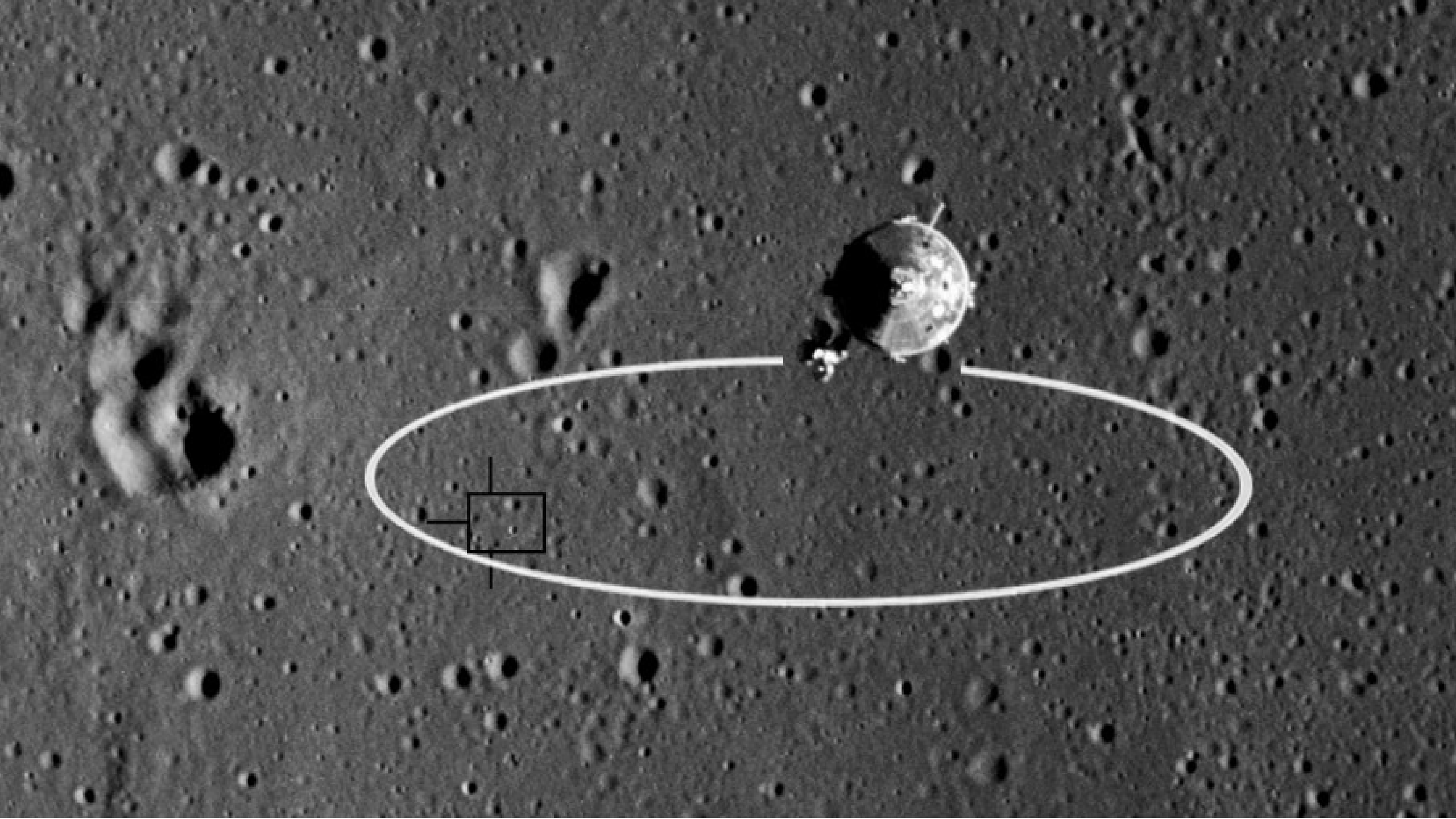
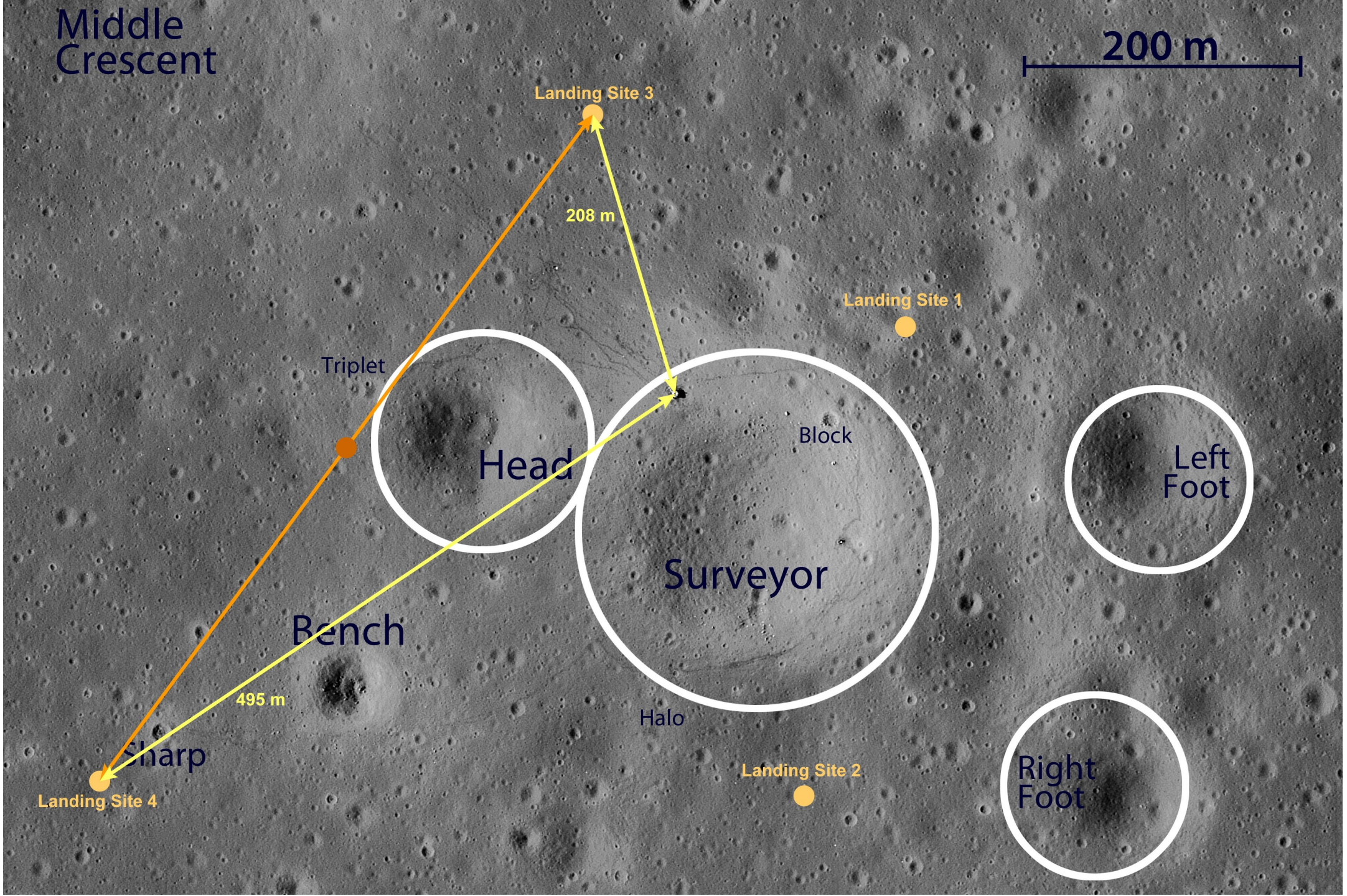
Apollo 12: Precision Landing

