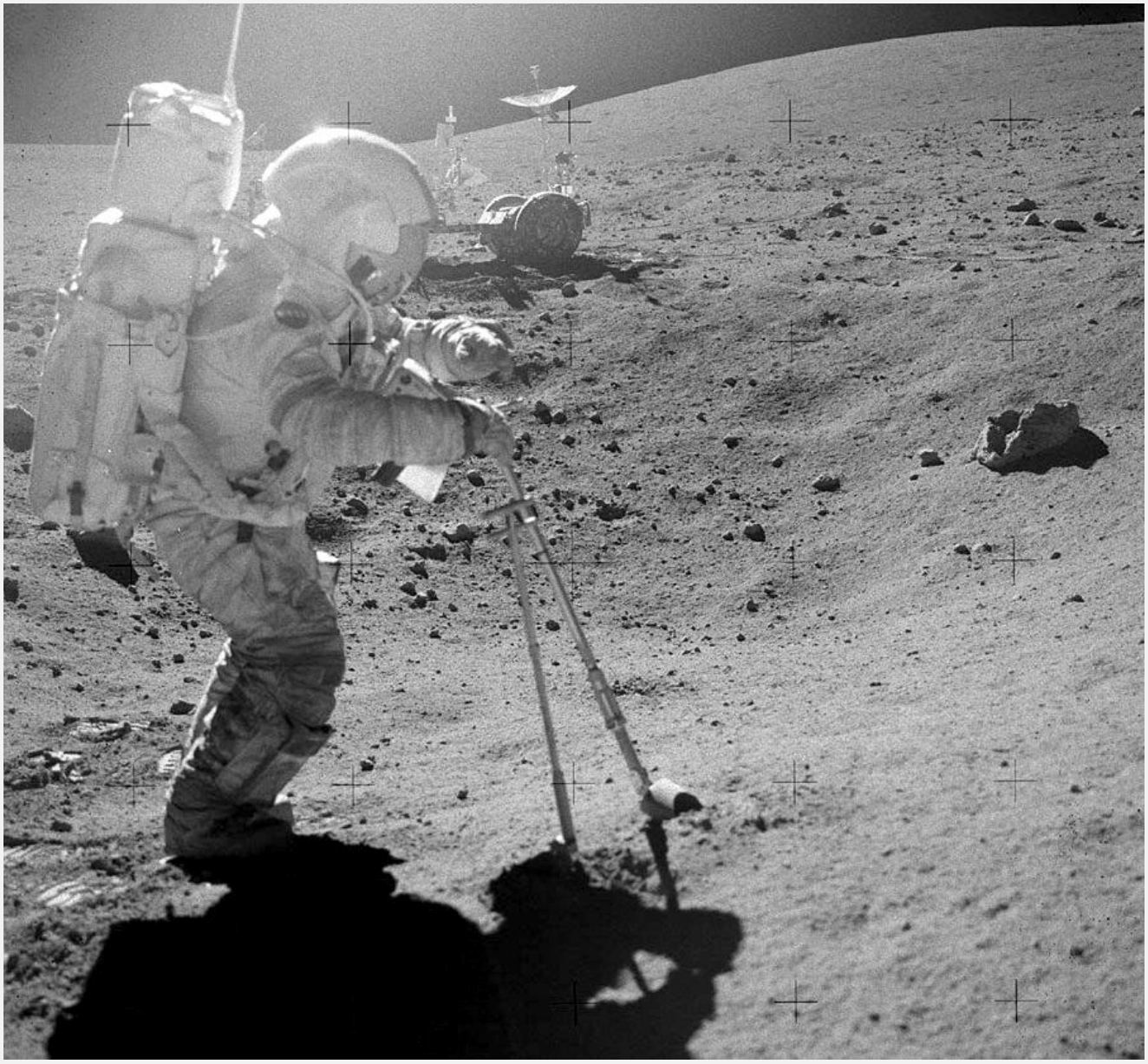
At 0552 they set off on a heading of 274° and this time it was cross slope, the Rover driving along tilted on its side. Duke was sitting on the down side. With no door, he was feeling a little insecure,

"Okay, we're going downslope ... cross-slope, Tony. And I feel like I'm about to fall out."

Although Duke didn't feel the Rover was going to tip over, it did slide sideways, sometimes the back slipping more than the front.

Station 6

As they were driving along Houston requested, *"Okay. And we would like Station 6 at the lowest terrace on Stone Mountain and a blocky crater, if possible."*



John Young takes a soil sample at Station 6. Image: NASA

They found a couple of suitable craters and chose the more blocky one, about 10 metres wide, to park on the east rim at 0600. A firmer regolith suggested they were standing on the Cayley Formation, but there was nothing exciting lying about. After picking up some sample rocks and soil, they left Station 6 at 0623 and headed 274° towards Station 8, bypassing Station 7 to save time.

Station 8

They made their third stop on Stone Mountain on its lowest terrace, with the LM bearing 11° at a distance of 2.9 kilometres.

Their speedometer showed they had travelled a distance of 7.9 kilometres, though the accuracy of this reading may have been affected by wheel slippage.

Arriving at 0634 they found that the lurain was much harder – their boots were hardly making an impression in the dust, and they could feel a hard layer under. They noticed they were on a Ray from South Ray Crater and there were boulders galore. After an hour of raking, coring, and picking up samples they had a variety of rocks including black and white breccias and smaller plagioclase-rich crystalline rocks.

Just before finishing at Station 8 Houston requested Young change battery loads by reconfiguring circuit breakers. This seemed to disable their navigation system, and they left

Station 8 at 0742, heading for inter-ray Station 9, unaware their bearing, distance, and range was not being updated, but the heading and speed indicators were operating normally.

Station 9

At 0747 the Rover pulled up at the last remote station of the day. Duke complained that Young always pulled up beside a crater so he couldn't get out on his side without falling in a hole.

"John, I can't get out."

"Why?"

"You parked right in a crater for me. That's good, now." To prove his point when Duke jumped off he fell down.

Duke's suit caught in the right rear fender of the Rover and pulled it off. When they drove off the lunar dust flew up and rained down all over them.

At 0756 Young decided to take a sample that was hopefully not contaminated, or had not been disturbed in any way, by approaching a patch of soil behind a rock very carefully and taking a sample with a Contact Soil Sampling device. They called it 'sneaking up on it.'

"Okay, that rock over there, the one I'm gonna sneak up on, Charlie."

"Don't scare it," England joked.

Young crept up to the 90 centimetre high rock, being very careful not to kick any dust around, reached over with the scoop and scraped two samples of pristine soil from behind it.

"I gotcha!" Young addressed his sample.

At this point Ed Fendell was having trouble locating the astronauts with his TV camera, and Houston missed the moment of collection, "Gee! The first lunar Great Rock Hunt and we missed it!" England exclaimed with disgust.

Eleven minutes later they looked for soil under a rock that hadn't been exposed to the solar radiation. They found a 1.8 metre boulder, but try as they might, they couldn't move it, so looked for a smaller one. Young found a 1.2 metre rock and managed to topple it over,

"Charlie, I got it!"

"He got it!" Duke echoed.

Young, *"That's a biggie. Man, it looks like it's been sittin' there for a while. Look at that soil underneath it … before I stomp all over it, Charlie, sneak over here and let's get some of this soil."*

"A chip off the bottom and the soil will probably do it," suggested England.

At 0823 the astronauts left Station 9 for home. The astronauts were still unaware their navigation system had failed and were reciting repeating figures until 0831 when Duke spotted the bearing, distance, and range readouts had not changed and there must be a problem, but by this stage it was not such an issue.

On the way to Station 10 they observed that it appeared to be a very old surface saturated with 4 to 5 metre subdued craters. With the missing fender, dust was being flung everywhere, all over their suits. Duke commented that the fenders really had a use.

As they sped homeward Duke was looking around,

"I can't believe how hilly this place is – there's not a flat place around."

"Right – except where that LM is," agreed Young.

