

Figure 80-Color photograph of Grover as it appeared in October 1970, complete with low-gain and high-gain antennae, cameras, etc.; USGS photo P4702g, F470160c.



Figure 81-The Apollo 15 prime and backup crews participated in a two-day exercise on 2-3 November 1970 at Cinder Lake Crater Field in Flagstaff, Arizona; (a) Walt Roeder with camera on left; Dave Scott on Grover holding map; Jim Irwin to Scott's right also on Grover; Jack Schmitt standing to Scott's left with sunglasses. Behind Schmitt is Gordon Swann, and to his right is professor Lee Silver; Bill Tinnin is closest to camera bending over Grover; and Dick Wisner on right bending over Grover; USGS photo F117036PR



Figure 81-(b) (l-to-r) Jim Irwin, Bill Phinney (MSC/Houston), Lee Silver (Caltech and USGS) and Dave Scott;
NASA photo S-70-53304



Figure 81-(c) Jim Irwin (left) and Dave Scott taking samples at Cinder Lake Crater Field during test; Grover is seen in background; USGS photo F117045



Figure 81-(d) Grover parked on rim of large crater in Cinder Lake Crater Field; Jim Irwin (l) and Dave Scott (r); NASA photo AP15-S70-53283 [1].



Figure 82-The final geologic training for the Apollo 14 crew was held at the SPE Branch's new Black Canyon Crater Field in Verde Valley, Arizona on 16 November 1970; (a) Al Shepard (l) and Ed Mitchell pulling the Modular Equipment Transport (MET) (referred to as the "Golf Cart by the crew) on a blocky surface in the Black Canyon Crater Field. The MET idea was conceived by Al Shepard for their use (to carry all of the tools, cameras, sample bags, rocks, and Al's "Golf club") for the trek up to Cone Crater during their upcoming Apollo 14 mission; NASA photo S-70-56096



Figure 82-(b) Al Shepard (red jacket) and Ed Mitchell setting the gnomon on the ground in preparation for taking photographs; MET on left; NASA photo S-70-56085



Figure 82-(c) Close-up view of Shepard placing the USGS-designed gnomon (with its photometric calibration chart) on the ground; NASA photo S-70-56100



Figure 82-(d) Jules Bergman (ABC Science Reporter) and an unidentified media-type interviewing Al Shepard (left) and Ed Mitchell during a break in their traverse activities during the 19 November 1970 exercise at the Black Canyon Crater Field. Bergman leaning on the MET; NASA photo S-70-54155



Figure 82-(e) Jules Bergman (ABC Science Reporter) interviewing Al Shepard (l) and Ed Mitchell; USGS photo P1117b, F1170173

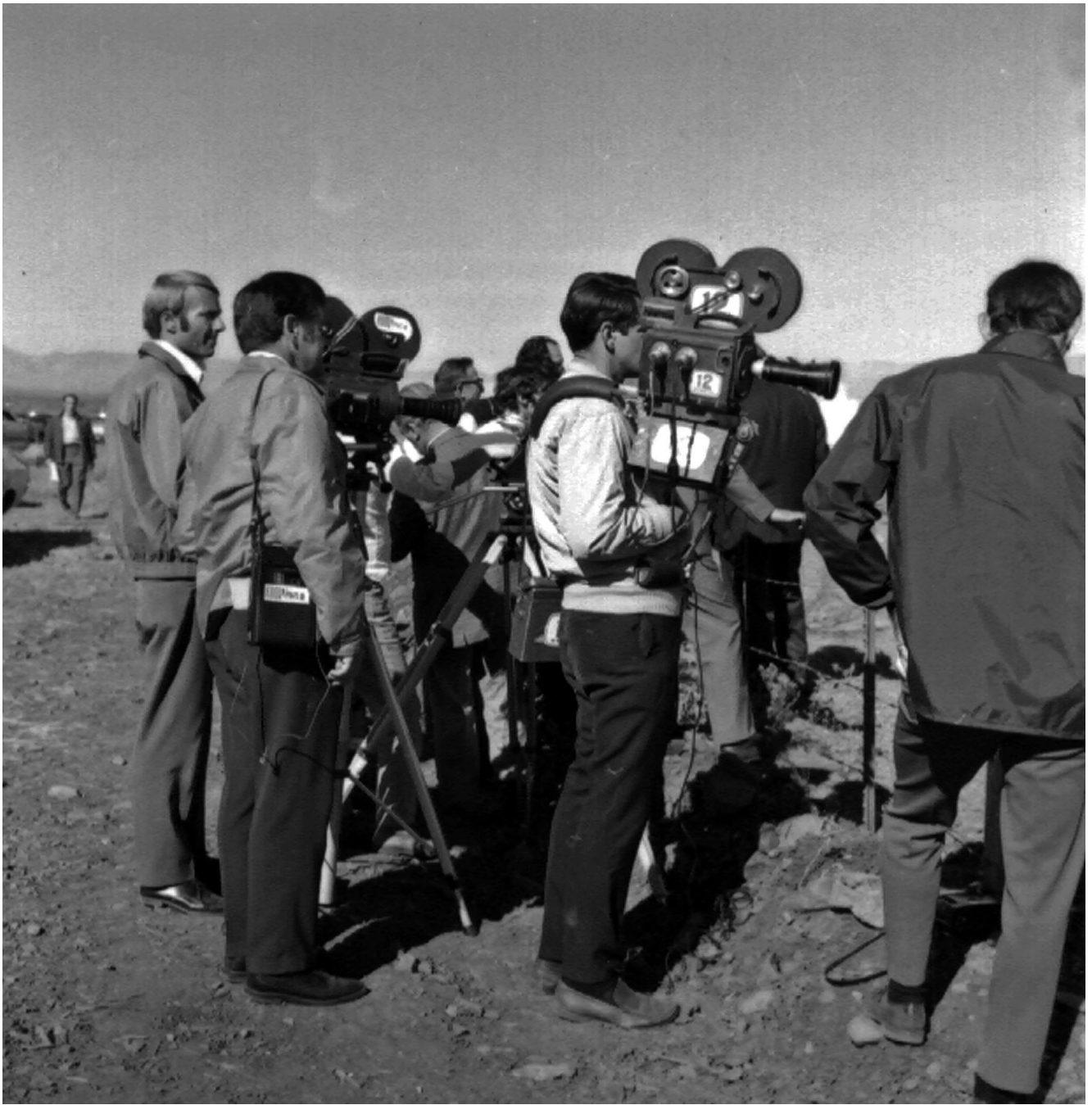


Figure 82-(f) entourage of media-types who were invited by NASA to observe this particular test; USGS photo P1117b, F1170177.



Figure 83-The 5-12 December 1970 Apollo 15 (prime and backup) astronaut trip to the big Island of Hawaii; (a) Apollo 15 prime and backup crew arriving at Hilo, Hawaii Airport 5 December 1970; (l-r) Jim Irwin, Dick Gordon, Dave Scott, Harrison Schmitt, Bob Parker, and Joe Allen; photo G. Schaber (USGS)



Figure 83-(b) “science backroom” during AP 15 5-12 December trip to Hawaii; (l-r) Jim Head (Bellcom, Inc., Washington, D.C.), Gerald Schaber, Bob Sutton (USGS, SPE Branch Flagstaff, Arizona); standing in back is Gary Lofgren (MSC/Houston, Texas); photo G. Schaber (USGS)



Figure 83-(c) A second “science backroom” group during Hawaii exercise; (l-r) Lee Silver (Caltech and USGS, Pasadena, California), Gordon Swann (USGS, Flagstaff, Arizona) and astronaut Joe Allen; photo G. Schaber (USGS)

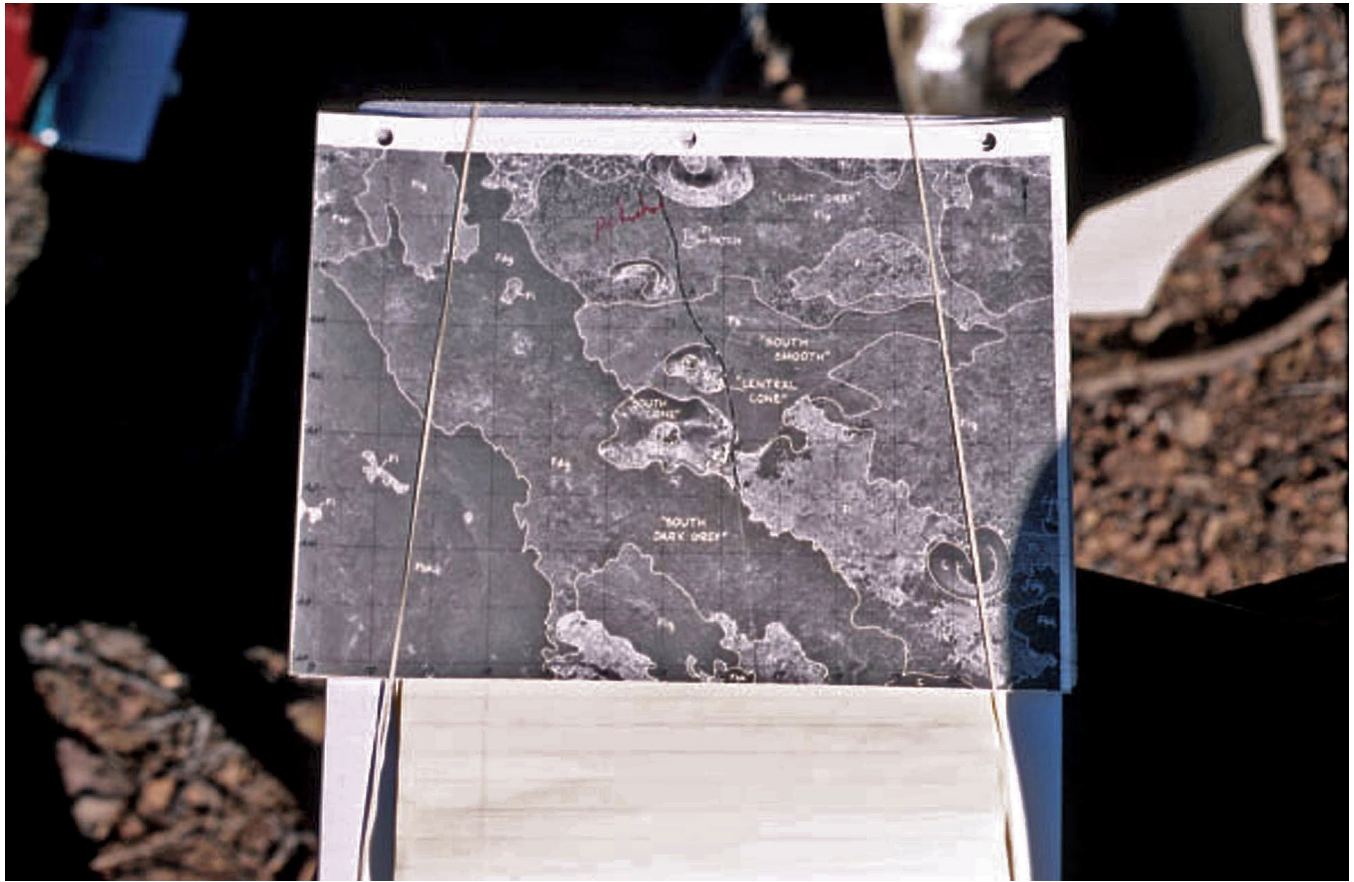


Figure 83-(d) page of traverse photo geology-map package compiled by G. Schaber for the Hawaii exercise; photo Gerald Schaber (USGS)



Figure 83-(e) during a break; (l-r) Bob Parker, Dick Gordon, Lee Silver and Harrison Schmitt; photo G. Schaber (USGS)



Figure 83-(f) Dave Scott carrying Apollo gnomon (left hand) and rake tools with electric Hasselblad camera and simulated backpack; NASA S-70-56380

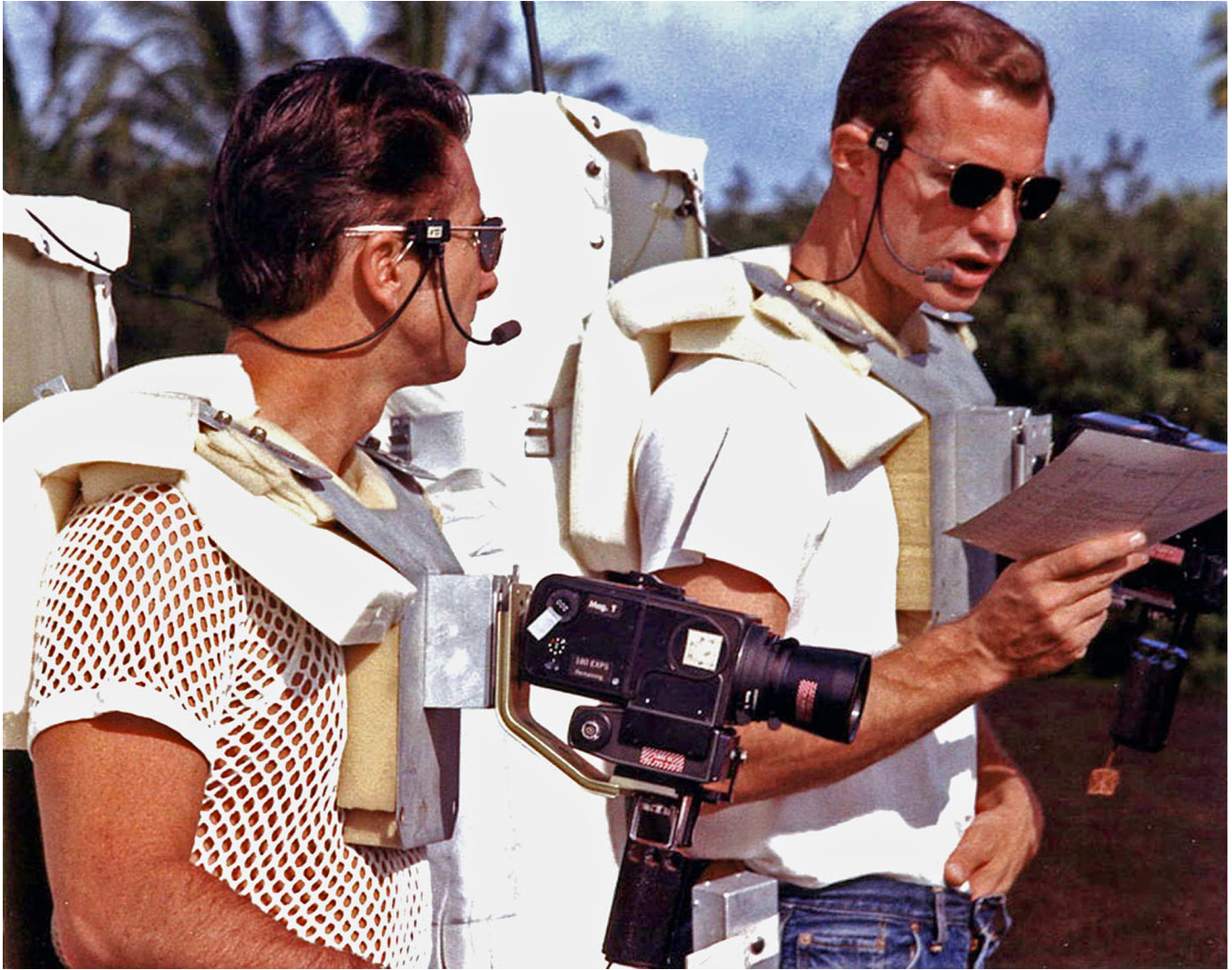


Figure 83-(g) Jim Irwin (l) and Dave Scott checking out traverse map during traverse in Hawaii; NASA AP15-S70-56431 [1]