INST 154

Apollo at 50

Apollo 12 Landing

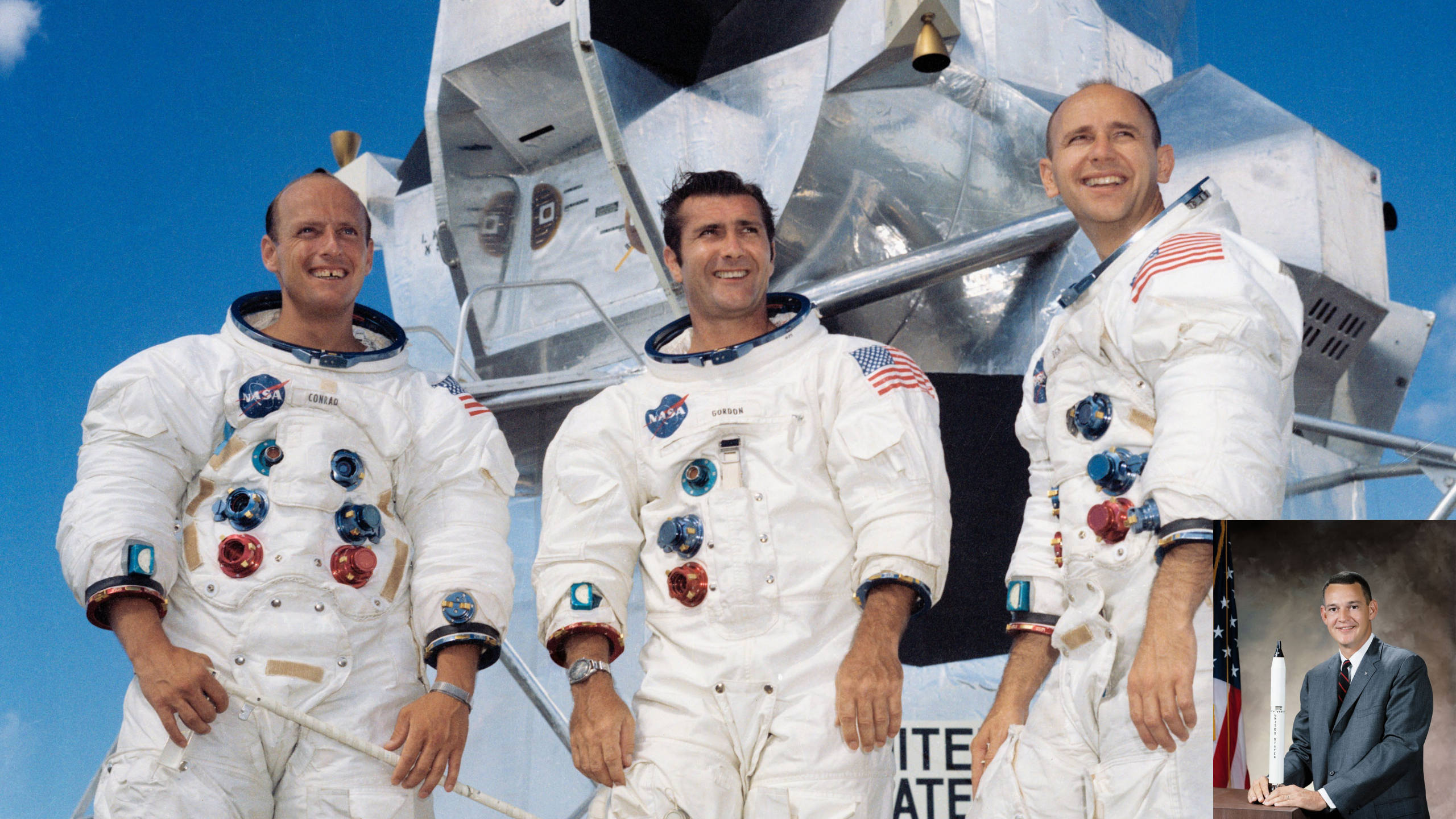



Middle Crescent
200 m
Landing Site 3
208 m
Landing Site 1
Triplet
Head
Block
Surveyor
Left Foot
Bench
495 m
Halo
Sharp
Landing Site 4
Landing Site 2
Right Foot