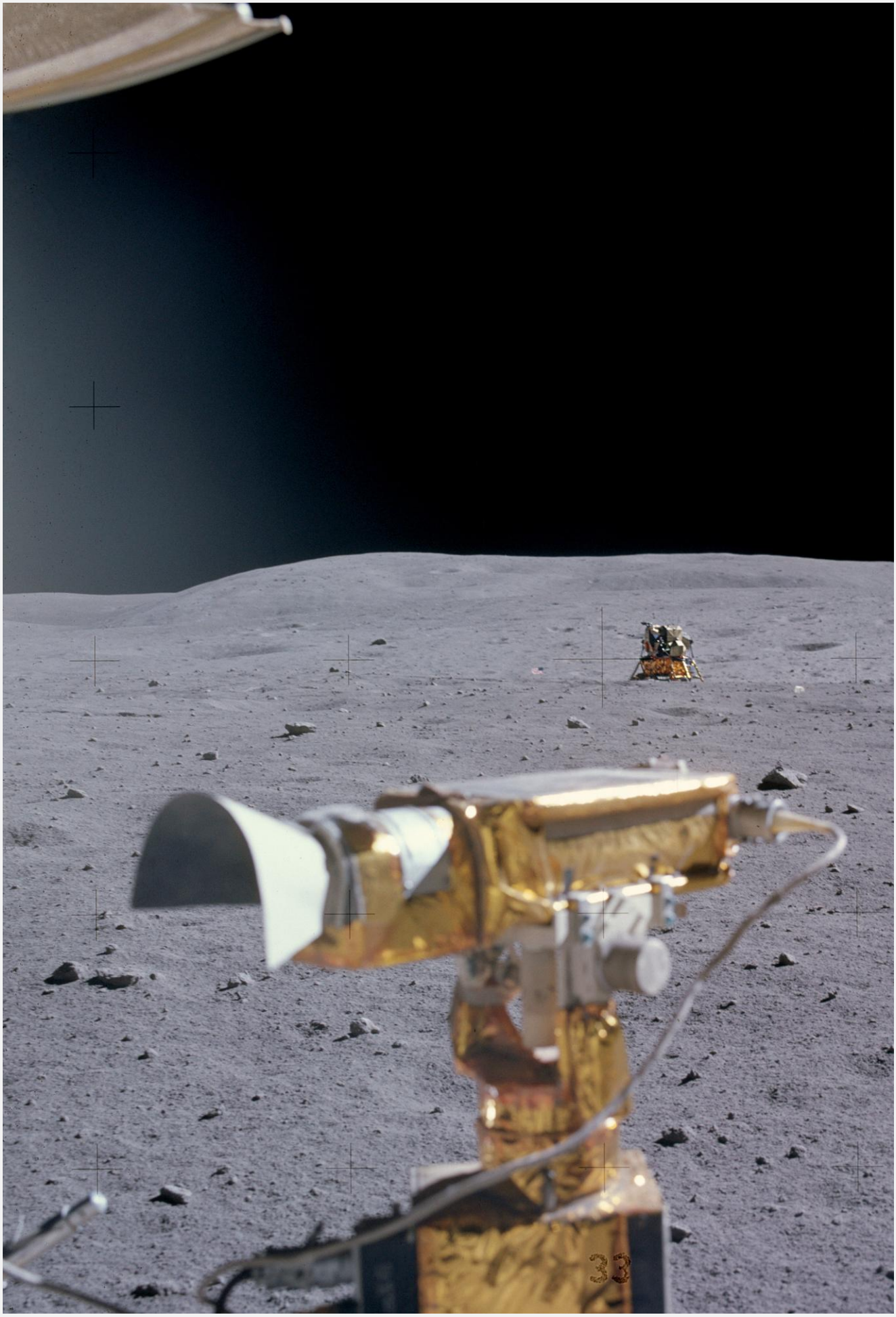
Station 10

They arrived at Station 10 at 0848, half way between ALSEP and the LM, and parked the Rover about 60 metres from the LM. By now they had been on the go for more than six hours, and they still had some work to do with the ALSEP. They dug a double core, and Charlie conducted a number of penetrometer tests on a line extending 50 meters east from the ALSEP.

Running a bit behind schedule, the boys on the Moon begged for an extension of the EVA; they probably also had their eye on taking the EVA record off the Apollo 15 team.

"Tony, how about an extension, you guys? We're feeling good." Duke pleaded.

"Oh, we understand, and we can understand why you wouldn't want to get back in, but we'd like you to get back in on time. And you've got a lot of science there, so don't worry about it."



A view to the LM on the traverse from station 9 to station 10. Image: NASA

"You said all we was gonna do tonight is sit around and talk!" challenged Young.

"Well, we like to hear you talk," England answered.

"Yeah, especially on a hot mike, huh?" Young laughed as he remembered their earlier gaffe.

Houston granted a ten minute extension, the medicos' only concern that their sleep period was not to be affected.

They left Station 10 at 0916 and returned back to the LM to end the EVA. The hatch was closed and cabin repressurised at 0956, making an EVA 2 elapsed time of 7 hours 23 minutes 26 seconds.

This EVA took the record off Apollo 15. The day ended for the astronauts at 1437 when they turned in for their second sleep period. This meant Honeysuckle Creek's Wing picked up a crew already asleep at our acquisition of signal at 1529. For a change the Prime site kept in touch with the CSM, steadily orbiting the Moon.

The Last Day

On the Moon it was broad daylight at 0632 in the 'morning' spacecraft time, and 2232 in the evening at Honeysuckle Creek where all systems were humming away, locked on to the Lunar Module's signal.

"Orion, Houston." Capcom Don Peterson called the LM through Tidbinbilla's transmitters.

"Who speaks?" a sleepy Duke was brought back to consciousness.

"Roger. How are you doing this morning?"

"Super. Is it time to get up?" Duke was stirring now.

"Yes, sir."

"Okay, reveille, reveille ..." Duke called across to Young.

With the third day the procedures for the day's preparations were much easier. It was their last day on the Moon, and they were facing a packed schedule. The Rover excursion was going to take them the greatest distance from the LM, they were going to see the largest crater any of the Apollo crews had seen, and they were going to launch themselves off the surface for the journey back to Earth.

HSK MISSION DAY 8
MONDAY, 24 APRIL 1972
EVA-3 and LM LIFT-OFF

Times: AEST (HSK local time)

EVENT	GET	AEST
Lunar orbits 54 - 59		
EVA-3 – commenced	165:32:57	0126:57
Rover excursion #3 - commenced	166:09:00	0203:00
Rover excursion #3 - terminated [14] [15]	169:15:00	0509:00
LM Hatch closed	171:12:57	0706:57
Lift-off	175:35:47.2	1129:47
LM/CSM docking	187:41:18	1335:18
Sleep period in CSM		1715:00 25/0112:00

[14] Distance travelled – 11.5 kilometres
[15] Rover excursion #3 elapsed time – 3h 6m