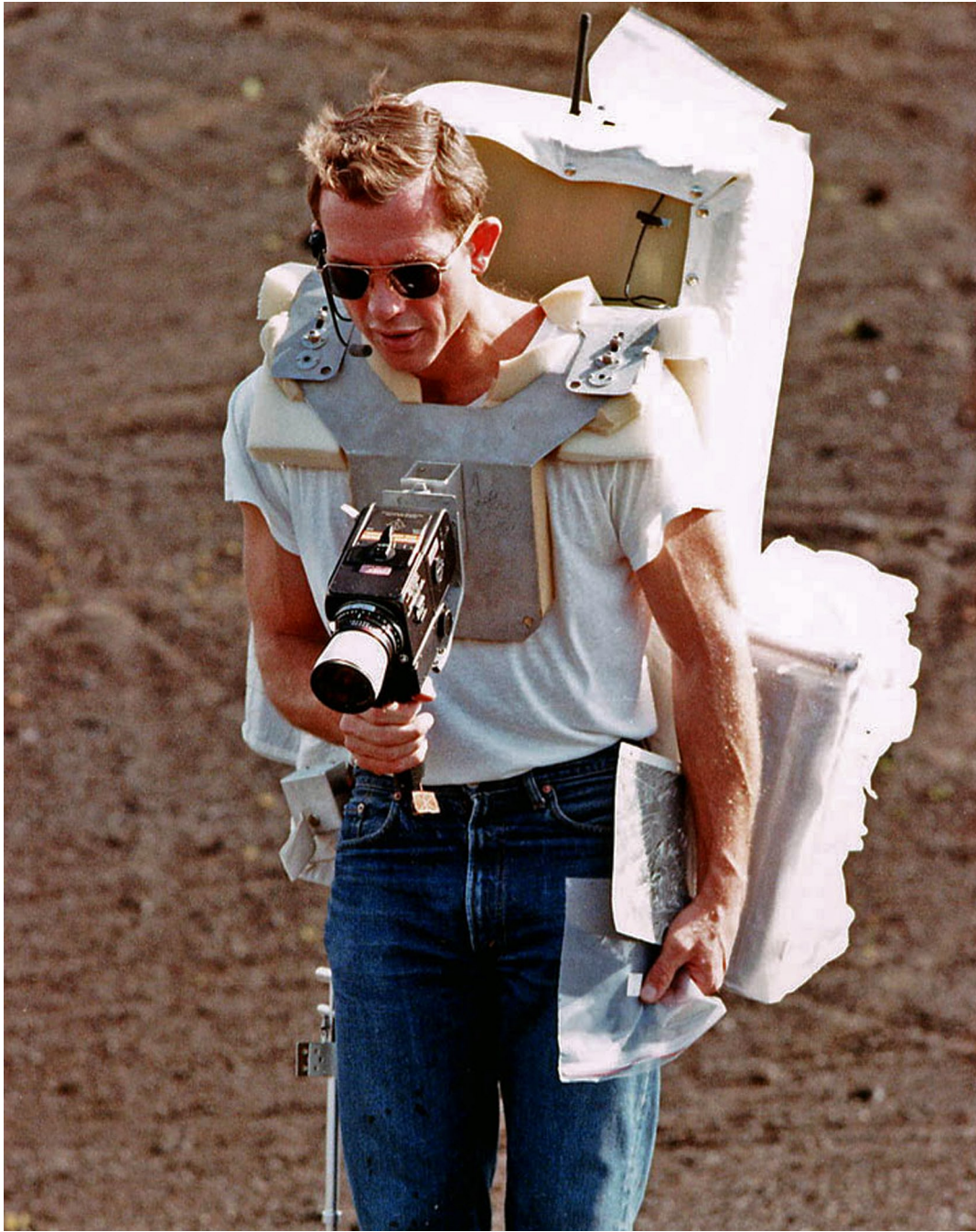


Figure 83-(h) Dave Scott carrying map and sample bag; NASA AP15-S70-56419



Figure 83-(i) Dave Scott adjusting mike, holding traverse map; NASA AP15-S70-56409.

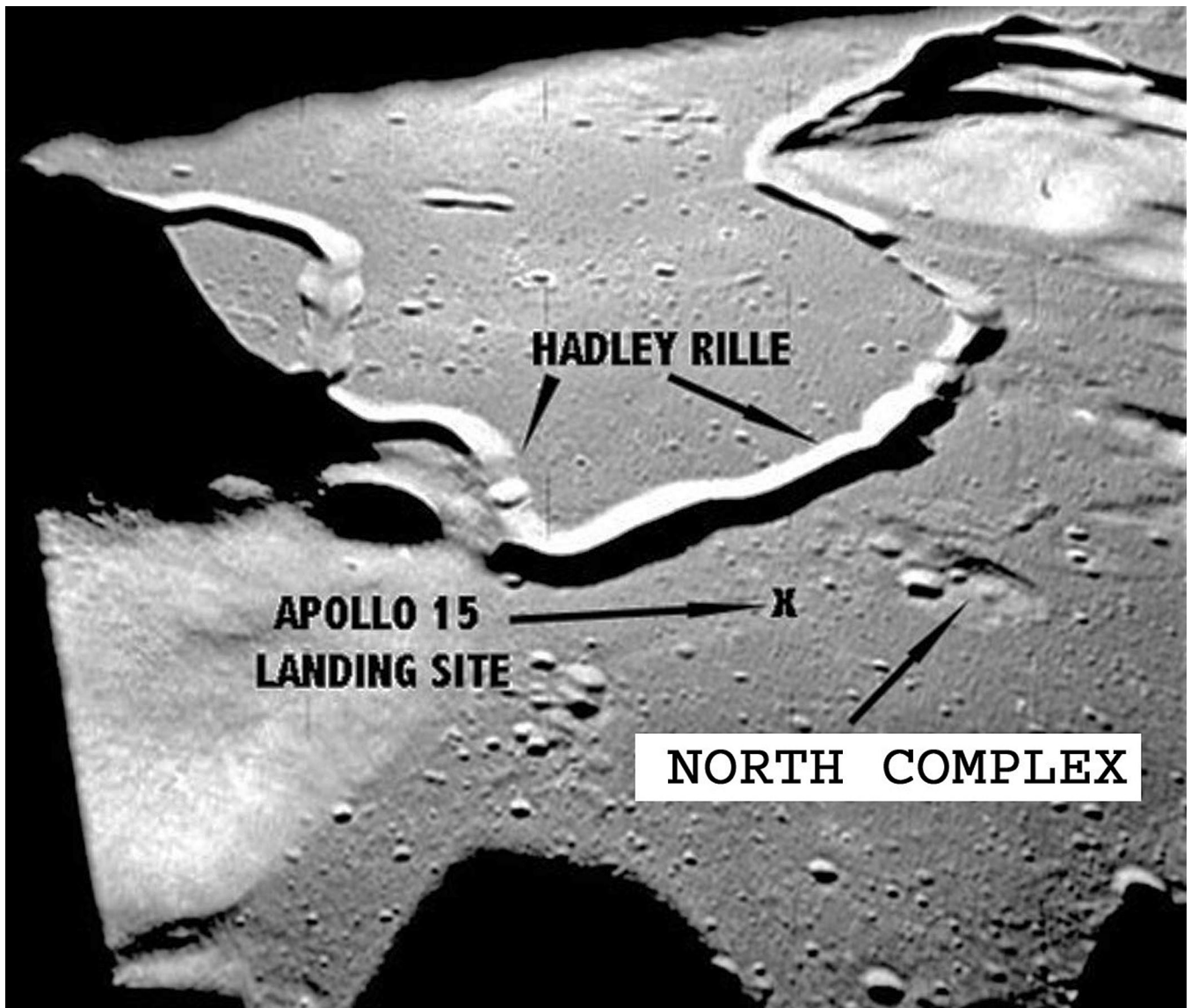


Figure 84- Apollo 15 metric photograph of Apollo 15 landing site at Apennine-Hadley; LM landing site, Hadley Rille, and the North Complex indicated; AP15 metric frame number unknown.



Figure 85-(a) Astronauts David Scott and James Irwin (left front) at Taos, New Mexico, during a field test on 11-12 March 1971. Geologic instructor Lee Silver (Caltech and USGS) with white hat behind Irwin; NASA photo S-71-23771



Figure 85-(b) Jim Irwin (l) with scoop tool and Dave Scott observing; NASA AP15-S71-23772



Figure 85-(c) Jim Irwin (l) (with scoop tool and traverse map) and Dave Scott; NASA AP15-S71-23769



Figure 85-(d) (l-r) Jim Irwin, Dave Scott (using rangefinder) and Joe Allen (AP15 CapCom); NASA AP15-S71-24015.



Figure 86-Apollo 16 crew (Duke and Young) participating in a Grover field test at Merriam Crater (day one) and the Cinder Lake Crater Field (day two) near Flagstaff, Arizona on 29-30 June 1971. The field test was organized and directed by the Branch of Surface Planetary Exploration personnel. One of the purposes of this test was to test out the remote TV camera that had been recently rigged up on the Survey's "Grover" LRV vehicle by Johnny Nuttall (Electronics Group leader, Branch of Surface Planetary Exploration) for use during the planned traverses; (a) (l to r)-Charles Duke, John Young, and an unidentified NASA engineer on Grover at Merriam Crater (day one of test)



Figure 86-(b) (l to r)- unidentified NASA engineer and Charles Duke taking soil sample by Grover vehicle at Merriam Crater; (c) (l-to-r)- unidentified NASA engineer and Charles Duke climbing ladder to canvas simulated Lunar Module (LM) during test at Cinder Lake Crater Field on day two of test.



Figure 86-(c) (l-to-r)- unidentified NASA engineer and Charles Duke climbing ladder to canvas simulated Lunar Module (LM) during test at Cinder Lake Crater Field on day two of test.



Figure 87-Final geology exercise for the Apollo 15 prime and backup crew at Coconino Point, Territory of the Navajo Nation, Arizona (north of Flagstaff, Arizona and south of the Grand Canyon) on 25 June 1971; (a) (l-to-r) Jim Irwin and Dave Scott checking out outcrop; NASA photo S-71-39711



Figure 87-(b) Jim Irwin (left) and Dave Scott during traverse using the USGS's Explorer vehicle; NASA photo



Figure 87-(c) General overview of western base of the Coconino Point monocline that dominates the Coconino Point Test site. Dave Scott and Jim Irwin in center of photo; NASA photo



Figure 87-(d) Jack Schmitt, standing on edge of an erosional canyon (showing layered rocks in far wall) that was used to simulate the large Hadley Rille at the Apollo 15 landing site

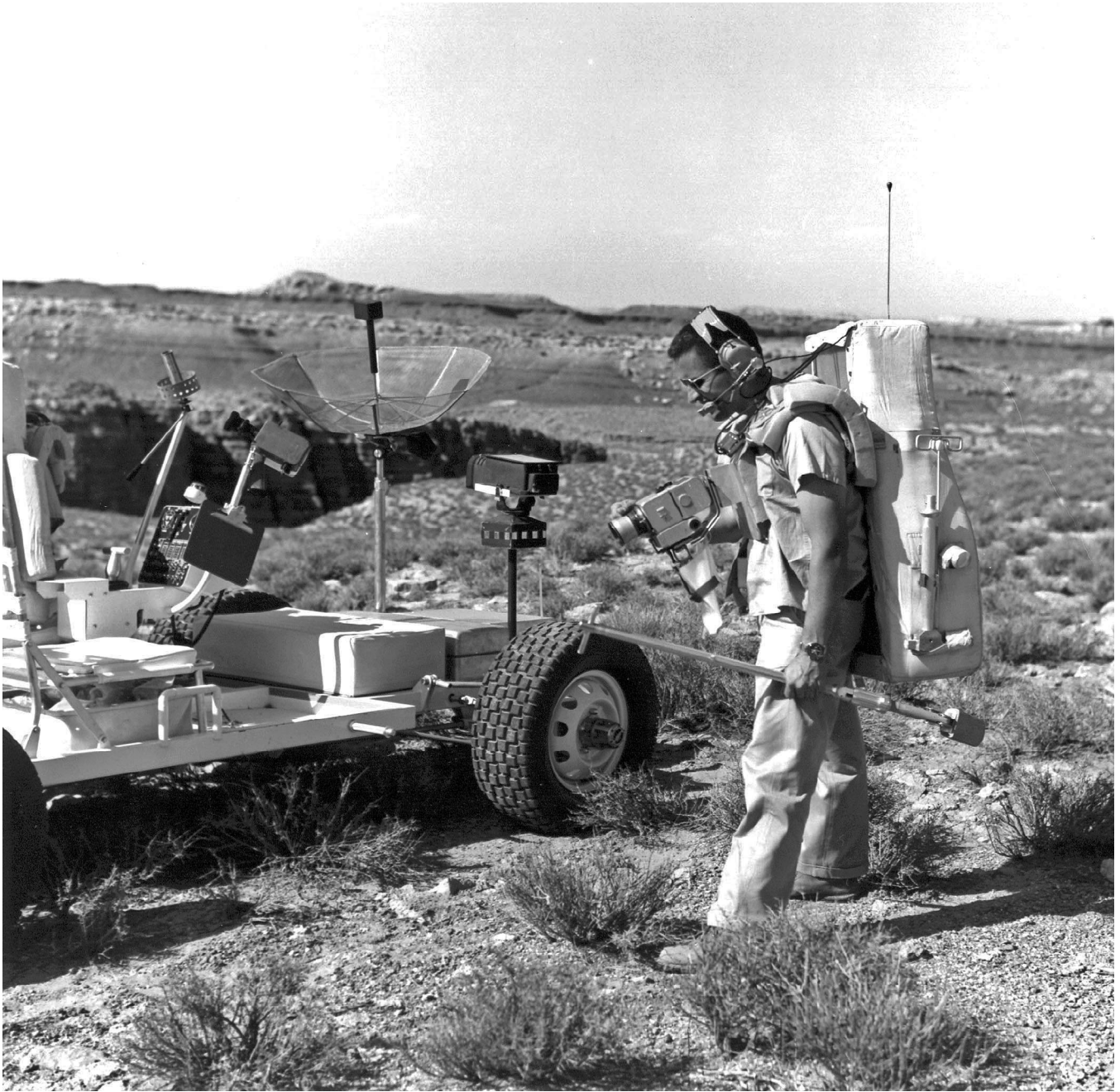


Figure 87-(e) Jack Schmitt by Grover carrying Apollo scoop tool; NASA photo.