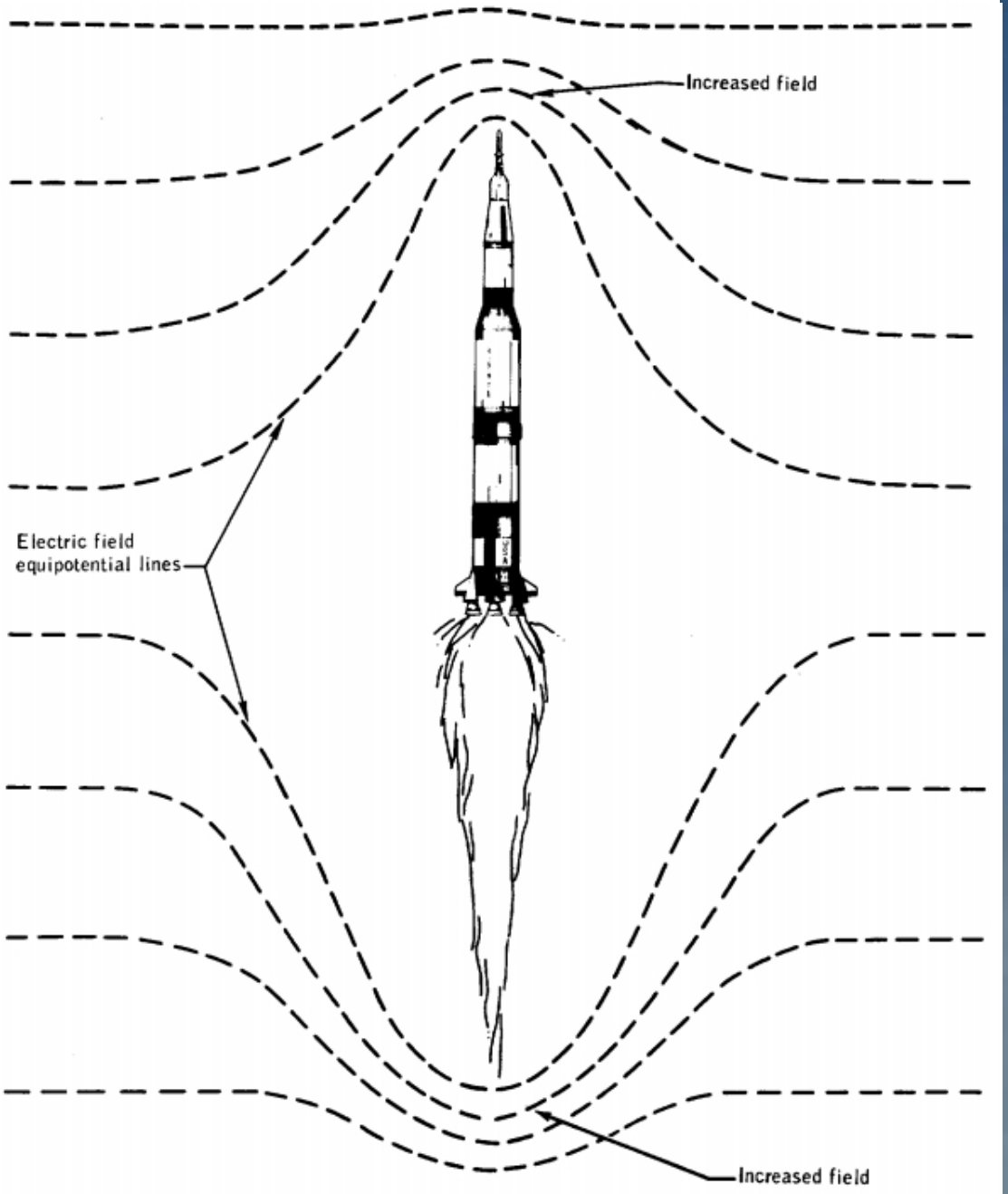
How to land next to a Surveyor - a short novel for do-it-yourselfers

August 1, 1969

1. While docked to the LM, **the command module should use balanced RCS couples for attitude control**. (A data book change involving LM plume impingement constraints is required which Bob Carlton will work out.)
2. When undocked, **the LM should use balanced RCS couples for all attitude control**. (This would have required an onboard computer program change which we can't get for this flight and MIT insists we are better off without it.)
3. Absolutely **no venting or dumping is allowed**!! For heaven's sake, will all spacecraft system people please take note of this. What seems insignificant to you is a nightmare to orbit determination people.
4. The LM RCS hot firing test should be reduced and modified. Specifically, **no translational hot firings should be made** and the ACA pulse mode jet firings should be made balanced and with minimum duration. (TTCA checkout should be done with cold firings.)
5. Particular attention should be given to minimizing LM PGNCS "average g" on time during DOI. To do this we have decided to **eliminate all residual ΔV trimming** (unless x is greater than 1 fps and it shouldn't be). MIT was asked to advise on how to terminate "average g" the best and fastest way.
6. Associated with item 5, program changes must be made in both the PGNCS and the RTCC. Specifically, we are **changing the PGNCS coast/align downlist to include the residuals** and the RTCC/MCC to process and display them to within 0.01 fps for use in "confirming" the DOI burn.
7. **The undocking maneuver should be executed in a radial direction** with the LM below the CSM. Docking probe capture latches should be used to eliminate any net ΔV but that technique requires approval of the structures people. (John Zarcaro is following up on this.) If this is impossible, the LM should null all residuals acquired during undocking.
8. **The LM 360° yaw around inspection maneuver should be eliminated** unless there is a real time indication (barber pole) that the landing gear did not deploy properly.
9. **All stationkeeping should be done by the CSM** - none by the LM. To permit this, the CSM should use Z rather than X-axis RCS jets to execute the separation burn, thereby retaining visual contact with the LM.