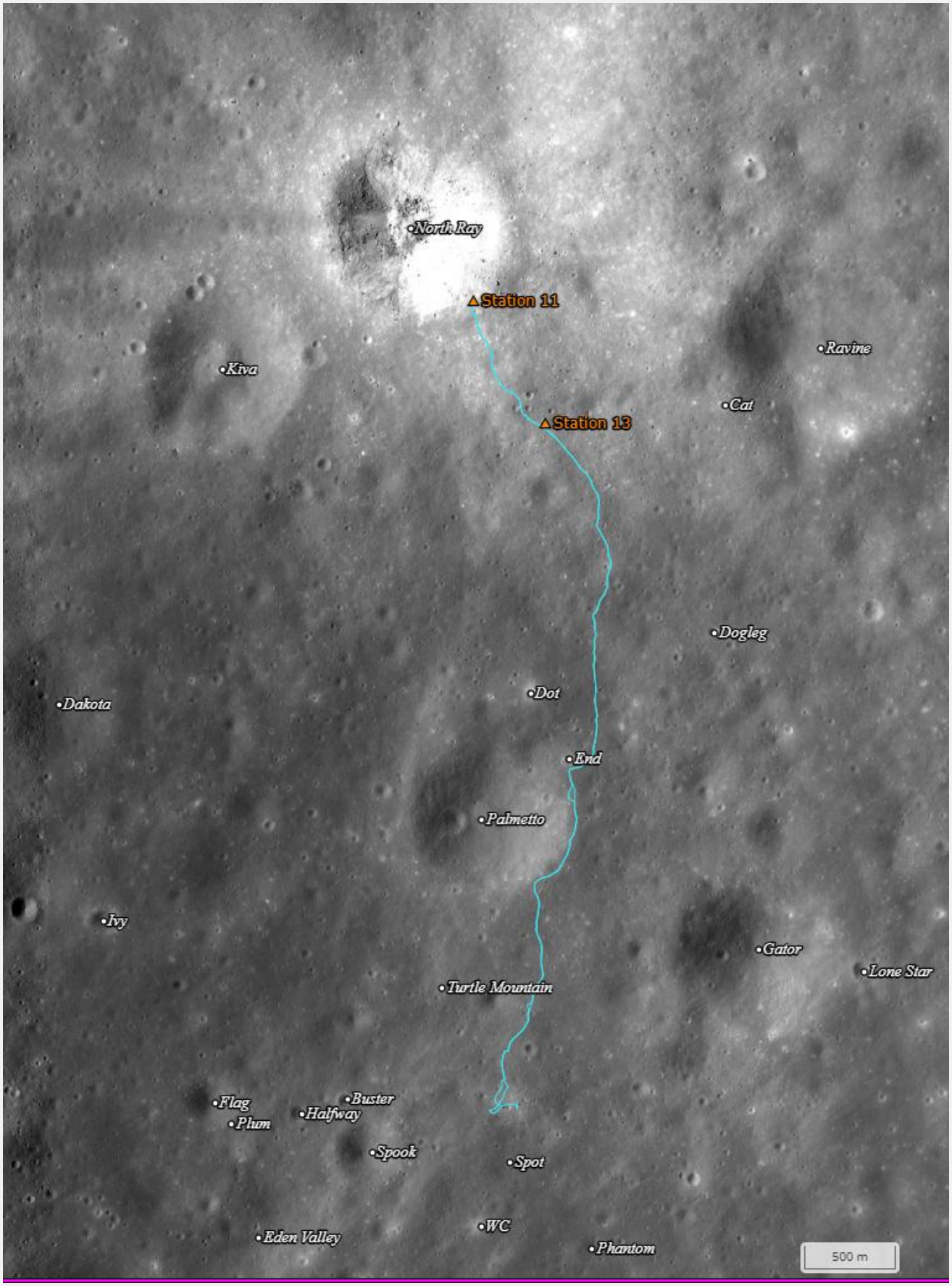
Prime HSK	Track Duration	AOS/LOS
LM	10h 07m 00s	1550:00 25/0157:00

Handovers	AEST
LM from GDS – not logged	
LM to MAD – not logged	0152:00

Wing HSKX	Track Duration	AOS/LOS
CSM	11h 06m 00s	1551:00

Handovers	AEST
CSM 2-way from GDS	1700:00
CSM 2-way to MAD – 9h 27m	25/0227:00

Parkes
Note: Released from active support but remained on standby.



The blue lines marks the traverse during EVA-3.
Travelling north from the LM's landing site, past Palmetto Crater to Station 11 at North Ray Crater.
After the longer than expected walk to House Rock, they journeyed south to Station 13,
there was a brief stop at End Crater (upper right of Palmetto), before making the trek back to the LM.

Image: NASA/Lunar Reconnaissance Orbiter Camera

Sunday, 23rd April 1972 – the start of EVA 3. Image enhanced using Photoshop/AI.

Ed von Renouard happened to be filming as Honeysuckle received the start of the TV from the lunar surface. This video was only seen at Honeysuckle. Here, Les Hughes and Laurie Turner watch the live TV.

Watch the film taken at Honeysuckle Creek

Ed von Renouard was filming at Honeysuckle as they received the TV singal at the start of EVA-3.

WATCH

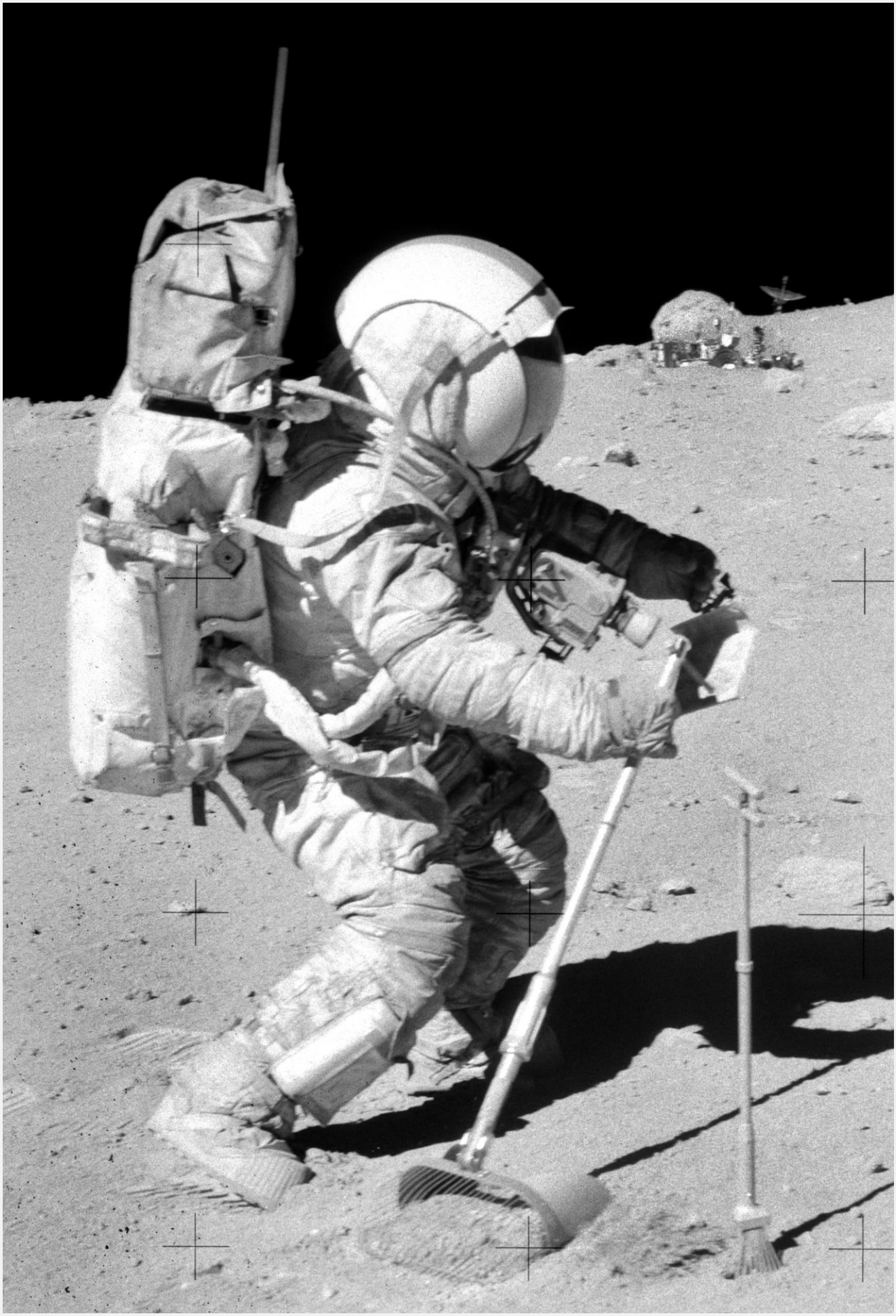
4mb mp4 clip. Running time: 60s

The third EVA was planned to explore North Ray Crater and hopefully find rocks from the greatest depth of any Apollo mission to help the scientists figure out the Moon's origin.

The two astronauts were nicely ahead of schedule as they waited for the cabin pressure to come down. Young looked out of the window, "Charlie, it's going to be hot out there today. I recommend you put your visor down. Shades down."

The sun was now well above the horizon, it had gone from about 15° when they landed, to 45°, and the surface temperature had risen from 29°C to over 95°C.

"I always have had mine down. I agree with you ... can't believe that shadow," Duke had noticed the shadows had shortened considerably from when they had arrived.



John Young using the rake tool to collect samples during the third EVA. Image: NASA

At 0138, 19 minutes before our LOS, Tony England called the LM,

"And, Charlie, they've got a good picture at Honeysuckle. We don't have it here yet."