Figure 88-Apollo 16 geologic training-exercises in Sudbury, Ontario, Canada 7-9 July 1971; (a) Charles Duke (left) and John Young studying traverse map prepared for them during geologic traverses at Sudbury. Both astronauts have electric Hasselblad cameras, similar to the ones they would use on the Moon, mounted on their chest plates; NASA photo S-71-39840



Figure 88-(b) close up of Charles Duke at Sudbury; geologist Fred Horz (MSC, Houston, Texas) (glasses) is in foreground; NASA S-71-39831



Figure 88-(c) close up of John Young at Sudbury; NASA photo S-71-39833



Figure 88-(d) Bill Muehlberger, PI of the Apollo 16 Lunar Geology Experiment, acting the part of astronaut along with Fred Haise; NASA photo S-71-39860



Figure 88-(e) Fred Haise preparing to take a photograph after setting up the gnomon on the ground in front of him. Fred is holding the Apollo rake tool in his left hand; NASA photo S-71-39844.

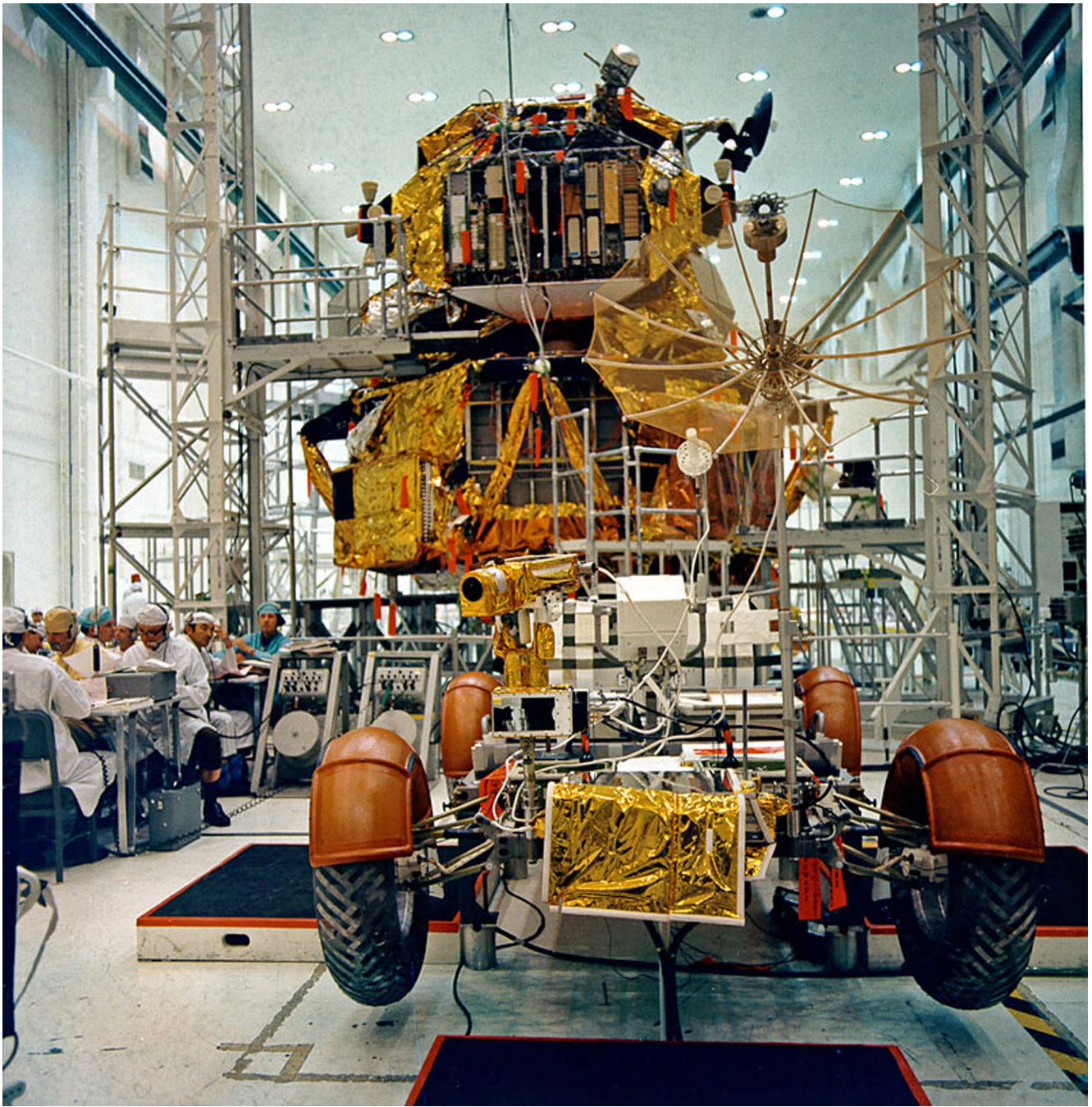


Figure 89-Selected NASA photographs from Apollo 15 mission (launch 26 July, 1971; landing Hadley-Apennine);
(a) LM and LRV-1 at KSC; before LRV stowage in LM; NASA AP15-S71-30542

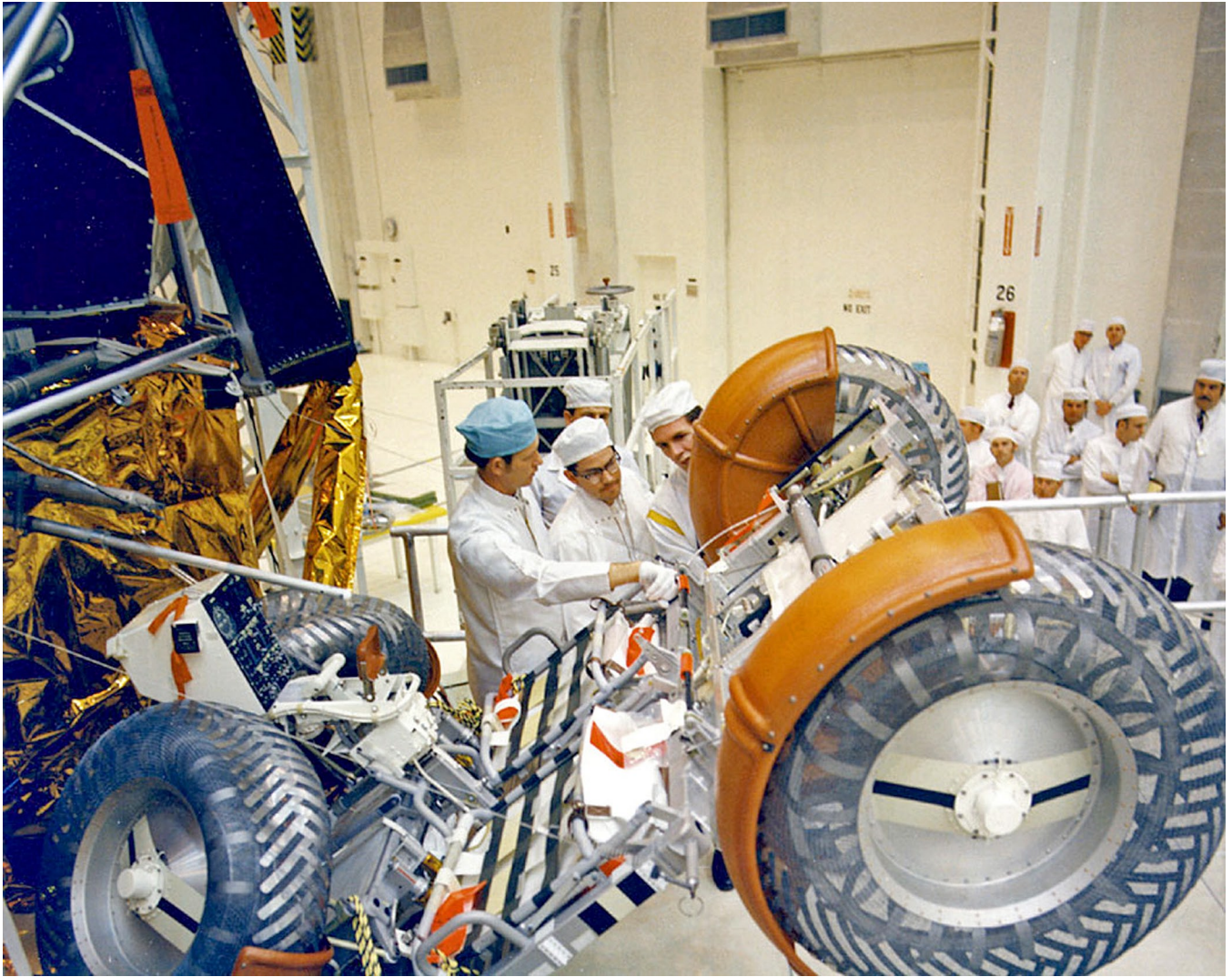


Figure 89-(b) Dave Scott observes loading of foldable LRV-1 into LM at KSC; NASA AP15-KSV-71PC-345



Figure 89-(c) liftoff of AP 16 from Cape Kennedy; 26 July, 1971; NASA AP15-KSC-71PC-572



Figure 89-(d) view of Hadley Rille and LRV from station 2 (EVA-1); NASA AS15-85-11451