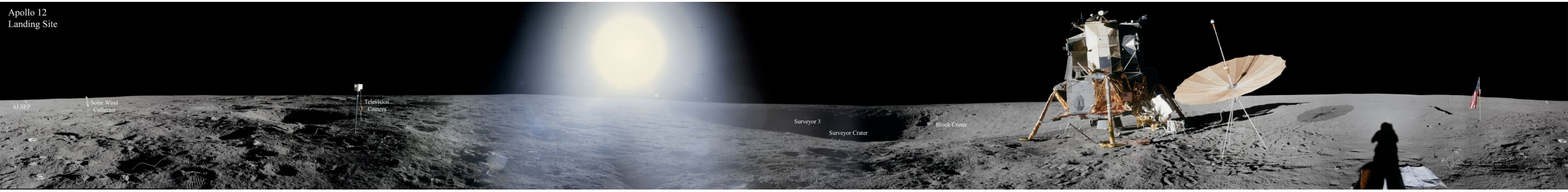

NASA
CONRAD
NASA
GORDON

Onboard Launch Audio



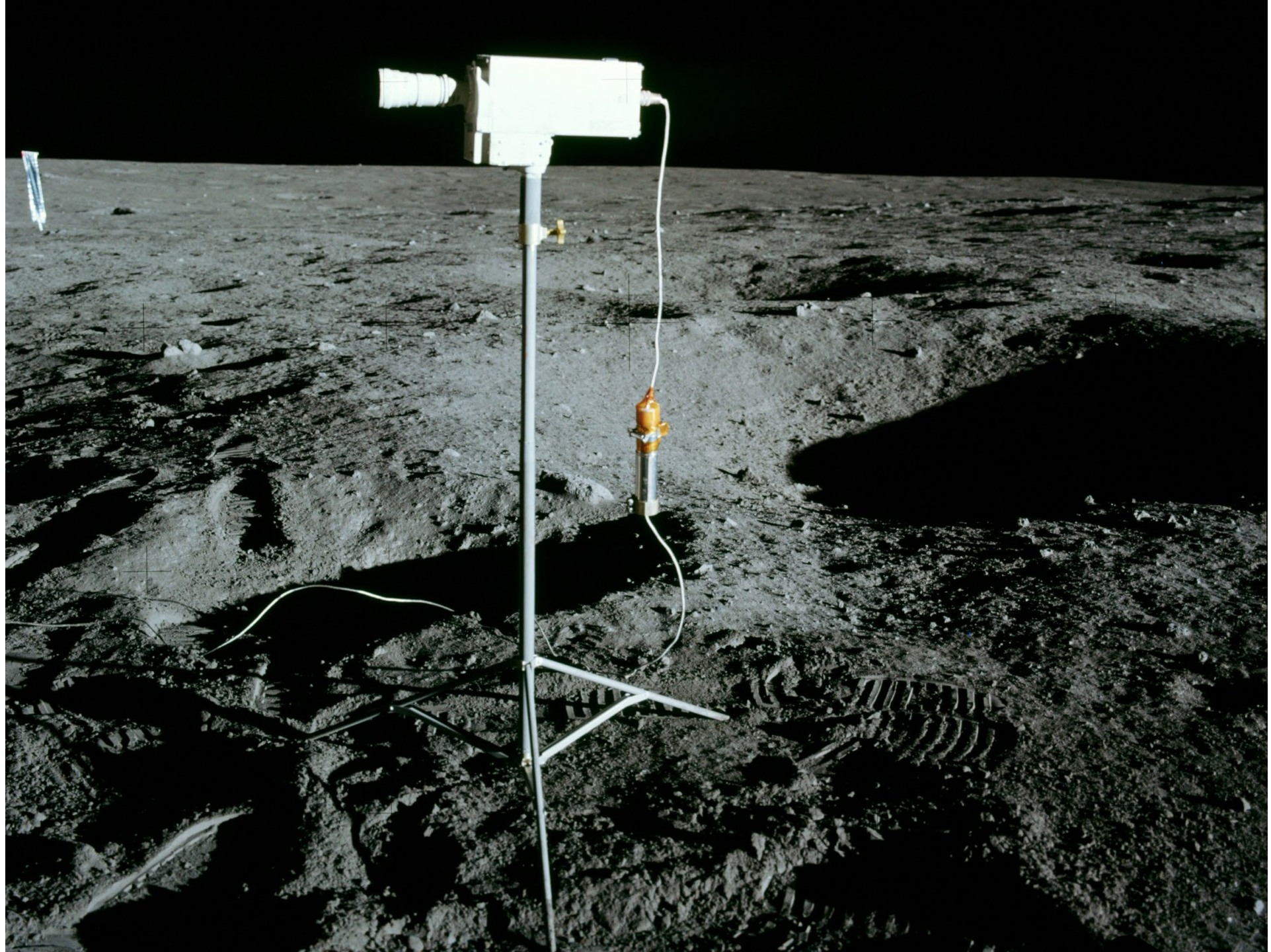
May 27, 2019