"Okay."

The reason for this was Houston had already configured their communication lines for Madrid, and it seems they had not acquired the LM at this point or at least set up their TV configuration. It was 7 minutes later before Madrid locked on to the TV.

At 0150, 7 minutes before our LOS, England again called the LM, *"And, fellows, we're going to do a site hand-off in a few minutes. We may lose comm for a second."*

So, we lost the LM's signal to Madrid for the third EVA, which began at 0203, as Young headed the Rover 030°. The lurain was a lot easier heading north, with rolling hills, an absence of small boulders and stones, and the craters were much more subdued and shallow than on the previous excursion. At 0.8 kilometres from the LM, they turned and headed 356° for 1.4 kilometres to reach North Ray.

As they approached the 800 metre wide Palmetto Crater on the way, the boulders began to increase. At 1.8 kilometres from the LM, they reached the southeast rim of Palmetto, but did not stop, merely deviating around the crater.

North Ray Crater and Station 11

As they neared North Ray Crater they encountered more and more rocks, larger than they had seen before, but here they had fractures in them. There were white rocks, black rocks, strange looking rocks and one boulder more than 3-metres high. Young slowed up as they approached the rim, in case they unexpectedly came upon an edge dropping into the crater. They parked the Rover about 90 metres from the rim of North Ray at 0238, 4.4 kilometres from the LM. There seemed to be an inner and outer rim.

"There we go. If we go 360 and park right here, it'll be flat ... Great, John. Super! Can't wait to get off. Got to get off." Duke was almost beside himself with excitement.

As they hopped down to the inner rim it became very steep. North Ray Crater is a kilometre across and 230 metres deep, with very steep sides. Trying to look for bedrock at the bottom of the crater the astronauts came as close as they dared to the rim, but found the slope steepened, not letting either astronaut see the bottom, even on the far north west side.

A s Young told England, *"Now, I tell you, I can't see to the bottom of it, and I'm just as close to the edge as I'm going to get. That's the truth."*

After taking photographs, they first jogged over to grab some unusual white rocks about 45 metres from the Rover. It was a busy scene as the two astronauts darted about grabbing samples and taking pictures, with the camera on the Rover trying to scan everything. The voice loops were full of chatter as the astronauts tried to describe their activities, the scene and the geology, and Houston trying to change the schedule in real time to keep up with events. Young and Duke had planned to work independently but when their sample bags kept falling off the brackets and they had to pick them up as well as carrying their shovels, tongs, and hammers they decided to work together.

House Rock

"John, how far away is that big boulder?" asked England.

"It is about, near as I can tell ..., 150 meters, but the rocks around it are really something else. That's the problem with trafficability up to it." Young replied.

"Okay, Charlie. Let's go back to the Rover. Put your bag on there and head out for the big rock. Because you got a bag on your back, and we'll use it."

Young looked towards House Rock, *"Look at the size of that biggie! It is a biggie, isn't it? It may be further away than we think because..."*

Duke, *"No, it's not very far. It was just right beyond you,"*

At right, partly hidden behind a ridge, Young and Duke are dwarfed by House Rock.
Processed image derived from the Rover TV camera. Image: NASA/JSC

"Theoretically, huh?" grunted Young, not so sure.

"Yeah."

"Like everything else around here, a couple of weeks later …" Young mused sarcastically.

Duke began running towards it ... so quickly Ed Fendell had trouble keeping the Rover's TV camera on him. It is estimated he was running at 7.9 kilometres per hour, which is probably the fastest any Apollo astronaut travelled on foot on the lunar surface. They both paused about 70 metres from the Rover to collect some samples of rock and soil.

Duke was confident it wasn't that far to House Rock, but he was deceived because there is nothing to compare sizes on the Moon – no atmospheric haze, no trees or buildings, so they just jogged and jogged – and the rock just kept getting bigger and bigger, while behind them the Rover kept getting smaller and smaller. On and on they went. In the TV picture the shrinking astronauts disappeared behind a ridge.

Back in the science room the watching scientists were urging them on, and astronaut Jack Schmitt caused a laugh when he called out *".....as our crew sinks slowly in the west."*

After jogging 220 metres the astronauts finally reached the rock at 0336. Bending back to look up, they realised just how big it really was – it was higher than a four storey building!

"Well, Tony, that's your House Rock right there," Duke told England.

In the science room Muehlberger wondered if this rock would show them what the Descartes

Charlie Duke examines veinlets at Outhouse Rock. Image: NASA

highlands were made of. House Rock was the final proof that the volcanic theory was erroneous.

They guessed it had come from the bottom of North Ray Crater. As it was sitting on the edge of the rim, they had to be careful where they went. It was a giant breccia with veinlets of glass running through it. In some places there were bullet-like holes where micrometeorites from space had tunnelled their way into the rock.

"Okay, now we had to come down a pretty good slope to get to this rock, so we may have to leave early to get back," Young was playing cautious as looked at the steep slope back to the Rover.

Duke began hacking away at House Rock but felt it was like trying to pull the Empire State building down with a crowbar, only able to crack a couple of grapefruit-sized pieces off. They explored around Outhouse Rock, finding a big split on the south side of House Rock before jogging back to the Rover.

The two astronauts loaded up the vehicle and departed from North Ray at 0403 after a 1 hour and 22 minute stop, and set off for Station 13, ignoring Station 12 on the south east rim of North Ray Crater. Station 13 was a large boulder field about half a kilometre from North Ray, on the way

back to the LM. It looked a very steep descent to get there.

"Okay, Station 13. Right down the same way we came. … Oh, my goodness." Young was suddenly confronted with a steep-looking 13° down slope.

They hadn't realised how steep the hill was coming up.

"We can't see old Orion from here" Duke laughed with anticipation, *"This is going to be something going down this hill."*

As Young tackled the slope Duke called, *"Look at that slope! Be sure that you got the brakes on. Tony, this is at least a 15-degree slope we're going down, and that Rover came right up it and you never even knew it … Brake that beauty, John … Man, are we accelerating. Super. I should have had the camera pointed forward … Okay, Tony, that was at ... I think it was 179 at 4.4,* (bearing and distance to the Rover) *that little steep slope there. Whoever said this was the Cayley Plain?"*

"Well, that was down the rim of the crater here. We've just set a new world's speed record, Houston; 17 kilometres an hour on the Moon." announced Young as he watched the speedo go off-scale high to an estimated 17.1 kilometres per hour.

"Well, let's not set any more," replied spoil-sport England.

"I'm with you." Young isn't such a daredevil after all!

Duke felt they were going to launch themselves into orbit. A few minutes later the two travellers had a surprise when the right wheels fell into a crater, tipping the Rover to the right. When Young tried to correct they spun around 180 degrees.

Station 13 and Shadow Rock

At 0411 and 3.8 kilometres from the LM the Rover arrived at Station 13. Here they were looking for some permanently shadowed soil. They found it under a 3 metre high boulder they had seen on the way out, they called Shadow Rock. Duke found a hole at least a metre deep back underneath the rock in the shadow.

He fell on his hands and knees and tried to crawl into the hole. *"Well, I don't know how long that rock's been there, but that dirt's been shadowed ever since it's been there."*

"That's what we want, Charlie," England sounded pleased as Duke reached to the back of the hole with the scoop and collected some of the most unique samples they were to bring back. He said he felt like the college student who had just passed his final exam.

It was time to return to the LM and prepare for lift-off. Leaving Station 13 at 0440 after a 29 minute stop, Young headed the Rover on a bearing of 140° with a sad feeling that all this fun was really coming to an end. With the confidence of over 20 kilometres of experience driving the Rover on the lunar surface, Young set a cracking pace back and set Mission Control on edge as they encountered near misses with boulders and craters. They didn't want any accidents at this stage.

England passed on Houston's concern with the comment after a near miss, *"We're all holding on to our chairs."*

Duke had a sudden thought, *"Don't anybody tell Ken* (Mattingly)*, how dirty we are."*

"Yeah, he won't let us in the hatch." Young explained the comment.

At 0453 they passed End Crater and decided to go and have a look at Palmetto Crater's rim. They pulled up on the edge of the crater but again are unable to see the bottom. Duke estimated it was at least 100 metres deep.