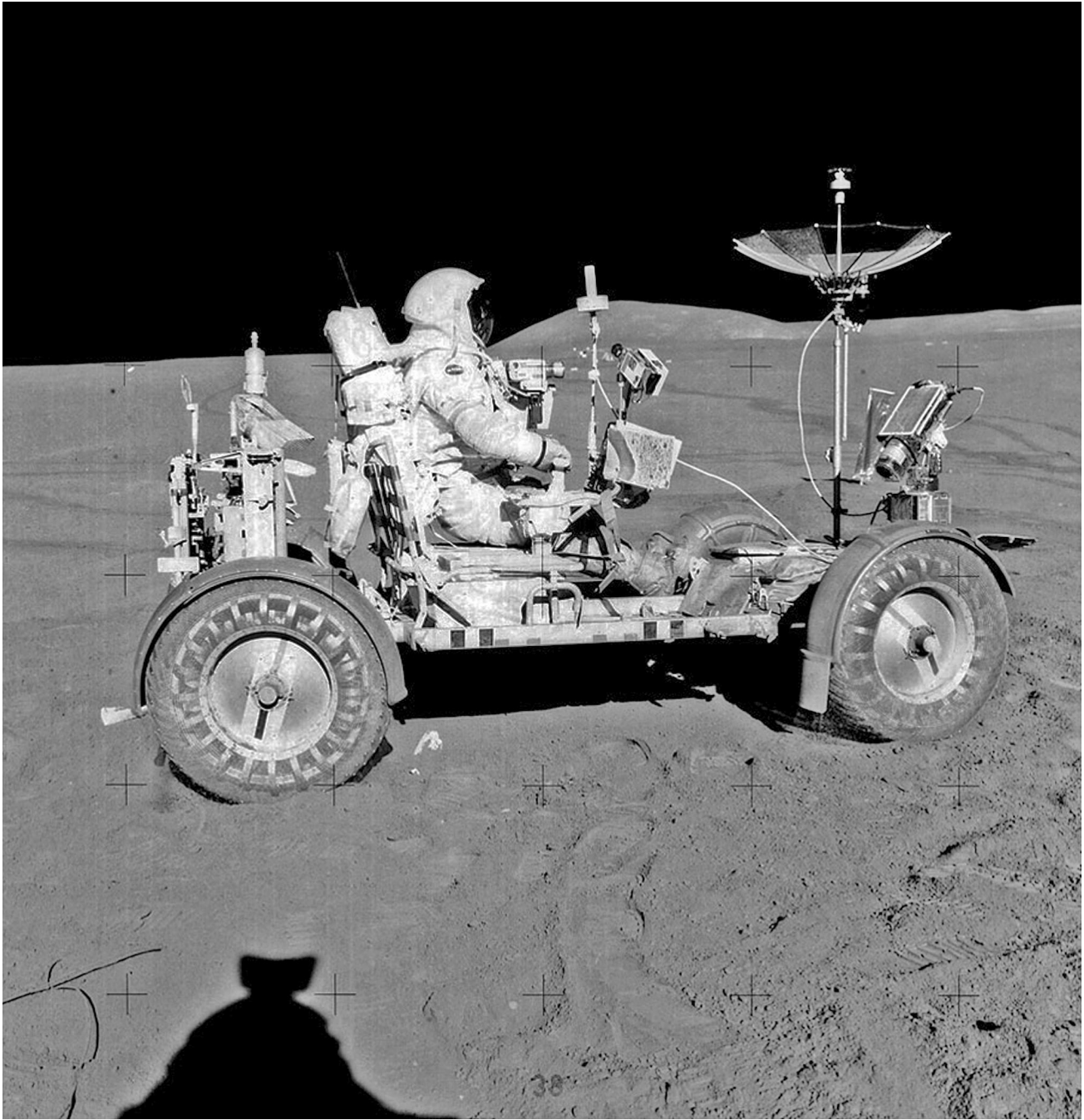


Figure 89-(e) Dave Scott on LRV prior to EVA-1; NASA AS15-85-11471

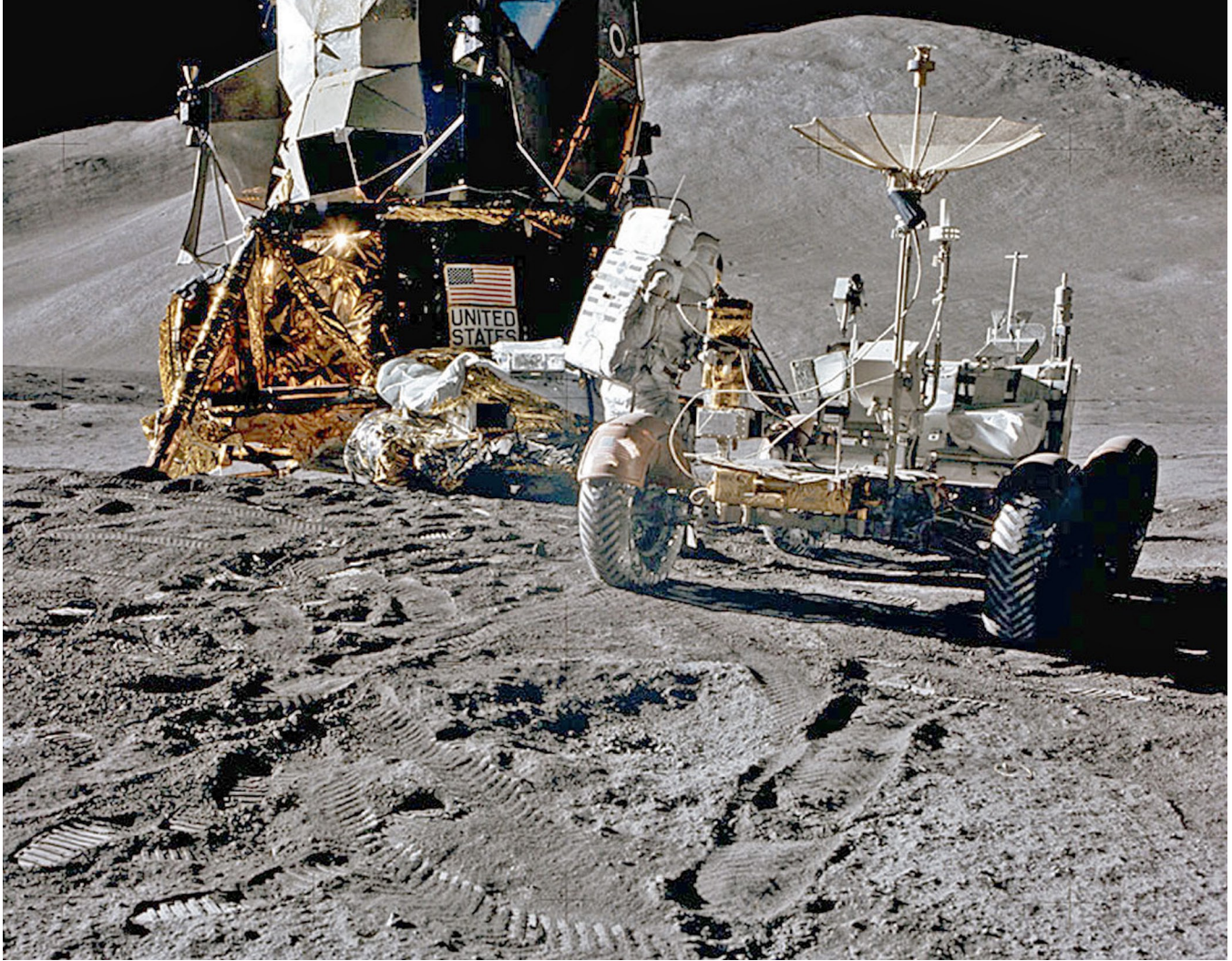


Figure 89-(f) Jim Irwin working at LRV parked by LM; NASA AS15-86-11598

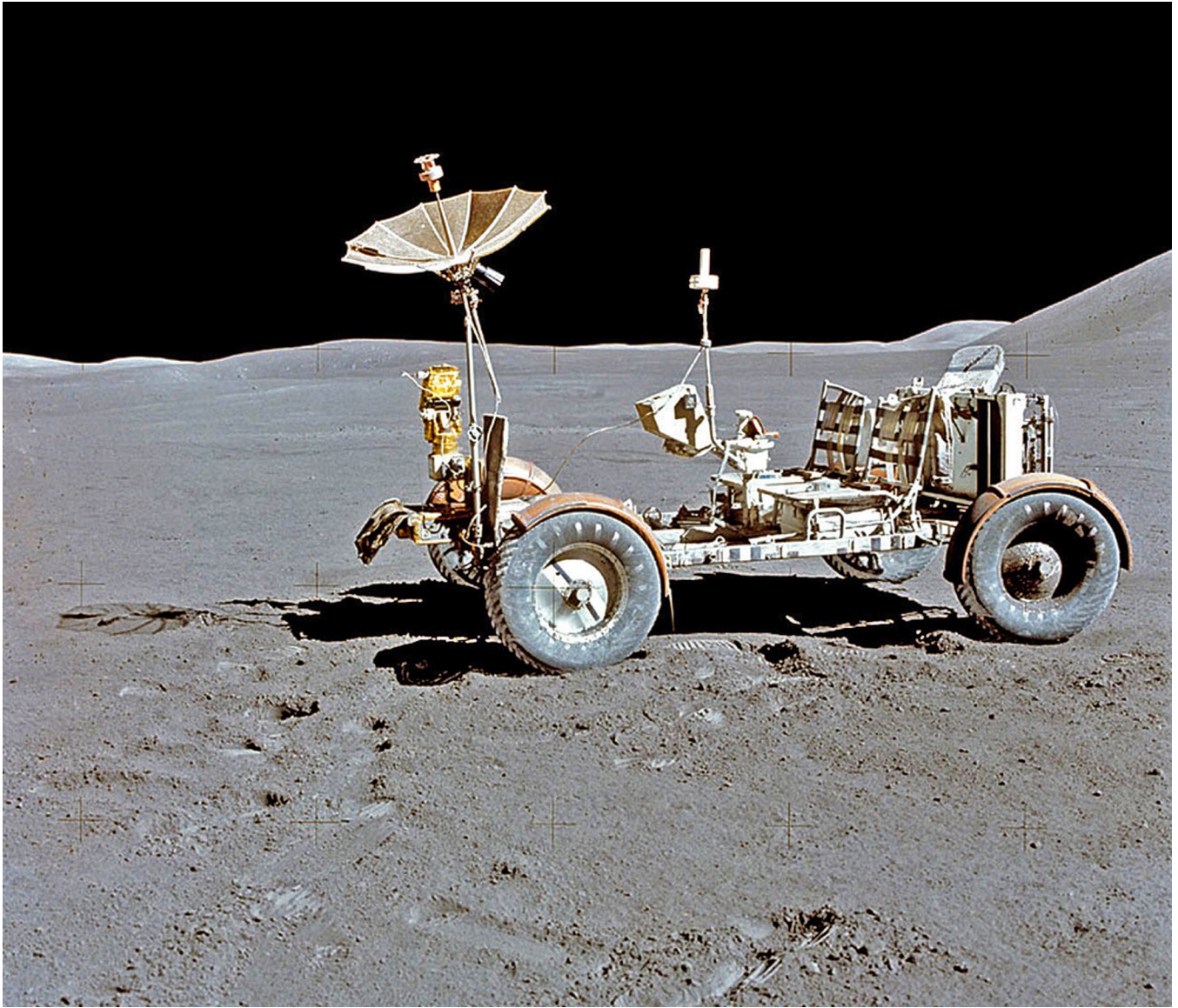


Figure 89-(g) final resting place for AP 15 LRV prior to liftoff; NASA AS15-88-11901.



Figure 90-Apollo 16 geologic training trip to Taos, New Mexico on 9-10 September, 1971; (a) Charles Duke (l) and John Young in the Geological Survey's Grover vehicle; NASA AP16-S71-51600



Figure 90-(b) John Young (l) and Charles Duke during EVA training; Young holding Apollo tongs and Duke holding Apollo scoop tools; NASA As15-S71-51605



Figure 90-(c) Charles Duke (l) taking 500-mm Hasselblad photograph across gorge; John Young on edge of gorge; NASA AP16-S71-51614



Figure 90-(d) John Young (l) and Charles Duke on rim of gorge; Duke taking 500-mm-photograph across gorge with Hasselblad; Young looking at exercise map; NASA AP16,71-H-1547



Figure 90-(e) Charles Duke (l) and John Young on Grover; Duke had traverse map in hand; NASA AP16-S71-51616



Figure 90-(f) Geologic mentor Lee Silver pointing out some geologic feature to astronauts; Charles Duke left of Silver; John Young in front of Lee Silver in blue shirt; others not identified; NASA AP16-S71-54564.

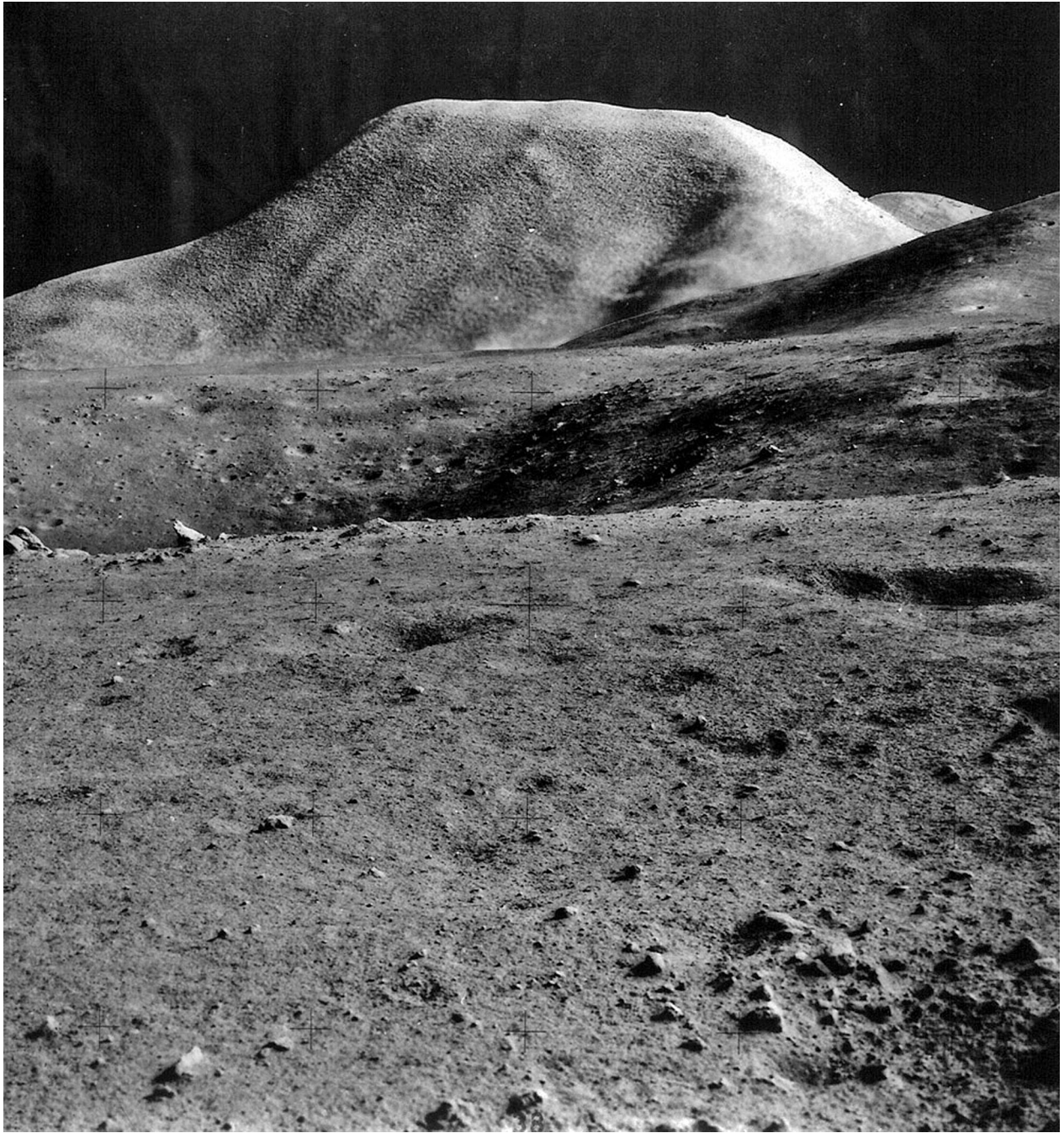


Figure 91-Comparison between the “cement” model of Mt. Hadley (a) (inserted into an actual Apollo 15 surface photograph) with (see b below) the original photograph of Mt. Hadley taken by the Apollo 15 crew while on the surface at the Hadley Rille Site

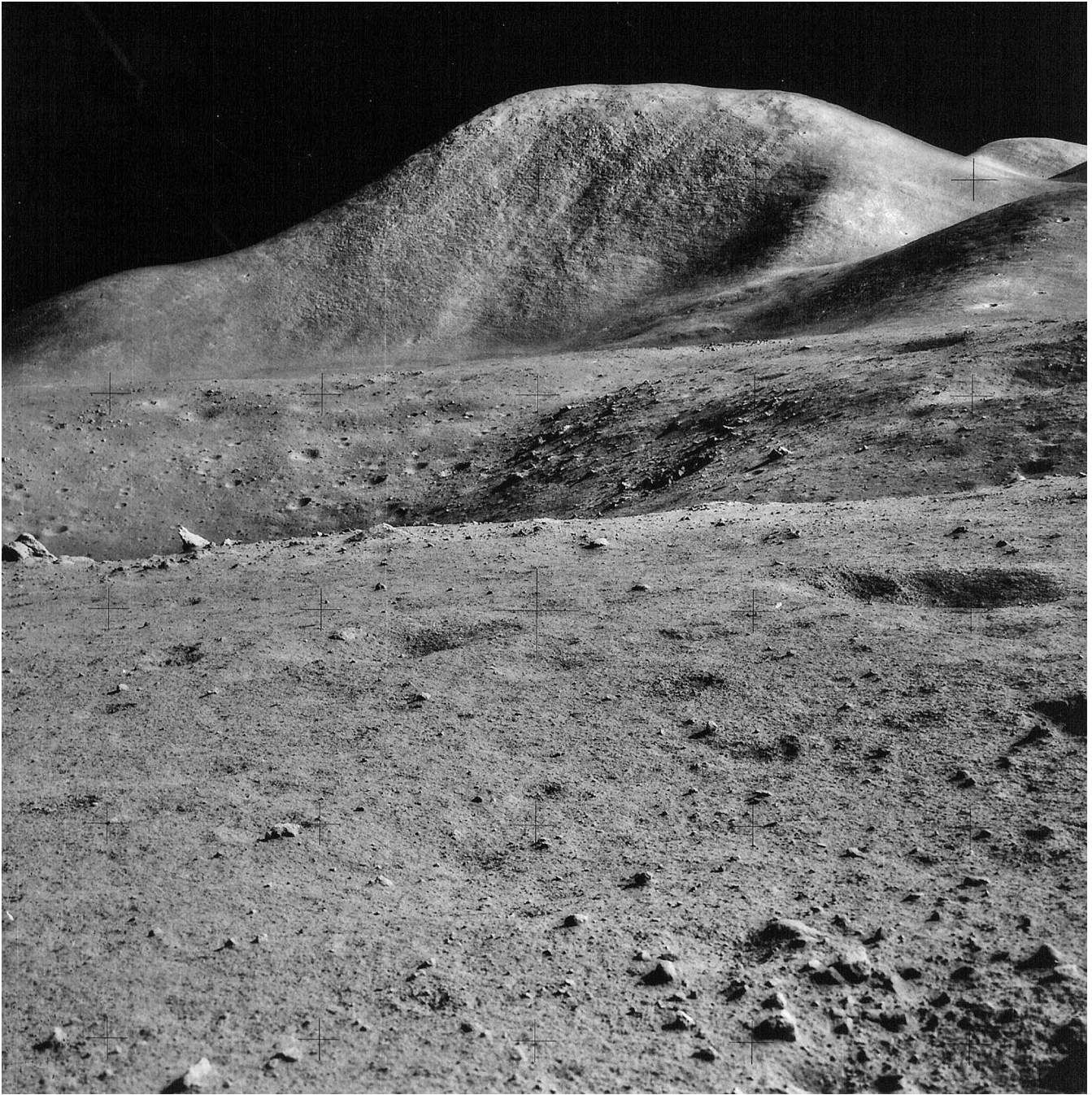


Figure 91-(b) the original photograph of Mt. Hadley taken by the Apollo 15 crew while on the surface at the Hadley Rille Site; both USGS photographs show remarkably similar “layers” sloping from the upper right to the lower left. This comparison convinced nearly everyone that the “layers” were in fact lighting artifacts, perhaps unique to the lunar surface.