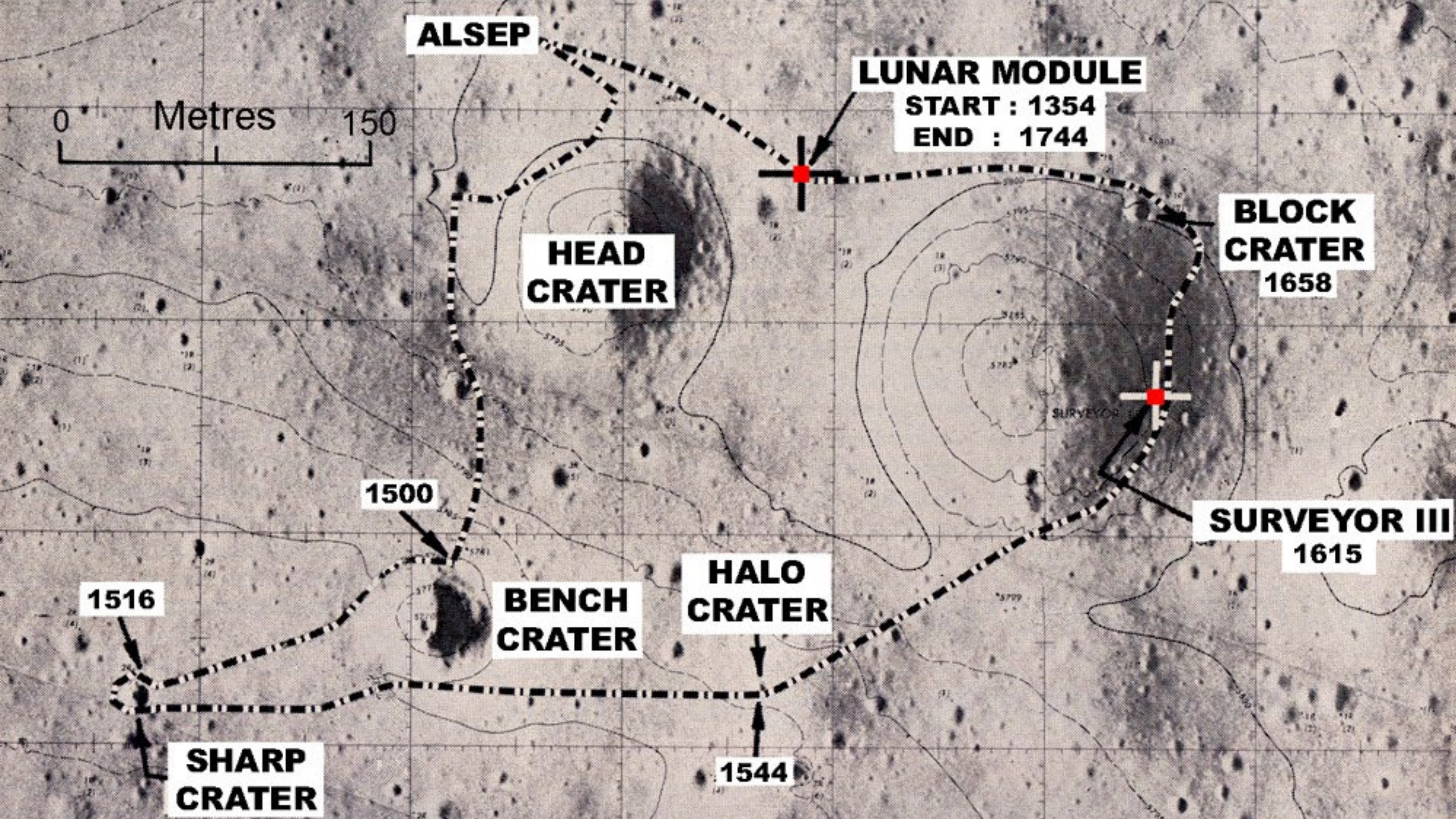
The flight path of the vehicle should not be through mid level clouds 6,000 feet or greater in depth, when the freezing level is in the clouds.