As they pushed on Young quipped, *"I've just finished my two pounds of potassium … I don't know whether I'm driving or sloshing!"*

"Don't let's go unstable with a fuel slosh mode." Duke expanded the quip.

Ignoring the quip, England advised them, *"… and the Command Module just did their plane change burn and it's a good burn."*

Mattingly in the CM was already getting into position for their rendezvous in about 6 hours' time.

Above: Charlie Duke at Shadow Rock.
Image: NASA
Below: In the shadow of Shadow Rock.

Charlie Duke left this photo of his family on the lunar surface. Image: NASA

The Duke Family
from left
Charles Duke III (7yo)
Astronaut Charles M. Duke Jr
Thomas Duke (5yo)
Dorothy Meade Claiborne

The Rover arrived back at the LM at 0509 after a 3 hour 6 minute excursion and finished off the experiments such as drilling a core sample before unloading the Rover. At 0555 Duke took the opportunity to put a family picture on the Moon,

"So, I walked about 30 feet from the LM and gently laid our autographed picture of the Duke family on the grey dust. As I made a photograph of it lying there, I wondered, 'Who will find this picture in the years to come?'"

Then he put a special US Air Force medallion and told England,

"Tony, a special salute from me to the US Air Force on their silver anniversary this year. This lunar boy in blue is pretty far out right now."

In earlier missions the crews had set up little cameo parts such as hitting golf balls, dropping feathers and hammers, so Young and Duke planned a mini Lunar Olympics to commemorate the 1972 summer games in Munich. Young was to long jump and Duke was to do a high jump. Young jumped up and down, but when Duke leapt into the air, rising over 1.2 metres, the weight of his backpack pulled him over backwards.

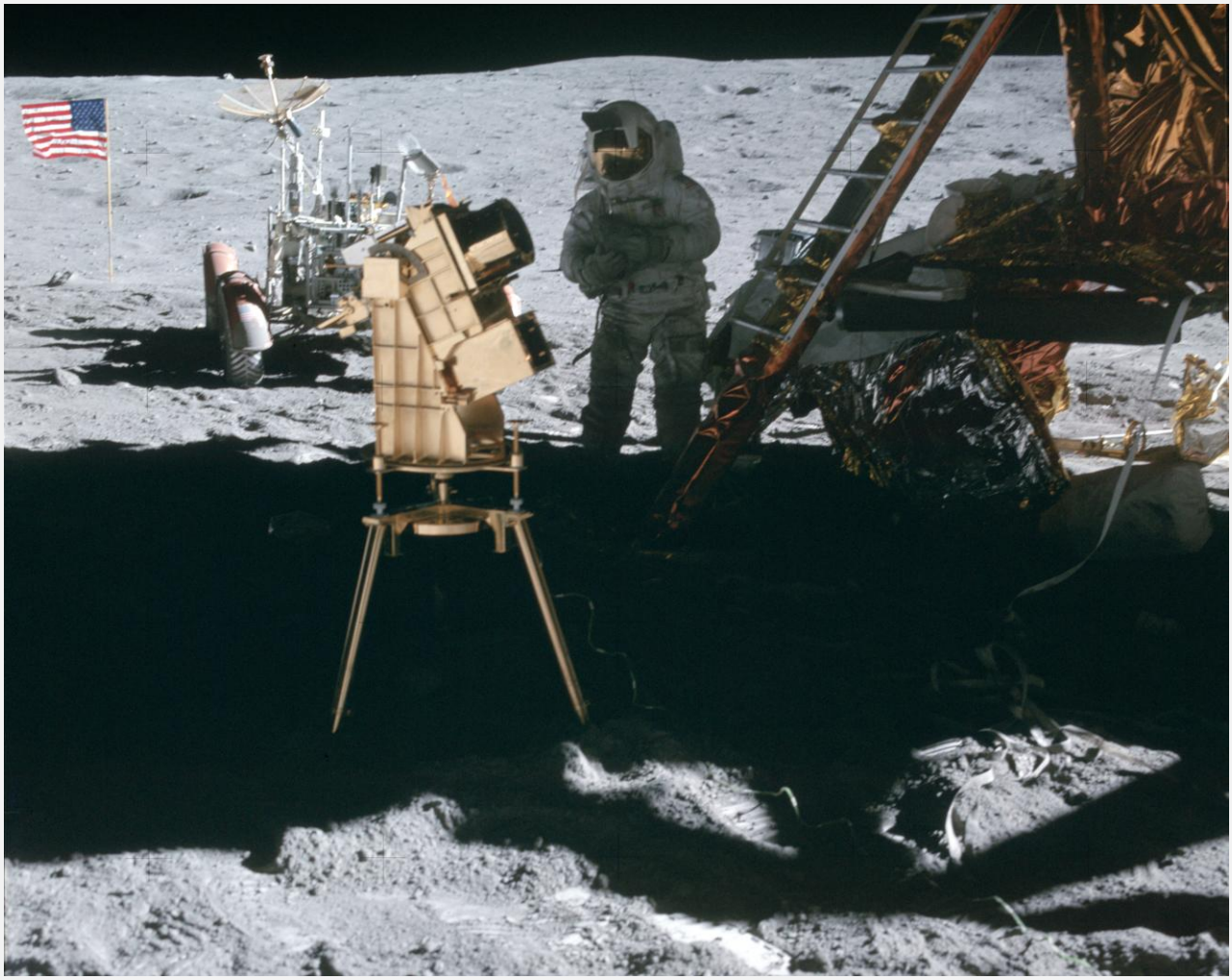
Although he tried to recover, he crashed down hard on his backpack. For a moment he was scared his suit might split, or the backpack break, and he would be dead in ten seconds, but luckily they all held together.

Young shouted *"Charlie! That ain't any fun, is it?"*

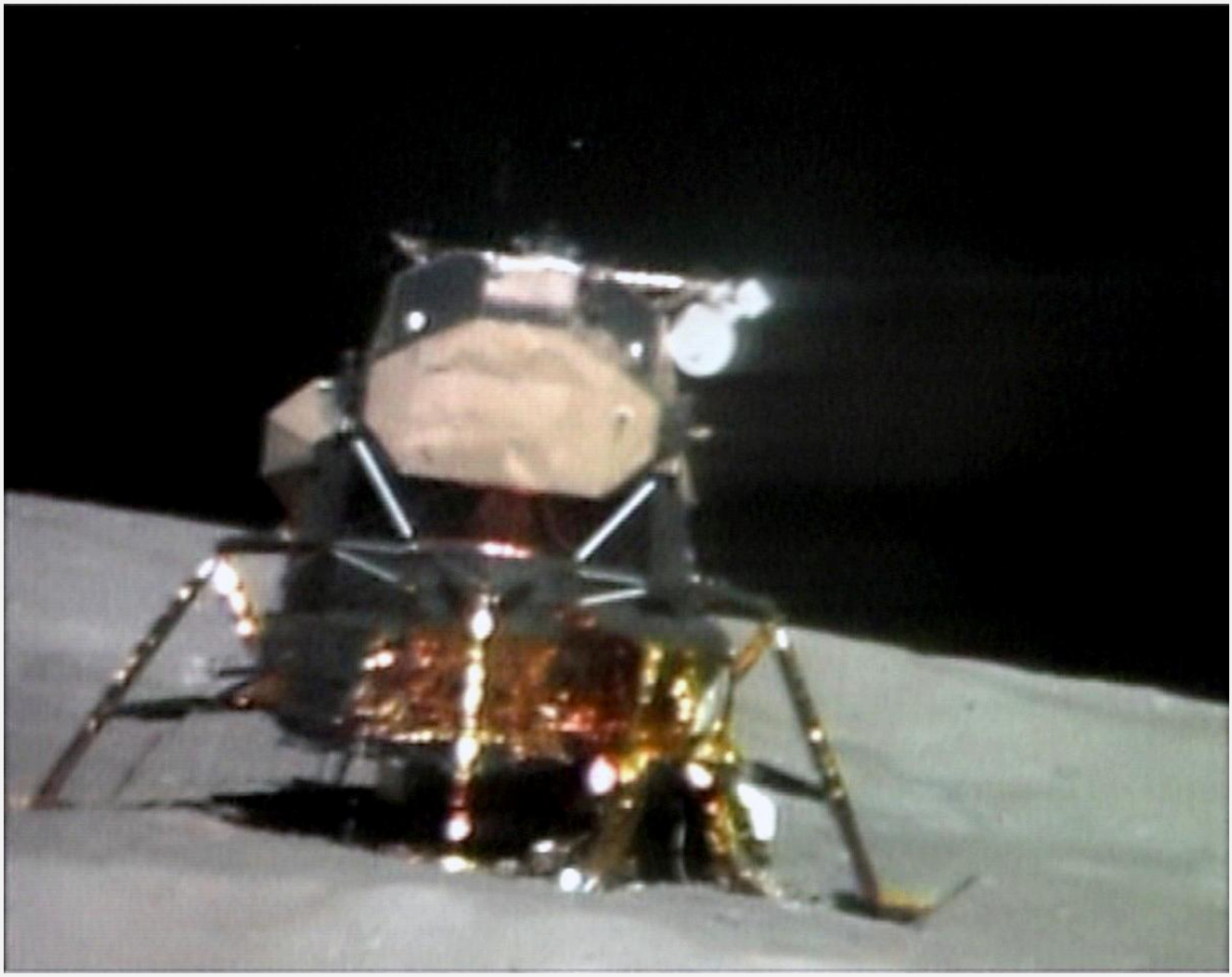
A relieved Duke agreed, *"That ain't very smart. Well, I'm sorry about that."*