Figure 92-The 17-18 November 1971 exercises for the crew of Apollo 16 at the Coso Hills Naval Ordnance Test Range, California; (a) John Young (left side of vehicle) and Charles Duke on Grover during the Coso Hills exercises; NASA photo S-72-59354



Figure 92-(b) John Young (left) and Charles Duke inspecting the rocks at Coso as unidentified NASA employee observes; NASA photo S-71-59357



Figure 92-(c) Charles Duke (bending) looking at boulder; John Young standing holding Apollo pickup (clamp) and scoop geologic tools; NASA AP16-S71-59355



Figure 92-(d) John Young (left front seat) and Charles Duke in Grover vehicle during by lava flow; NASA AP16-S71-59354

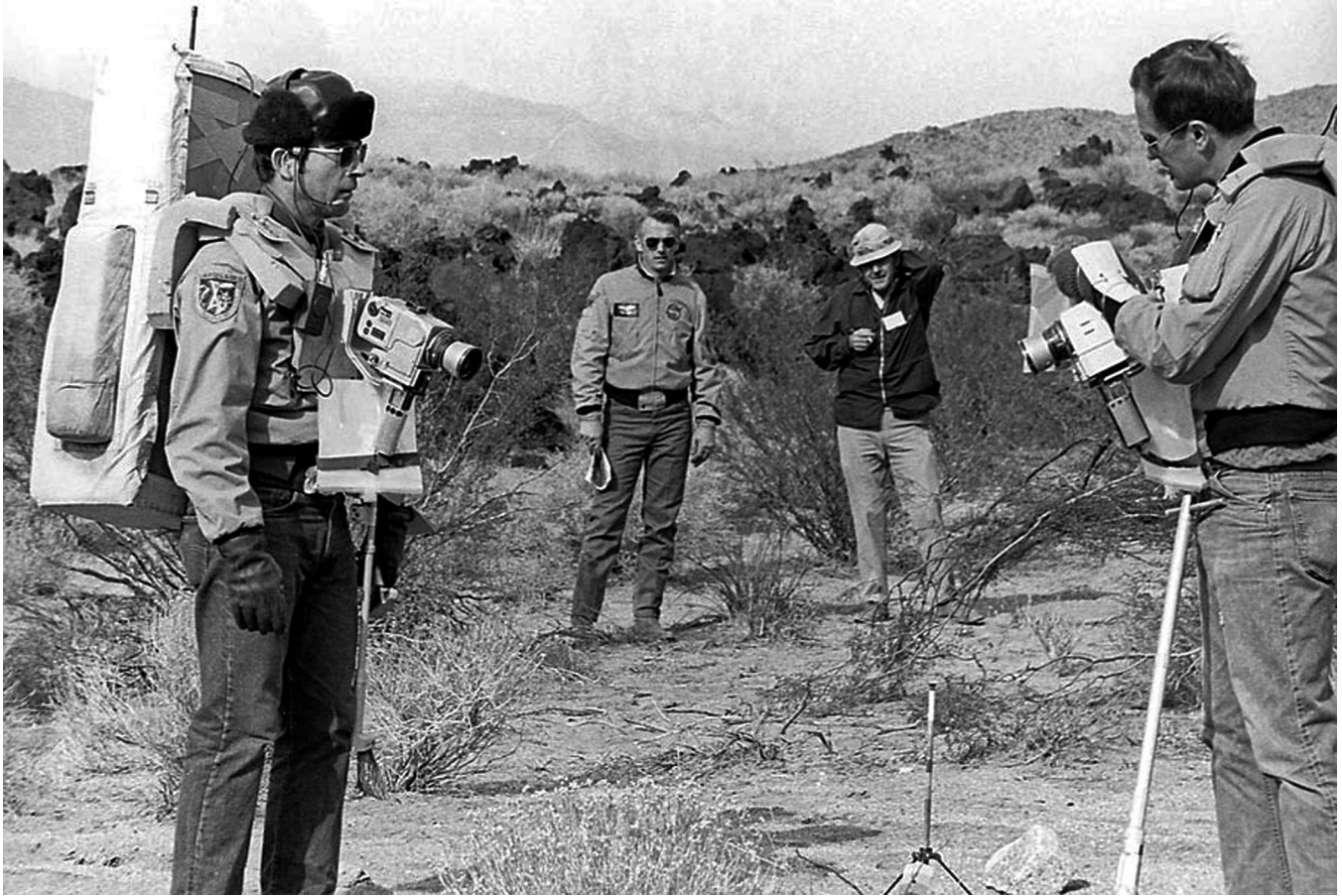


Figure 92-(e) (l-r) John Young, unidentified astronaut, Dale Jackson (geologic trainer from USGS) and Charles Duke; Duke looking at cuff check list; NASA AP16-71-H-1785



Figure 92-(f) Ed Mitchell (l) and Fred Haise (AP 16 backups) prepare to document a sample; Haise carrying gnomon, gripper, and scoop tools; NASA AP16-71-H-1786.



Figure 93-Geologic training exercise at Boulder City, Nevada on 24 January 1972; (a) Jack Schmitt (l) and Gene Cernan looking over exercise traverse map; NASA AP17-72-H-126;



Figure 93-(b) Jack Schmitt (l) and Gene Cernan documenting a sample; NASA AP17-72-H-128.



Figure 94- Geologic training exercise at the Nevada Test site for the AP 16 crew on 16-17 March 1972; (a) John Young standing by the Geological Survey's "Explorer" vehicle; NASA AP16-S72-31555



Figure 94- (b) Charles Duke (l) and John Young on Explorer vehicle; NASA AP16-S72-31183.

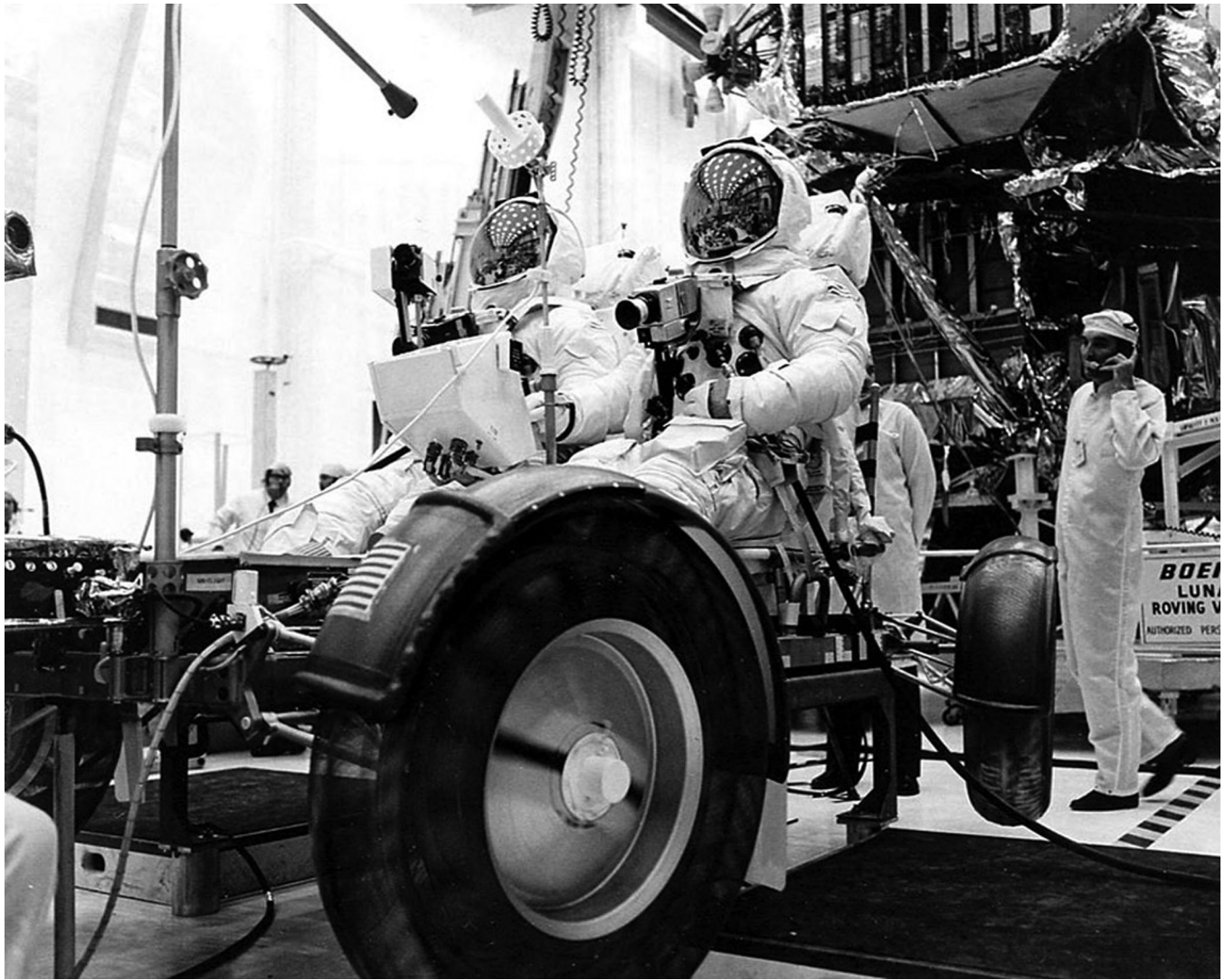


Figure 95-Selected NASA Apollo 16 photographs including pre launch, launch, and lunar surface activities (launch: 16 April 1972; landing: Descartes highlands on 21 April); (a) crew suited up on LRV-2 before it is loaded on LM; 4 November 1971; NASA AP16-71-H-1739

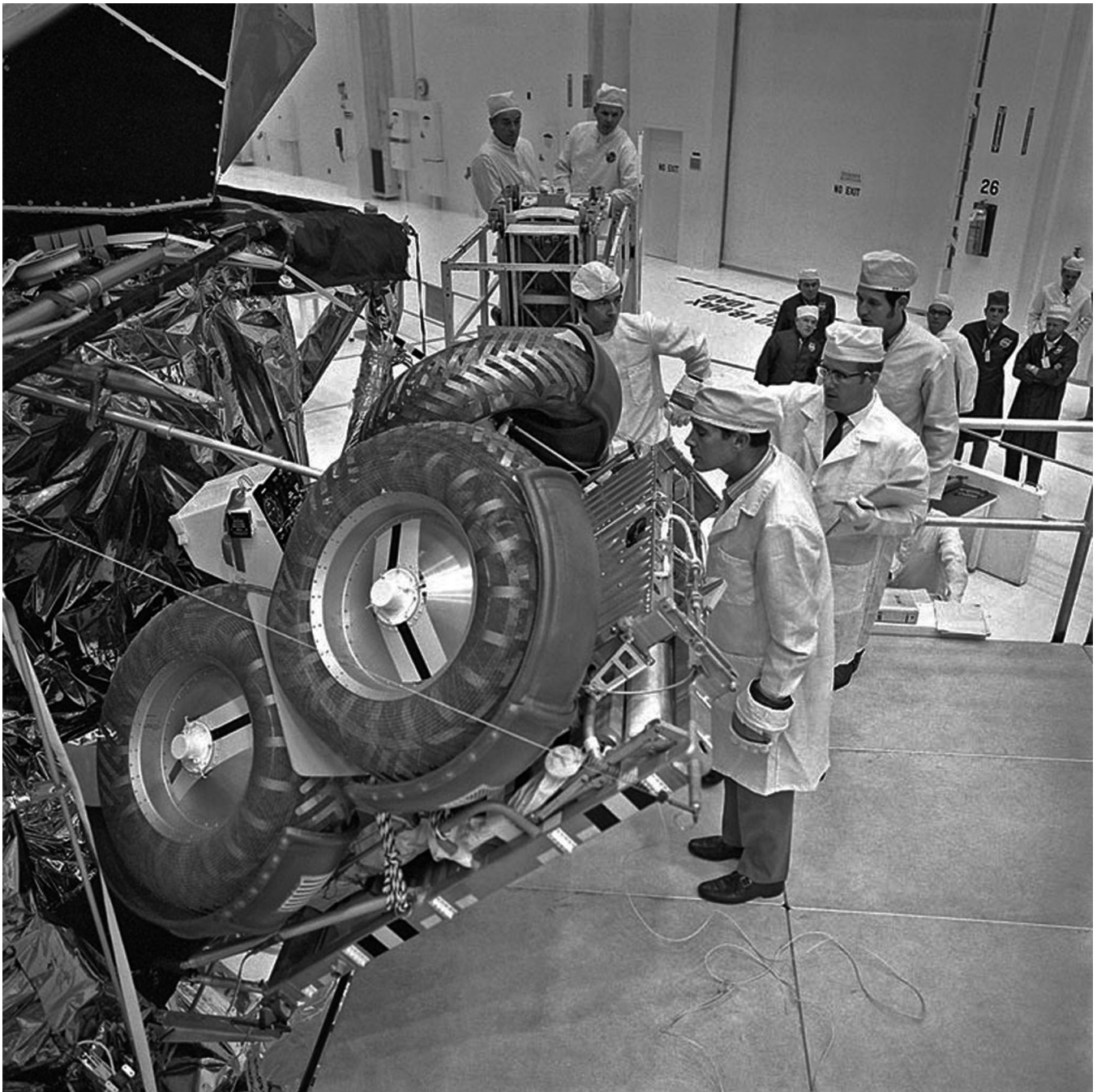


Figure 95-(b) crew observes loading of LRV-2 into Apollo 16 LM at KSC on 12 November 1971