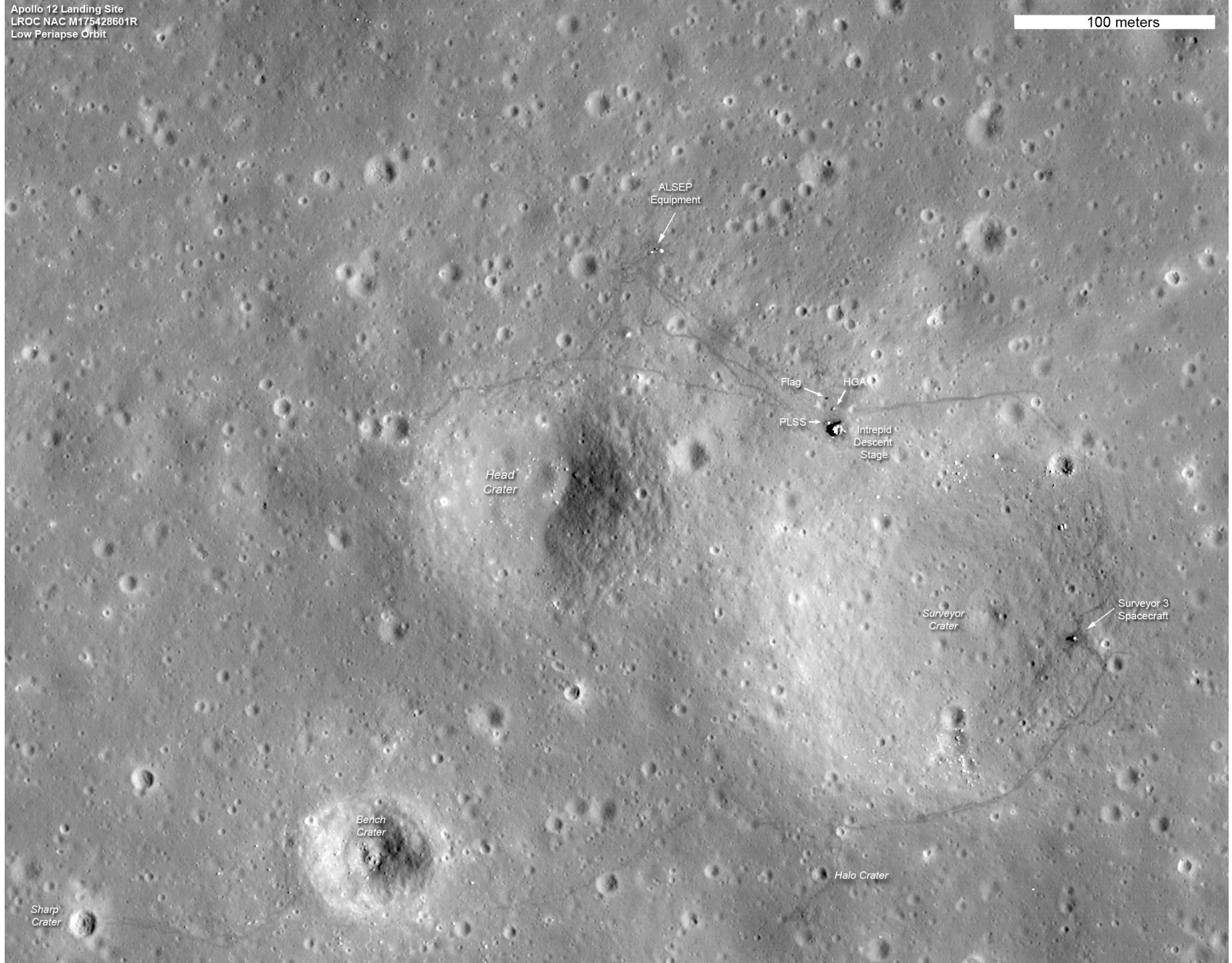


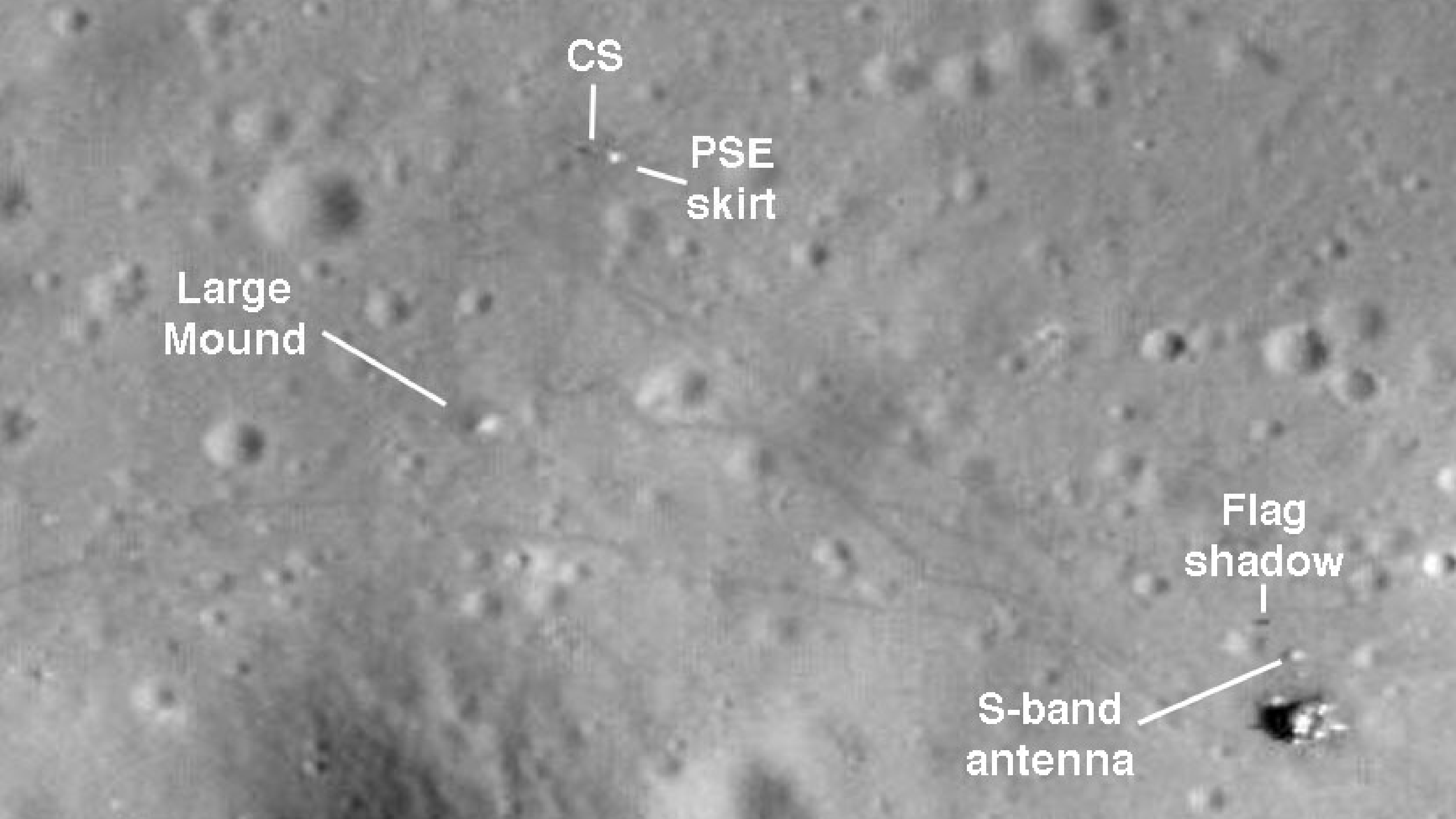
Apollo 12
Landing Site

View from 9 m southeast of LM




ALSEP
0 Metres 150
LUNAR MODULE
START : 1354
END : 1744
HEAD CRATER
BLOCK CRATER
1658
1500
SURVEYOR III
1615
1516
BENCH CRATER
HALO CRATER
SHARP CRATER
1544


Apollo 12 Landing Site
LROC NAC M175428601R
Low Periapse Orbit
100 meters
ALSEP Equipment
Flag
HGA
PLSS
Intrepid Descent Stage
Head Crater
Surveyor Crater
Surveyor 3 Spacecraft
Bench Crater
Halo Crater
Sharp Crater