Lying flat on his back and unable to get up Duke asked Young to help him up, *"Agh! How about a hand, John? There we go. Okay."*

Once on his feet he checked his suit very carefully. Embarrassed, he was rather subdued for the rest of the EVA.



The Far Ultraviolet Camera/Spectrograph telescope made observations of the Sun and Earth. Image: NASA



Orion shortly before liftoff – from the Rover TV camera.

The white dot above the LM is an artifact of the TV picture.
This, and the image captures below, by Colin Mackellar from JSC-supplied video.

Lunar Lift-off

At 1117, or T-8 minutes, Irwin told the crew they were ready to go, *"Orion, you're GO for Lift-off."*

At T-2 minutes they turned the Master Arm switch on, then finally the Abort-stage button and waited for ignition. At ignition, three bolts holding the LM's ascent and descent stages together were severed by small explosive charges and the interconnecting cables were severed by a guillotine.

Duke wrote he was surprised at all the noise and movement at ignition,

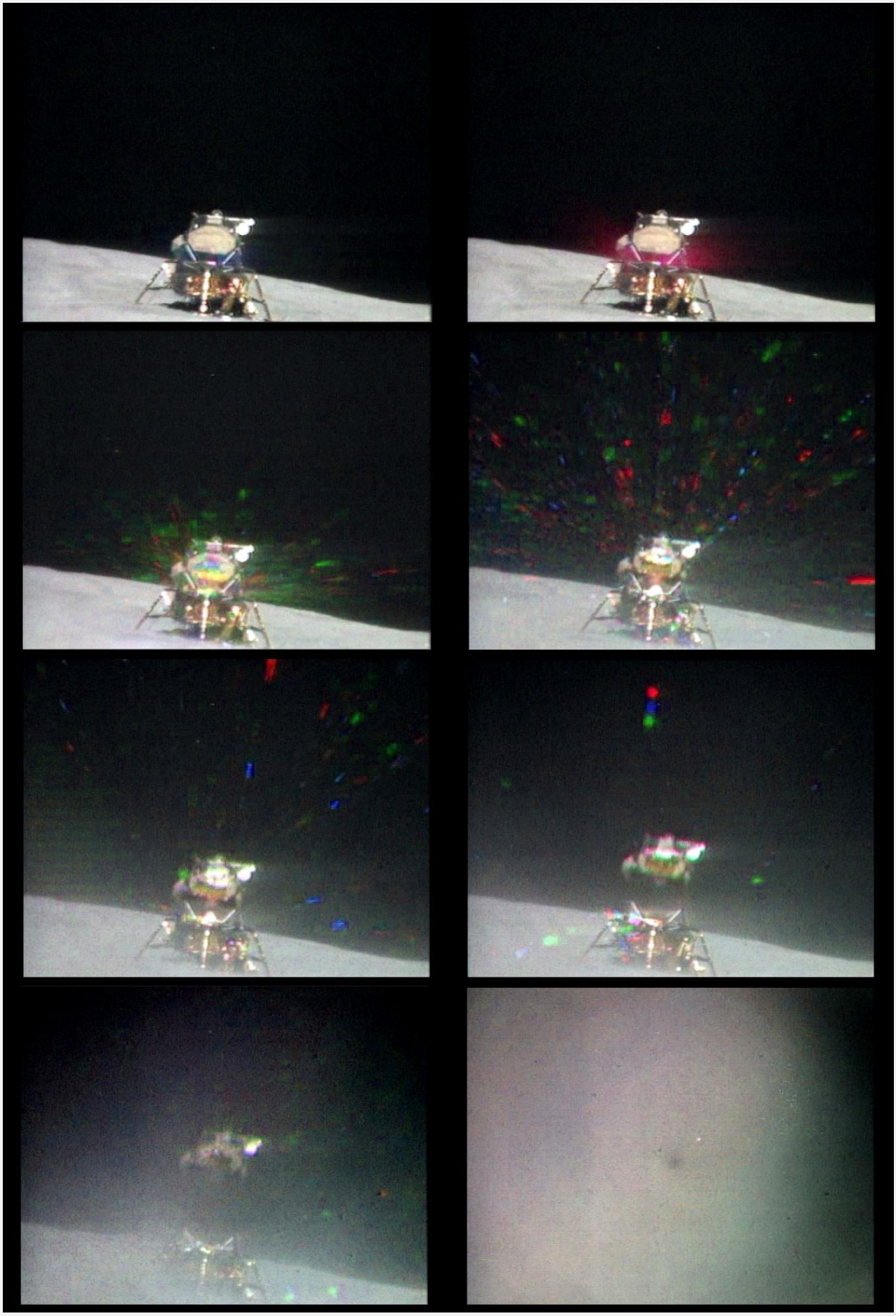
> *"When the bolts exploded, instead of being propelled upwards, we dropped. Oh, no, it didn't light and we are dropping! flashed through my mind. Then, bang! The engine ignited and instantly there was 3,500 pounds of thrust.*
>
> *A kick hit the bottom of my feet, and off we went – straight up for about 800 feet* (240 metres)*!"*

Watch Lunar Module Lift-off

Lunar Module 'Orion' lift-off recorded by the camera on the Rover parked nearby and operated from Mission Control Center, Houston.

WATCH

14mb mp4 file. Running time – 41s



The LM liftoff was broadcast live from the Rover TV camera. Images: NASA/JSC

The red, green and blue colours of the ejected material are artifacts of the colour-wheel system in the TV camera. Dust kicked up by the ascent engine quickly reduces visibility as Ed Fendell at Mission Control tilts the camera to follow the LM. Within seconds (bottom right) it is a small white dot in the lunar sky.

The abandoned descent stage sits on the lunar surface. Image: NASA/JSC

The TV camera's lens has been clouded by a coating of dust kicked up by the ascent engine.

Standing up, cinched down with straps, they could feel the force of their acceleration as their feet were pressed against the floor. When they pitched over and were looking down, they could see the descent stage and the Rover surrounded by all their tracks in the lurain.

When the horizon disappeared from their view and they could only see the Moon's surface, Duke squatted down to look out the top window for the horizon to check they were heading in the right direction. Then as the thrusters fired to maintain their attitude the LM began jolting from side to side, *"What a ride! What a ride!"* Duke shouted in ecstasy – it was one of the most exciting flying machines he had ever been in.

After six minutes they were travelling at 5,000 kilometres per hour and were soon in orbit.

They pitched the LM towards the CM, above and ahead of them. At 0140, 233 kilometres from the CM behind the Moon, the rendezvous radar locked on round about the same time that Young spotted its brilliant flashing light against the blackness of space. As soon as the LM turned on its tracking light Mattingly saw it. By the time they came around the rim of the Moon and were in sight of the Earth and Madrid again, they were only 5 kilometres apart.