Figure 95-(c) first rollout of AP 16 at KSC on 13 December 1971; NASA AP16-rollout-NOID



Figure 95-(d) liftoff of Apollo 16; 16 April 1972; NASA AP16-KSC-72PC-176

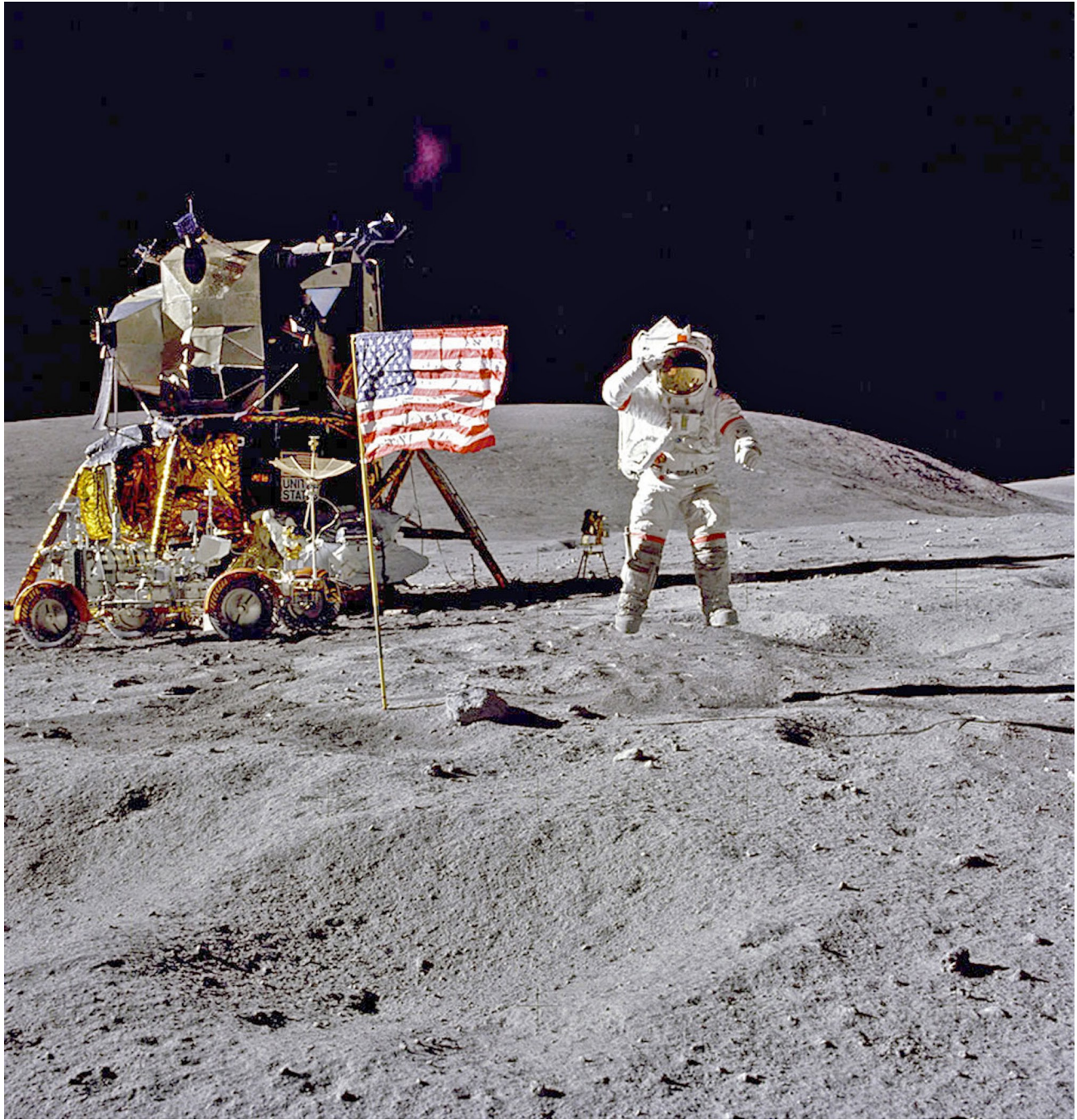


Figure 95-(e) John Young jumps off lunar surface to salute flag by LM and LRV-2; NASA AS16-113-18339

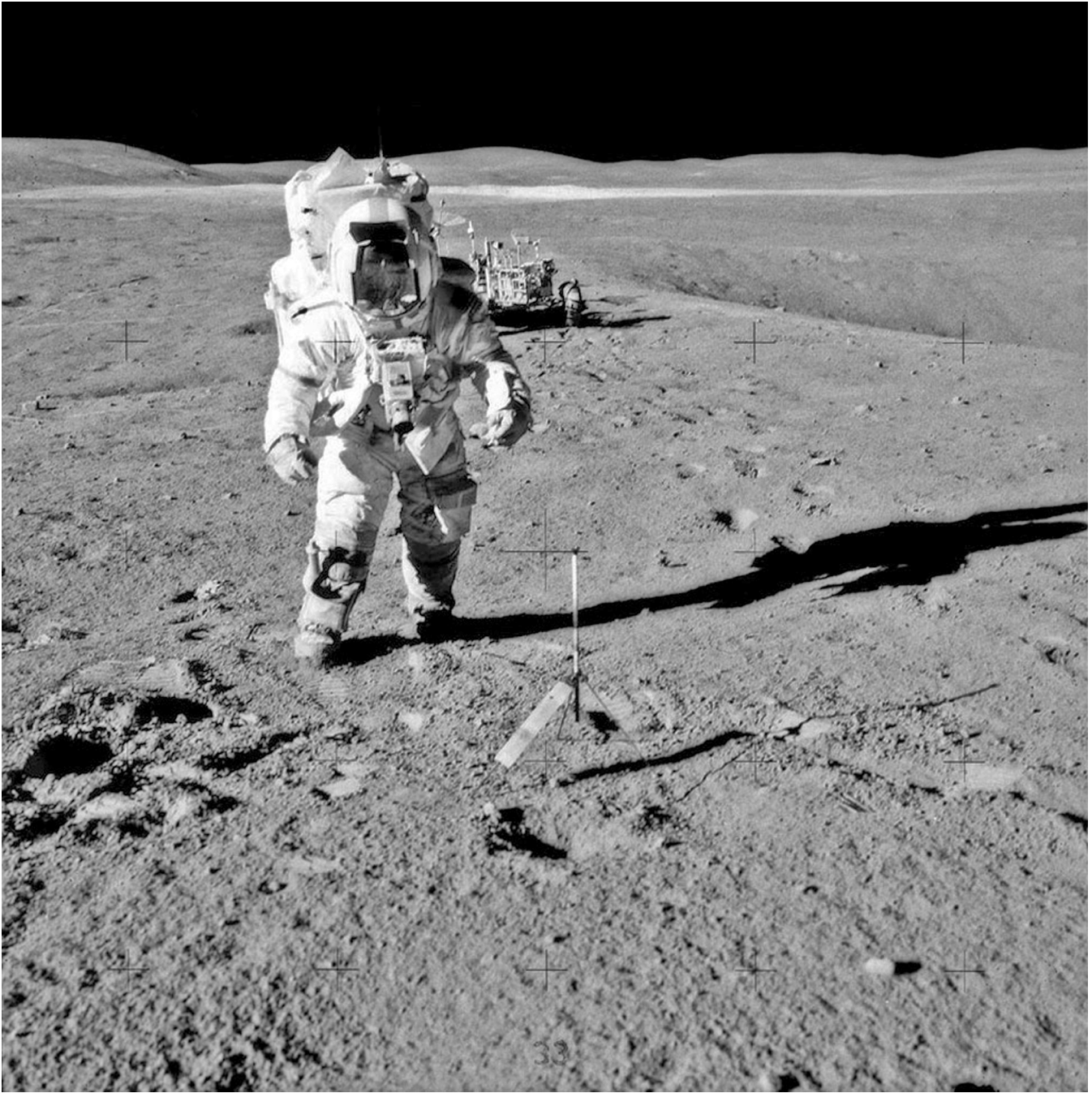


Figure 95-(f) John Young at station 1; EVA-1; gnomon on ground in front of Young; LRV behind; NASA AS16-109-17797

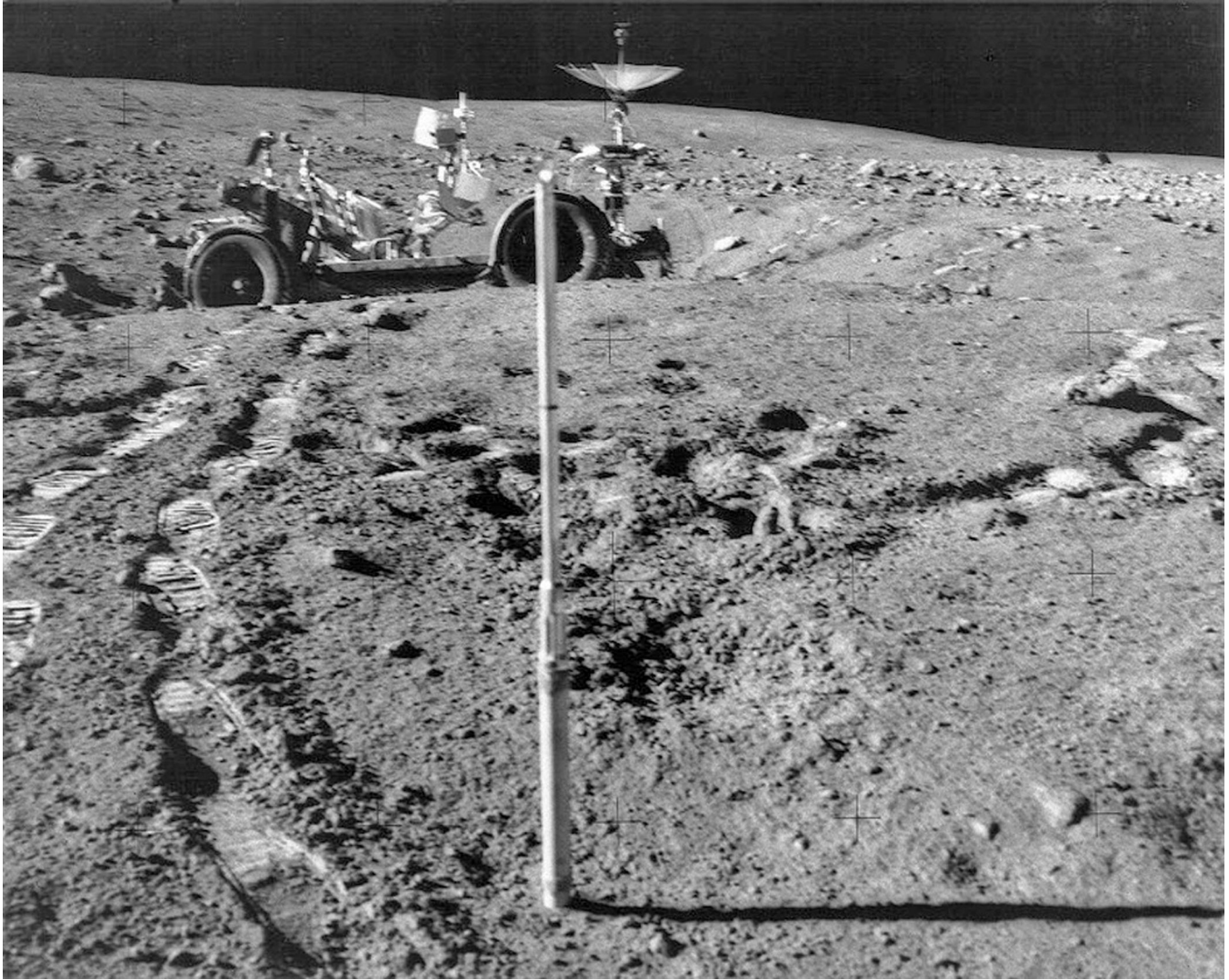


Figure 95-(g) drive tube in lunar surface at station 4-Eva-2; LRV parked behind in small crater; NASA AS16-110-17951



Figure 95-(h) pan frame including LM and LRV; Eva-2; NASA AS16-107-17436



Figure 95-(i) Charles Duke sampling at station 11, EVA-3; good view of cuff checklist; NASA AS16-116-18649



Figure 95-(j) close-up of Charles Duke at LRV-EVA-3; NASA AS16-116-18718



Figure 95-(k) John Young exits Command Module (CM) in Pacific after return to Earth 27 April 1972; NASA AP16-S72-36492.