CS
PSE
skirt
Large
Mound
Flag
shadow
S-band
antenna

TOOL OR CONTAINER	WEIGHT (g)	
Bag, Documented Sample	713.4	
Bag, Documented Sample, Flat, Rectangular-shape	170.8	
Bag, Documented Sample, Flat, Rectangular-shape	170.8	
Bag, Documented Sample, Flat, Rectangular-shape	170.8	
Bag, Organic Sample Monitor	90.2	
Bag, Organic Sample Monitor	101.9	
Bag, Weigh, tether hook	69.0	*
Bag, Weigh	135.9	
Bag,Weigh	132.9	
Bag, Weigh	136.8	
Bag, Weigh	132.9	
Bag, Weigh	140.0	
Bag, Weigh	140.0	
Container, Apollo Lunar Sample Return (ALSRC)	7200.0	
Container, Apollo Lunar Sample Return (ALSRC)	7756.0	
Container, Apollo Lunar Sample Return (ALSRC), aluminum mesh packing material	199.0	
Container, Apollo Lunar Sample Return (ALSRC), aluminum mesh packing material	930.9	
Container, Contingency Sample, Soft	1180.0	
Container, Gas Analysis Sample (GASC)	246.7	
Container, Lunar Environment Sample (LESC)	468.8	
Container, Special Environment Sample (SESC)	360.0	
Drive Tube, 2-cm Diameter, cap	33.8	
Drive Tube, 2-cm Diameter	272.2	
Drive Tube, 2-cm Diameter	272.3	
Drive Tube, 2-cm Diameter	271.2	
Drive Tube, 2-cm Diameter, cap & bracket assembly	315.2	
Drive Tube, 2-cm Diameter	272.8	
Extension Handle, Short	590.0	
Gnomon	227.0	
Hammer, Light-weight	860.0	
Scale, Sample	498.0	
Scoop, Box-shape	410.0	
Scoop, small	163.0	*
Tongs, Small	140.0	
Tool Carrier, Small	4200.0	*
TOTAL WEIGHT for APOLLO 12	29172.3	grams

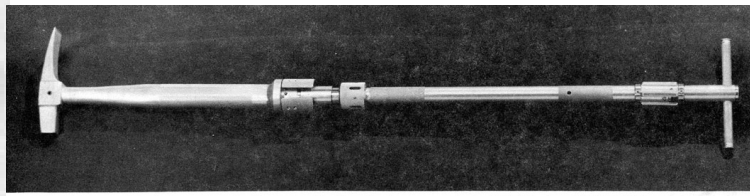
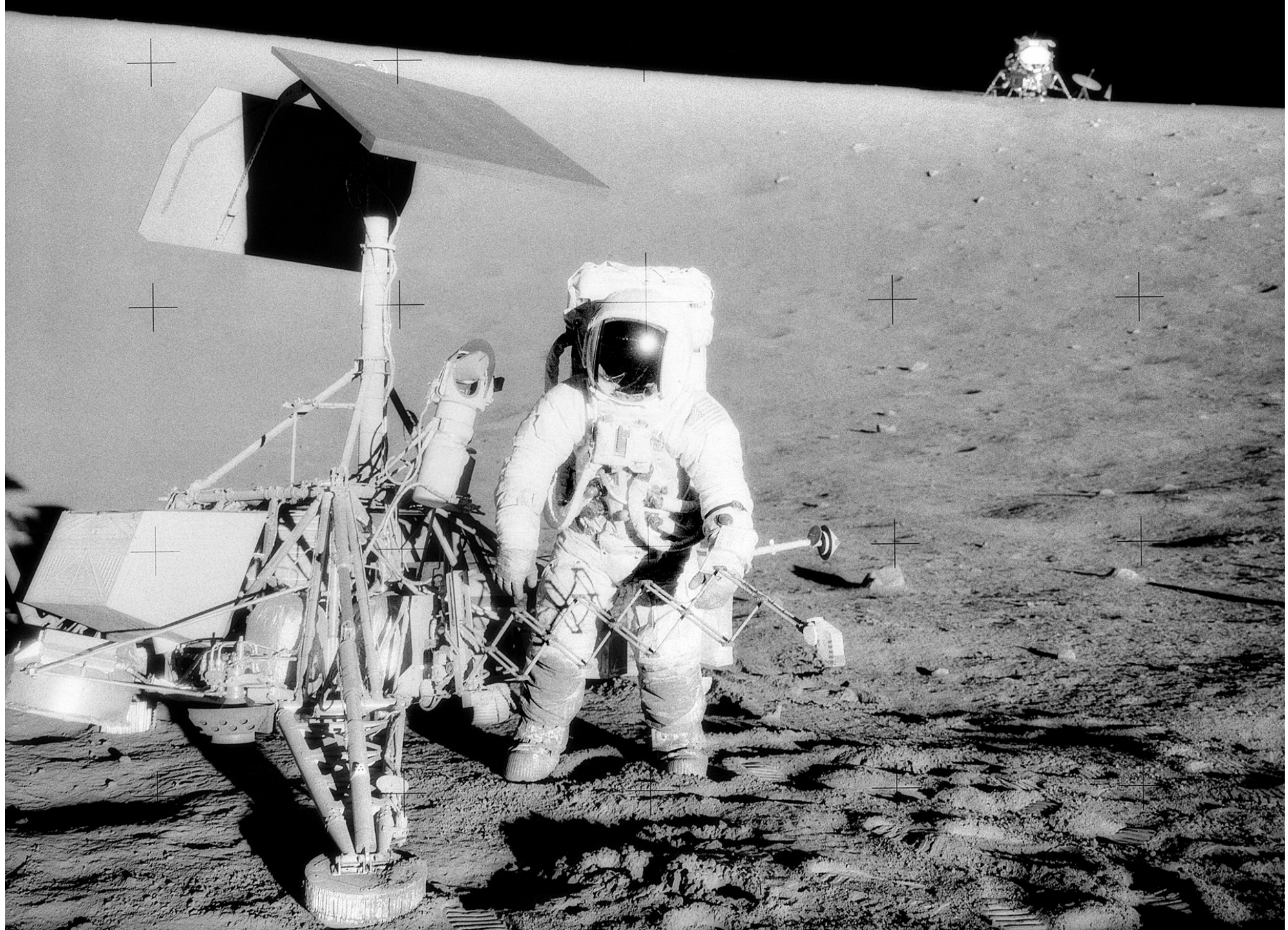


Fig. 32. Lighter weight hammer attached to extension handle for use as a hoe (NASA photo S60-31849).