To the crew's surprise Houston asked Young to do a 360° yaw in front of Mattingly as they thought some pieces may have come off the LM at lift-off. It turned out some panels had blown off the back, but there was no threat to the integrity of the spacecraft.

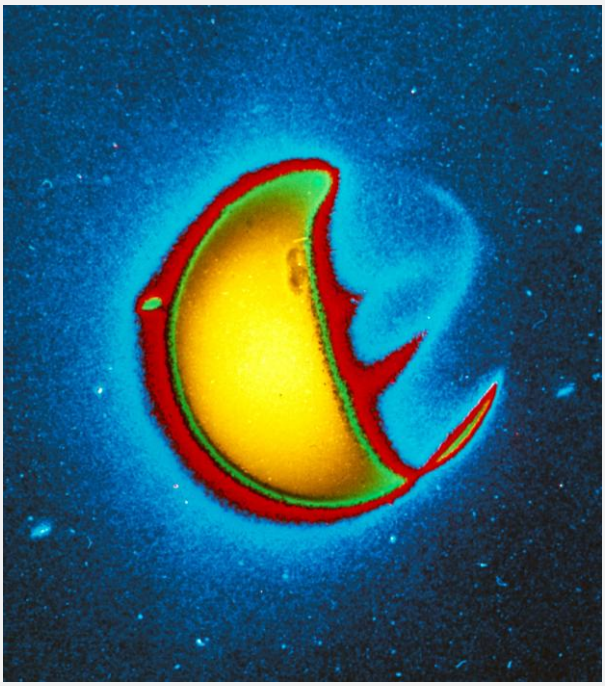
By this time, they were racing the lunar sunset, so quickly docked before there was any chance of

The crescent Earth from the surface of the Moon. Image: NASA/JSC

Shortly after Young and Duke lifted off from the lunar surface, Ed Fendell at Mission Control used the Rover TV camera to catch this view of the crescent Earth. The out-of-focus Rover antenna system partly obscures the view.

becoming involved with the approaching darkness. Mattingly was very pleased to welcome his mates back, but their greetings were cut short by Irwin in Mission Control wanting to read up flight plan changes that ordered only a partial transfer to the CM, an eating and sleep period aboard the CM, and to complete the transfer and LM jettison the next day, instead of doing it all at once.

At Honeysuckle Creek we followed the first transfer period when the astronauts struggled with an internal lunar dust storm, before settling down to a meal before going to sleep. They had been up for nearly 20 very busy hours.



Earth in far ultra-violet light. Image: NASA

Orion’s ascent stage as seen from the Command Service Module “Casper”. Image: NASA

Panel damage on the back of the ascent stage caused during lift-off. Image: NASA

HSK MISSION DAY 9
TUESDAY, 25 APRIL 1972
TEC – DAY 1

Times: AEST (HSK local time)

EVENT	GET	AEST
LM – jettison	195:00:12	0654:12
P&FS – launched [16]	195:14:00	0708:00
TEI – engine burn [17]		1215:33

[16] P&F Sub-satellite launched during orbit 62
[17] Engine burn time – 162.4 seconds

Note: GET clock updated at 202:26:00 by 24h 34m to follow original flight plan.

Prime HSK	Track Duration	AOS/ LOS
LM	6h 26m 00s	1640:00 2306:00
ALSEP 1 – 4	3h 45m 00s	2321:00 26/0314:00

Wing HSKX	Track Duration	AOS/LOS
CSM	11h 13m 00s	1601:00 26/0314:00

Handovers	AEST
CSM 2-way from GDS	1842:00
CSM 2-way to MAD – 8h 11m	26/0253:00

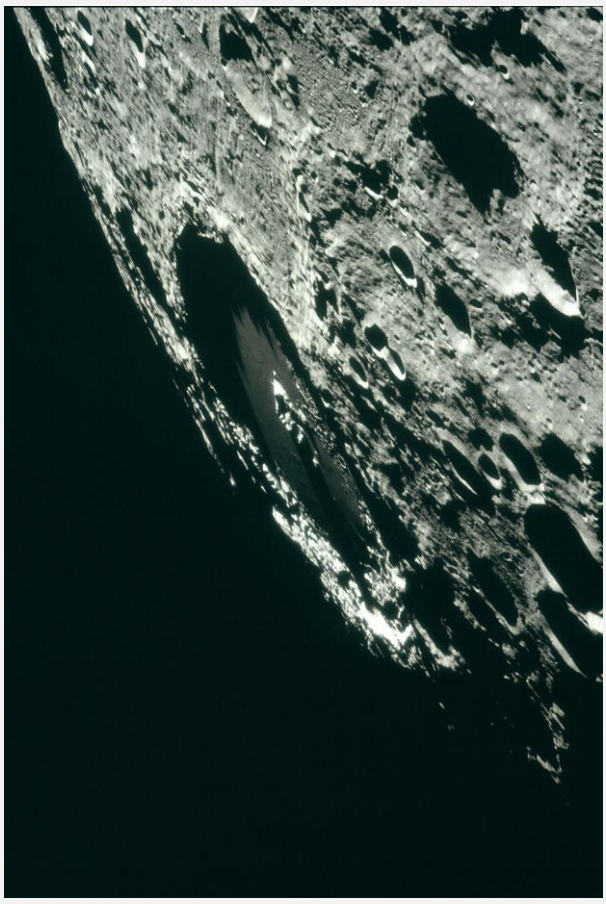
Honeysuckle Creek then tracked them right through their sleep period so saw little action until they were woken up at 0123 during their 59th orbit and 34 minutes before our LOS. Madrid and Goldstone then covered the busy periods.

Due to the earlier CM's control system problems Houston had decided to bring them home a day early, despite protests from the spacecraft's crew. If the engine gave trouble this change would give them a day to fix it before getting low on power and consumables.

When the astronauts jettisoned the LM at 0654, it appears they inadvertently left the ATCA/PGNS circuit breaker open, which left the LM with no attitude control or propulsion capability. As a consequence, the RCS thrusters did not fire in preparation for the engine burn to remove it from orbit, so it just tumbled out of control. It was nearly a year later that Orion finally crashed into the lunar surface.

An hour later, during orbit 62, they deployed the Particle & Fields Sub-Satellite at 0756. Unfortunately, the spacecraft's orbital shaping manoeuvre was not performed before ejection, and the sub-satellite was placed in a non-optimum orbit that resulted in a much shorter lifetime than the planned year. Loss of all sub-satellite tracking and telemetry data on the 425th revolution at 0631 – on 29 May – indicated that the sub-satellite had hit the lunar surface.

At 1215, during the beginning of Orbit 65, Mattingly fired the SPS engine on Casper to leave lunar orbit and return to Earth. Despite its earlier tantrums, the SPS performed perfectly and Apollo 16 was safely on its way home.



HSK MISSION DAY 10
WEDNESDAY, 26 APRIL 1972
TEC – DAY 2

Times: AEST (HSK local time)

EVENT	GET	AEST
EVA – Cislunar space [18] [19]		0556:00
Sleep period – start		1633:00
Wake-up		2330:00

[18] Mattingly retrieved film from the SIM bay
[19] Cislunar EVA – 1h 24m

Prime HSK	Track Duration	AOS/ LOS
ALSEP	10h 44m 00s	1715:00 27/0359:00

Wing HSKX	Track Duration	AOS/LOS
CSM	11h 20m 00s	1603:00 27/0323:00

Handovers	AEST
CSM from GDS	1850:00
CSM to MAD – 8h 18m	27/0308:00

On their way back to Earth, a large film canister of pictures from lunar orbit had to be retrieved from the SIM Bay at the back of the Service Module. After depressurising and opening the hatch, Mattingly climbed out at 0643 followed by Duke. Instead of their view bounded by the windows of the spacecraft looking forward, they could now see the Earth ahead and the Moon behind while they were suspended in a void between the two. Duke tried to describe the feeling,

"As I floated out, I was again overcome with the awesome beauty of space. The panorama of the universe was spread out before me, and I felt like a spectator in an audience watching the play unfold. Ken was the performer and the universe was the stage.

To the right was the Earth, 318,641 kilometres away. It was a crescent Earth just a thin sliver of blue and white yet breathtaking to behold. Over my left shoulder was the Moon, only 67,590 kilometres away and enormous. It was a full Moon, and I could see clearly all the major features the Sea of Tranquillity where Neil and Buzz had landed, Ocean of Storms, even the Descartes highlands. It was spectacular!