Figure 96-The Apollo 17 geologic exercise at Tonopah, Nevada on 6-7 September 1972; (a) backup crew John Young (right) and Charles Duke on the Survey's Grover vehicle; NASA photo S-72-488597;



Figure 96-(b) Jack Schmitt (right front seat) and Gene Cernan on the Survey's Explorer vehicle; NASA photo S-72-48936



Figure 96-(c) Jack Schmitt (left) and Gene Cernan examining a rock sample; NASA photo S-72-48859

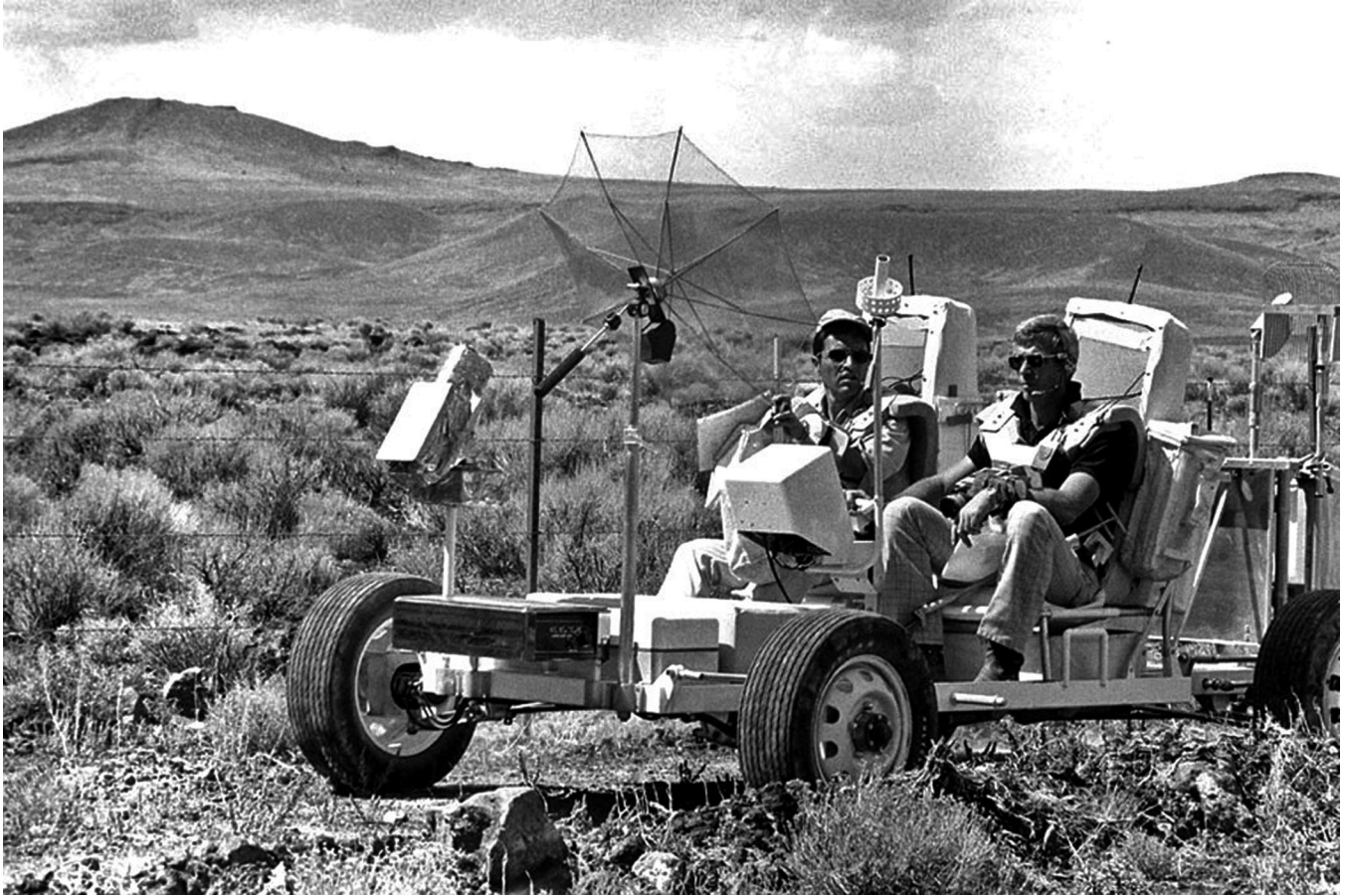


Figure 96-(d) Gene Cernan (left front side) and Jack Schmitt on Grover; NASA photo S-72-48865



Figure 96-(e) Jack Schmitt (l) and Gene Cernan looking over Lunar Crater(a volcanic maar crater); NASA AP17-S72-48854.



Figure 97-The final geologic field exercise for the Apollo 17 crew--and for the Apollo Program—occurred 2-3 November 1972 at Sunset Crater National Monument and the Cinder Lake Crater Field just northeast of Flagstaff, Arizona: (a) Gene Cernan (yellow jacket and “70’s” pants) and Jack Schmitt on platform containing the Geological Survey’s canvas simulation of the Lunar Module (LM) ascent stage. The astronauts, to describe their surrounding before egression onto the “lunar” surface, used the LM windows--at the same height above the surface as those on the actual LM--during the test. The snow-covered San Francisco Peaks are prominent in the background; NASA photo S-72-54547



Figure 97-(b) close-up of Gene Cernan (red jacket) and Jack Schmitt during test. Their pensive faces perhaps reflecting the fact that they (with a bit of luck) will be exploring the surface of the Taurus-Littrow Valley on the Moon within a month; NASA photo S-72-50713



Figure 97-(c) Gene Cernan (nearest) and Jack Schmitt on the Survey's Grover vehicle driving by part of the Bonita Lava Flow near Sunset Crater; NASA photo S-72-54502



Figure 97-(d) Schmitt and Cernan describing crater within the Cinder Lake Crater Field; NASA photo S-72-54471



Figure 97-(e) a relaxed moment for the last of the Apollo lunar explorers-Cernan (a veteran fighter pilot and military man) and Schmitt (a geologist) during their final geologic field exercise; NASA photo S-72-52835.



Figure 98-Selected NASA Apollo 17 photographs from pre-launch activities through the end of Apollo 17 (launch 7 December 1972; landing in the Taurus-Littrow Valley on 11 December 1972; (a) rollout of Apollo 17 Saturn 5 from VAB; NASA AP17-KSC-72C-3229



Figure 98-(b) Apollo 17 Saturn 5 on launch pad 39-A; NASA AP17-KSC-72PC-445



Figure 98-(c) spectacular night launch of Apollo 17; 7 December 1972; NASA AP17-S72-55482



Figure 98-(d) Jack Schmitt poses by flag by LM; NASA AS17-134-2038

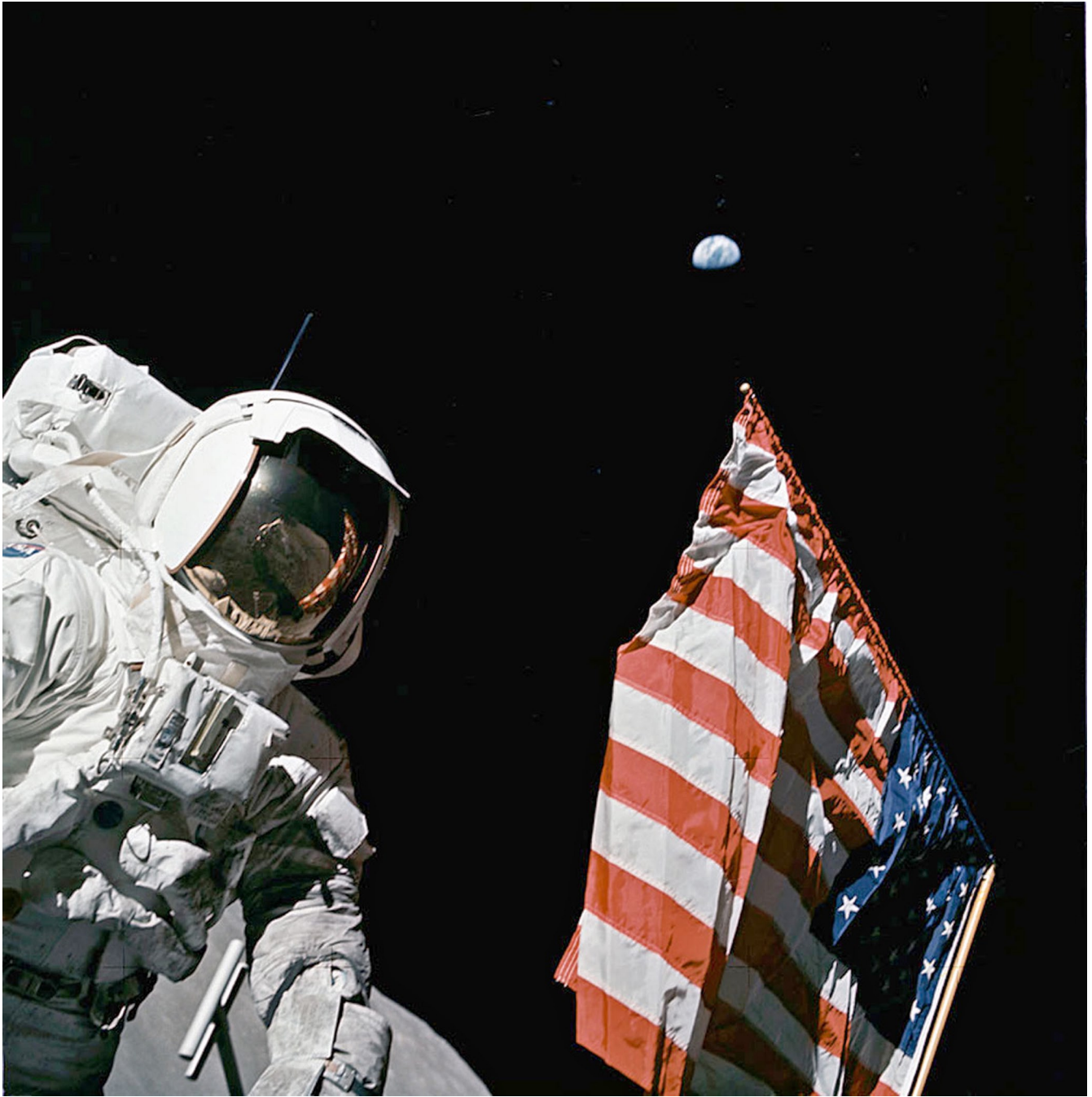


Figure 98-(e) Jack Schmitt poses by flag with Earth overhead; NASA AS17-134-20384