DISCARD CUTTING TOOL
(LMP LOAD TV CAMERA IN BAG)
COMPLETE GEOLOGY TRAVERSE
REPORT START AND END OF TRAVERSE

2+46 SRC 2 PACKING

(LMP REMOVE PARTS BAG)
PLACE 70 mm IN ETB
REMOVE & EMPTY LMP SADDLE BAG
RETRIEVE SWC
STOW IN SRC 2:
- SWC FOIL/BAG
- CORE TUBES (3)
- ENVIRONMENTAL SAMPLE CAN
- GAS SAMPLE CAN
- DOCUMENTED SAMPLES

CHECK & CLEAN LMP EMU
SEAL SRC 2

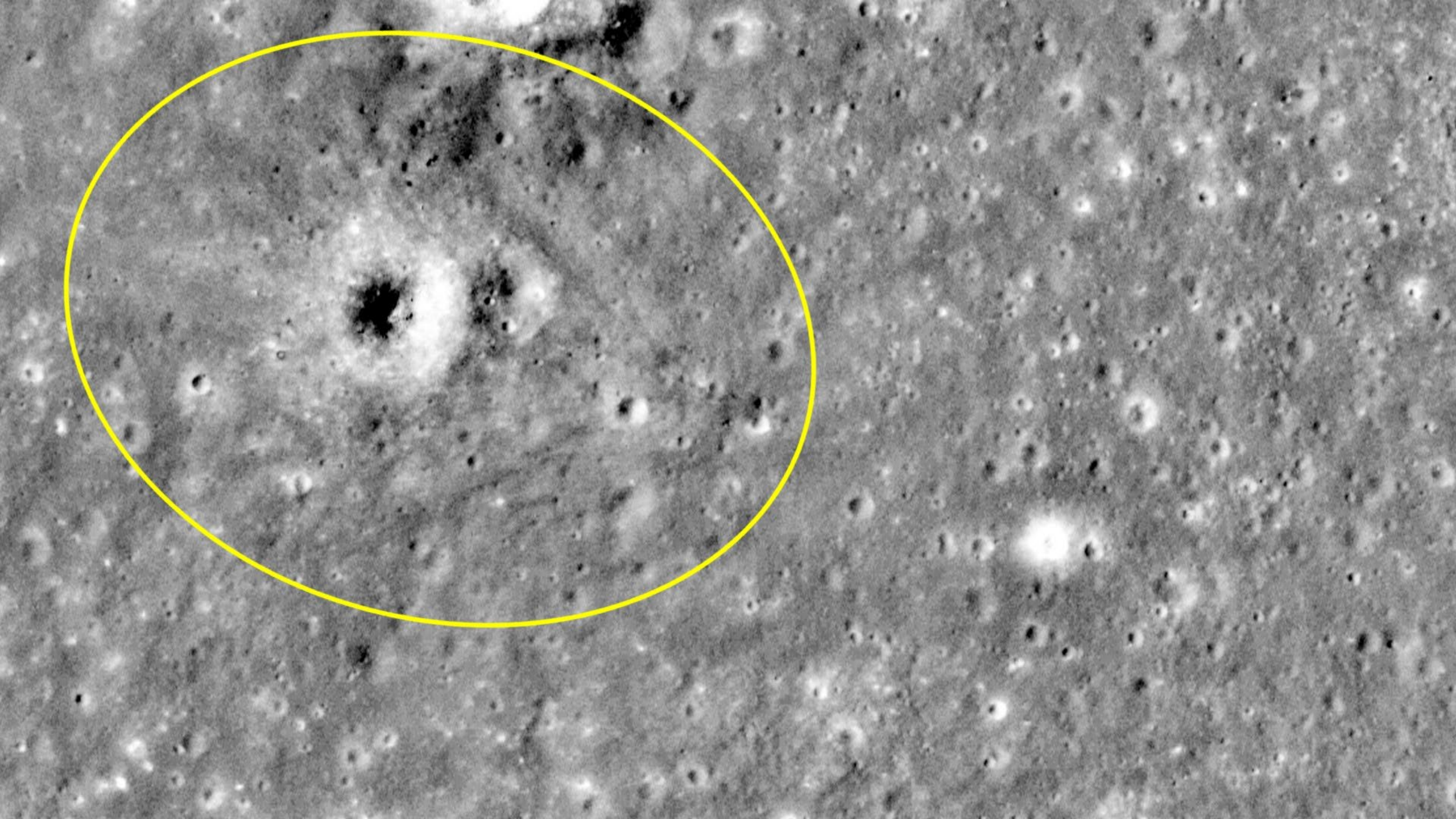
3+01 LEC TRANSFERS

CHECK 70 mm (2) IN ETB
TRANSFER ETB
TRANSFER SRC 2
TRANSFER SURVEYOR PARTS BAG

3+20 EVA TERMINATION

CLEAN EMU
CLEAR LEC OF ASCENT STAGE
INGRESS
JETTISON EQUIPMENT
CLOSE HATCH
REPRESS CABIN

EMU MALF. 1 - 3
EMU MALF. CONT'D - 6
EMU MALF. 10 - 11
LEC XFER
EVA TERM.



Discussion Groups

- **Chaikin Chapter 6 (“Sailors on the Ocean of Storms”)**
  - **A telling of the astronaut’s view of Apollo 12**
- Apollo 12 Mission Report Chapter 9 (“Pilots’ Report”)
  - The astronaut’s actual view of Apollo 12
- Cox Chapter 26 (“I Think We Need to do a Little More All-Weather Testing”)
  - A view of Apollo 12 from mission control
- From the Earth to the Moon Episode 7 (“That’s All There Is”)
  - An dramatization of a mission that largely lacked video

Term Paper Outline

Your outline should contain at least:

1. an **introduction** that clearly states the goal, — 10%
2. a **background** section that describes the context in which your goal was, was not, or may yet be achieved, — 10%
3. a section **analyzing the factors** that made or may make your goal achievable or unachievable, — **50%**
4. the **story** of how your goal did work out or speculation on how it may work out, and — 10%
5. a **conclusion** in which you draw out some important points that can be learned from your analysis about how big things get done, illuminating both commonalities with and differences from Apollo. — 20%

Apollo 13 Readings

- Apollo 13 Review Board Report
  - The reconstruction of what happened
- **Chaikin Chapter 7 (“The Crown of an Astronaut’s Career”)**
  - **The astronaut’s view of Apollo 13**
- Cox Chapter 27 (“You Really Need to Understand that th CSM is Dying”)
  - The initial response from Mission Control
- “Apollo 13” movie
  - A unified dramatization of the events