Everywhere I looked it was blackness the empty blackness of space, so powerful it seemed I could reach out and touch it. The feeling of detachment I experienced was strange; it was almost euphoric, and I wondered what it would be like to float off into this blackness."

Mattingly was experiencing similar feelings as he collected the film from the SIM Bay. He was very aware of the vast nothingness surrounding the life supporting infinitesimal speck they had called Casper. Tightly gripping the handrail, he could feel the comforting solid security of the spacecraft flow through his gloves and fingers. He looked for the stars, but none were visible, so he briefly lifted his gold visor and they came into view.

As they cruised back to Earth, he remarked: *"There's not a scene on the Moon that carries the emotional impact of watching your Earth shrink to a little ball."*

‘Ken’ Mattingly (red striped helmet) performs a cislunar EVA, assisted by Charlie Duke. Image: NASA

HSK MISSION DAY 11
THURSDAY, 27 APRIL 1972
TEC – DAY 3

Times: AEST (HSK local time)

EVENT	GET	AEST
Sleep period - crew wake-up		2307:00

Prime HSK	Track Duration	AOS/ LOS
CSM	4h 11m 00s	1554:00 2005:00
ALSEP	7h 58m 00s	2008:00 28/0406:00

Wing HSKX	Track Duration	AOS/LOS
CSM	11h 20m 00s	1603:00 27/0323:00

Handovers	AEST
CSM 2-wayfrom GDS	1908:00
CSM to MAD – 9h 00m	28/0408:00

Parkes
Note: Officially released from mission support at 2207:00

At 2307 Houston noticed that Duke had been in a really deep sleep and had just woken up, so called Young,

"Good morning Apollo 16. We see on his biomed that old Charlie woke up. He was really sawing away there."

"Charlie was sawing away on his BIOMED?" Young queried with feigned surprise.

"Sure was."

"I wouldn't be surprised that's why it doesn't work." Mattingly quipped.

"Termites do the same thing!" Young couldn't resist a dig.

As we approached midnight at Honeysuckle Creek Apollo 16 was 73,740 kilometres away and homing in to Earth at 10,760 kilometres per hour, its speed rapidly increasing. The crew settled down to their last breakfast in space and prepared for re-entry. A minor mid-course correction steered them away from a small island near the landing area.

HSK MISSION DAY 13
FRIDAY, 28 APRIL 1972
RE-ENTRY and SPLASHDOWN

Times: AEST (HSK local time)

EVENT	GET	AEST
Astronaut press conference		0807:00 0525:00
CM/SM separation		0516:33
Splashdown		0545:05

Prime HSK	Track Duration	AOS/ LOS
CSM	1h 7m 00s	0418:00 0525:00

Handovers	AEST
CSM 2-wayfrom GDS	0507:00
CSM to ARIA – 0h 05m	27/1554:00 0428:00

Wing HSKX	Track Duration	AOS/LOS
CSM	12h 34m 00s	27/1554:00 0428:00

Mission duration – 265h 51m 05s
Distance travelled – 2,238,597 kilometres

The weather around the recovery vessel USS Ticonderoga, waiting 2,400 kilometres south of Hawaii, was fine with scattered cloud at 2,000 feet and a 16 kilometre per hour breeze from the east. Wave height was minimal at 1 metre.

At 0516 Young announced, *"Separation, Houston."*

Recovery in the Central Pacific Ocean. Image: NASA

The Apollo 16 Command Module, splashed down in the Pacific Ocean - approximately 215 miles southeast of Christmas Island - to successfully conclude their lunar landing mission. Later the three crewmen were picked up by a helicopter from the prime recovery ship USS Ticonderoga.

The spacecraft lifted, rolled over, and dived deep into the atmosphere, the crew suffering up to 7g's as they slowed up on the way down. At 2,438 metres the three parachutes blossomed to deposit Casper in the Pacific in front of the television cameras just 5 kilometres from the big aircraft carrier.

For us at Honeysuckle Creek it was 0545, the early hours of the morning. As we began clearing away before heading home it was still dark as the sun wasn't due up for another 50 minutes. The now deserted full Moon hung low in the western horizon, appropriately about to set.

On 17 July 1972 only three months after it was set up, Apollo 16's seismometer registered the largest impact ever recorded on the Moon when a meteor hit the far side near Mare Moscoviense.

The results from this impact showed that the Moon's crust was 14.5 kilometres thicker at the Descartes highlands than the mean.

Until the Apollo 16 mission the geologists were able to predict the type of soil the astronauts would bring back. The Descartes samples ended this run. Confidently predicting soil and rocks with a volcanic origin, the geologists were taken aback to find the samples suggested an interlocking sequence of igneous and impact processes. As geologist Don Wilhelms admitted, *"...we goofed."*

The materials found in the Descartes region were similar to those found earlier by the Russian Luna 20 in the Apollonius region, but there were significant differences in the aluminium content. Also, there were differences in the abundance of fragments of distinctive crystalline rocks known as the anorthosite-norite-troctolite suite.

The last crystalline age of some of the Apollo 16 rocks appeared to be 3.9 billion years and continued to indicate that this age was a major turning point in lunar history. Luna 20 and Apollo 16 confirmed its great importance to the understanding of the ancient, melted shell.

The tracking network now faced Apollo 17, our last Apollo mission, with a feeling of sadness.

Those heady days of lunar landings and Rover excursions, now a regular part of our daily life, were running out.

The end of Apollo was no longer over the horizon – it was here.

Essay by Hamish Lindsay.
Images, illustrations and captions by
Hamish Lindsay, Colin Mackellar, and Glen Nagle.
Unless specified, audio and video recorded,
edited and encoded by Colin Mackellar.
PDF formatted by Glen Nagle.

REFERENCES

Documentation
Honeysuckle Creek *(retired documents)*

Apollo 16 - *NASA Press Release*

Apollo 16 - *pamphlet by Manned Flight Awareness, Marshall Space Flight Center*

Books and Publications
'Apollo Expeditions to the Moon'
NASA SP-350 edited by Edgar Cortright

Aviation Week and Space Technology

'Failure is not an Option'
by Gene Kranz

'Moonwalker'
by Charlie and Dotty Duke

'On the Moon with Apollo 16'
NASA EP-95 by Gene Simmons

'To a Rocky Moon'
by Don Wilhelms

Interviews
Hamish Lindsay's personal interviews with John Young and Charlie Duke

Online
The Apollo Lunar Surface Journal
edited by Eric Jones

Various internet sources on Apollo used.

IMAGES

Unless otherwise attributed, the images used in this essay are sourced from:

Official releases from *NASA.gov* websites

Flickr Photo Album Websites:
- Project Apollo Archive
- NASA Johnston
- NASA Kennedy

The Apollo Image Gallery
maintained by Kipp Teague

The Apollo Lunar Surface Journal
originally edited by Eric Jones

Honeysuckle photos and selected scans
by Hamish Lindsay

Some image have been reformatted, cropped, noise-removal and cleaned using Photoshop and some AI tools.

AUDIO

Sources as stated in the text.

Audio processing, clean-up, and editing
by Colin Mackellar – honeysucklecreek.net

VIDEO

Sources include:
- Super 8 footage taken at Honeysuckle Creek *by Ed von Renouard*
- Official releases from *NASA.gov* websites
- Mission videos, *courtesy of Mike Gentry at JSC*

Video processing, formatting, and editing
by Colin Mackellar – honeysucklecreek.net

PROCESSING NOTES

Stills taken from the TV, were, where possible, cleaned up and enhanced by stacking adjacent video frames to increase the signal to noise ratio.

Some of the video – such as that covering the LM liftoff – had the green and blue fields reversed. This was corrected in Photoshop.

Processing by Colin Mackellar, using Lynkeos and Photoshop on Macintosh.

ABOUT THE AUTHOR

Hamish Lindsay (1937-2022) worked at the Muchea, Carnarvon and Honeysuckle Creek space tracking stations between 1963 and 1981.

He wrote many essays on the history of human spaceflight, and was the author of the book, Tracking Apollo to the Moon.