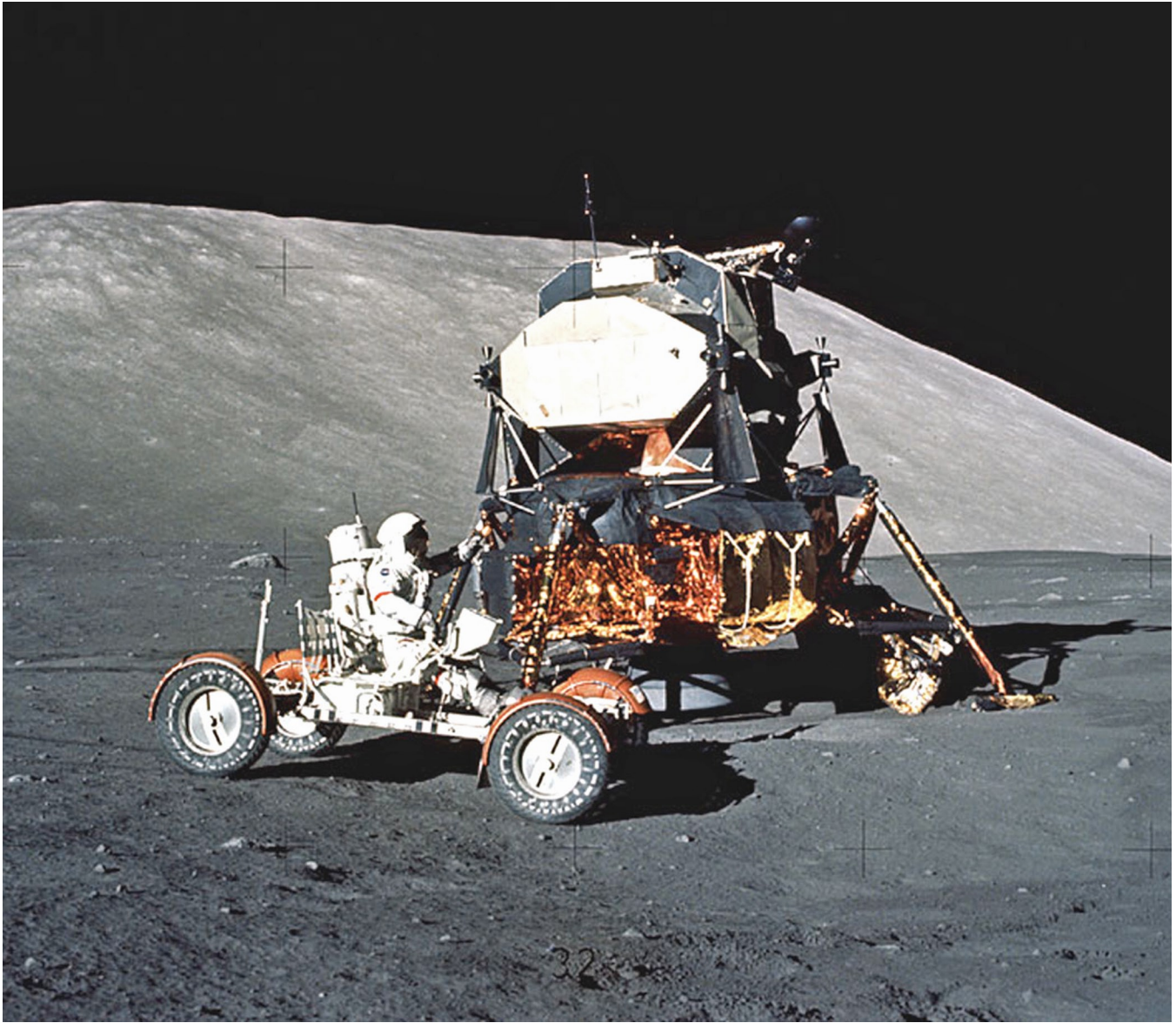


Figure 98-(f) Gene Cernan test-driving LRV-3 near LM; NASA AS17-147-22527



Figure 98-(g) Jack Schmitt jumping into LRV at station 9; NASA AS17-134-20453

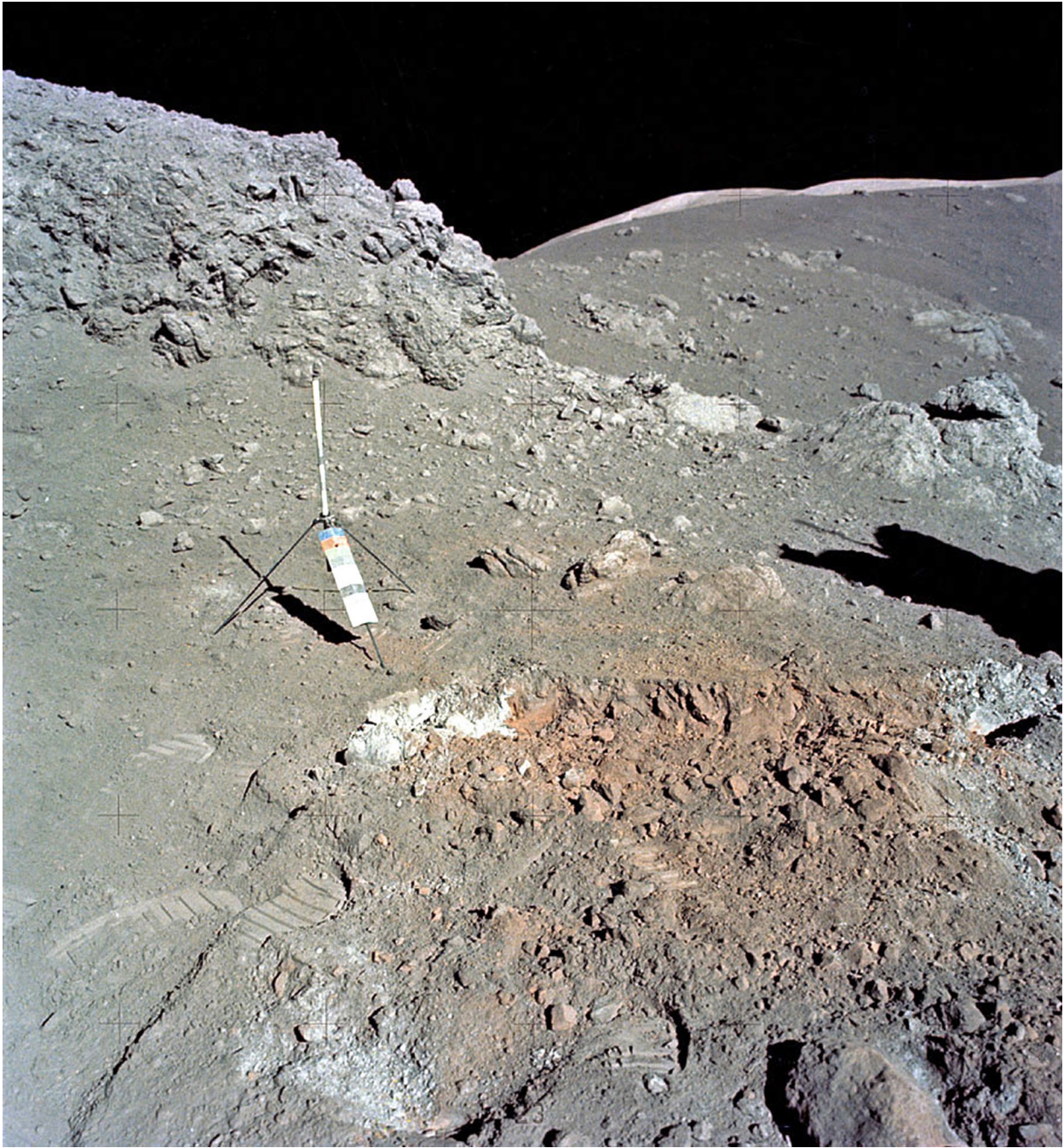


Figure 98-(h) the “orange soil” found at Shorty Crater; NASA AS17-137-20990

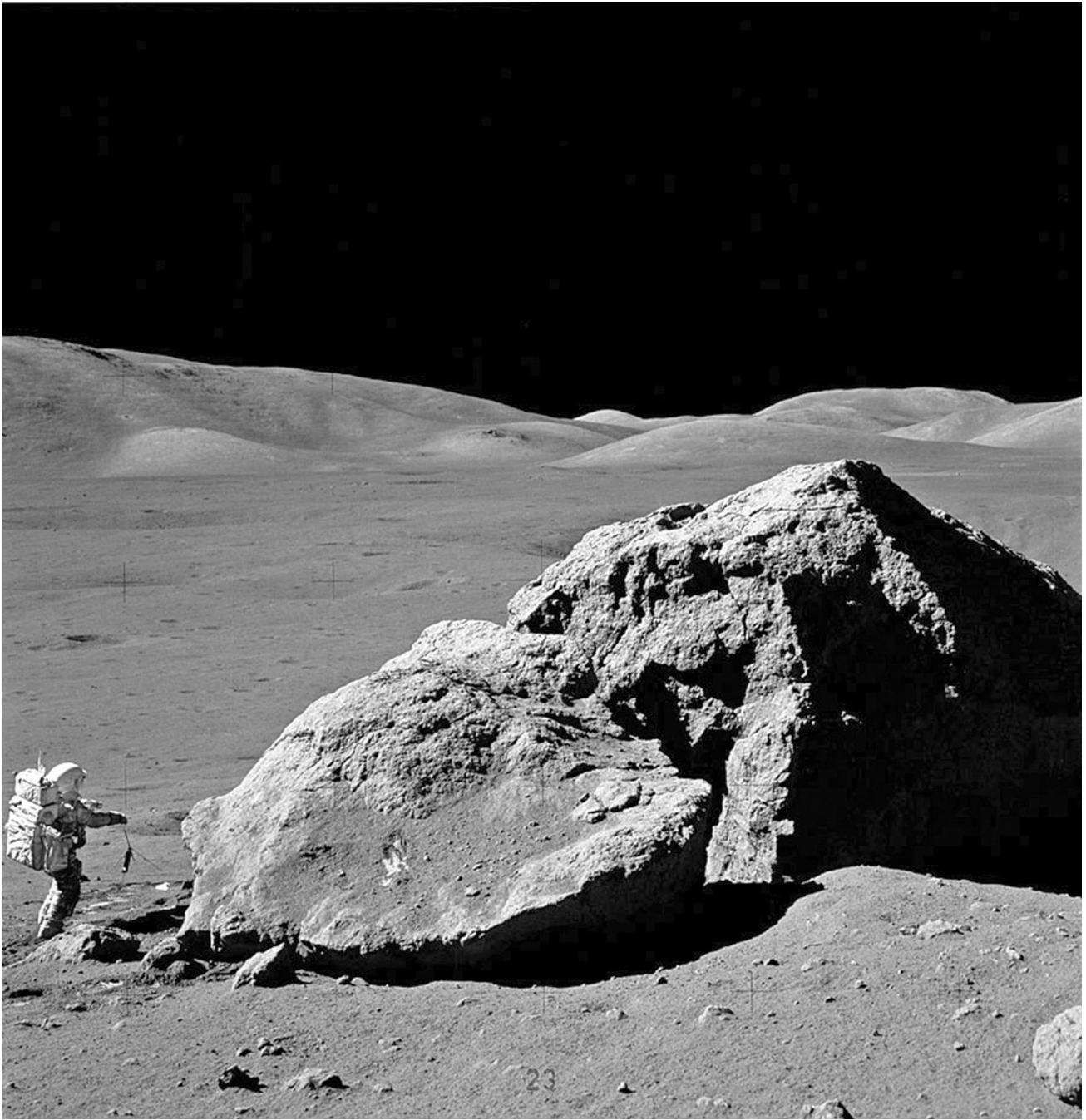


Figure 98-(i) Jack Schmitt at “Tracy’s rock”; NASA AS17-140-21496



Figure 98-(j) Jack Schmitt collecting soil tube sample by boulder at station 5; NASA AS17-145-22157

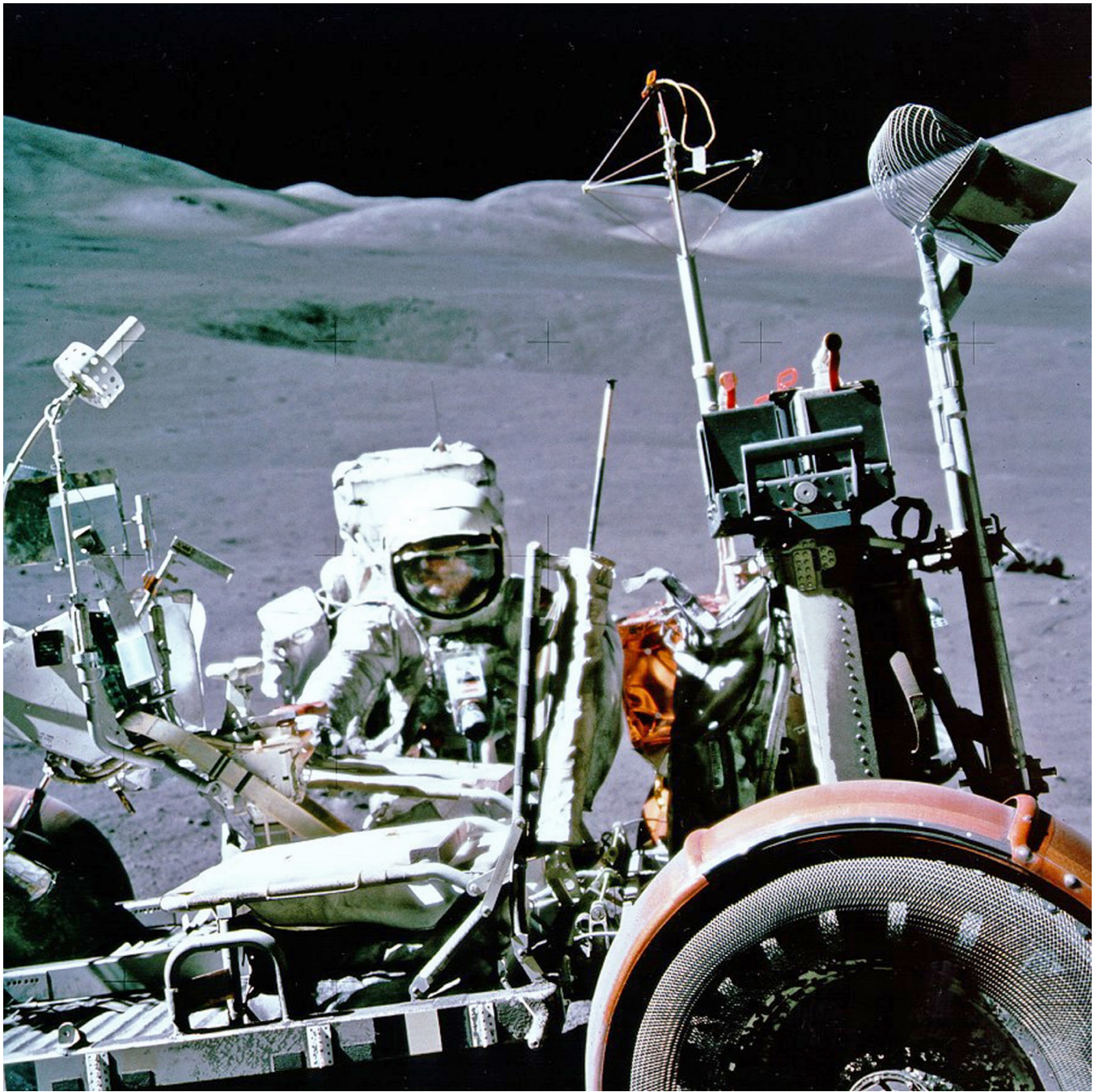


Figure 98-(k) Jack Schmitt at LRV with gold visor raised at station 6; NASA AS17-146-22296



Figure 98-(1) repaired LRV fender (that broke off) using several pages from the U.S. Geological Survey's Lunar Surface Map Package; NASA AS17-137-20979

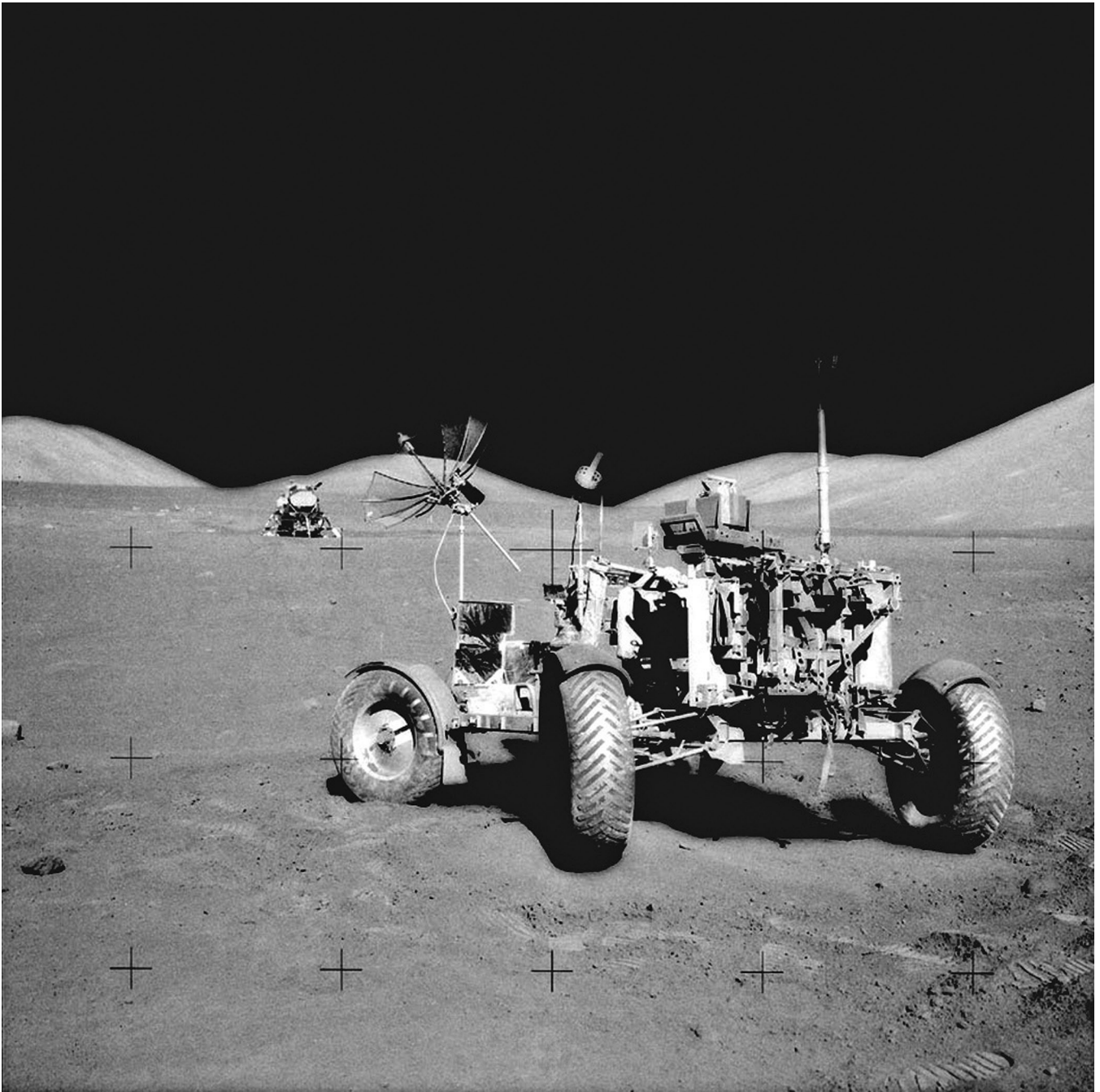


Figure 98-(m) final resting place of LRV; LM in background; NASA AS17-143-21933

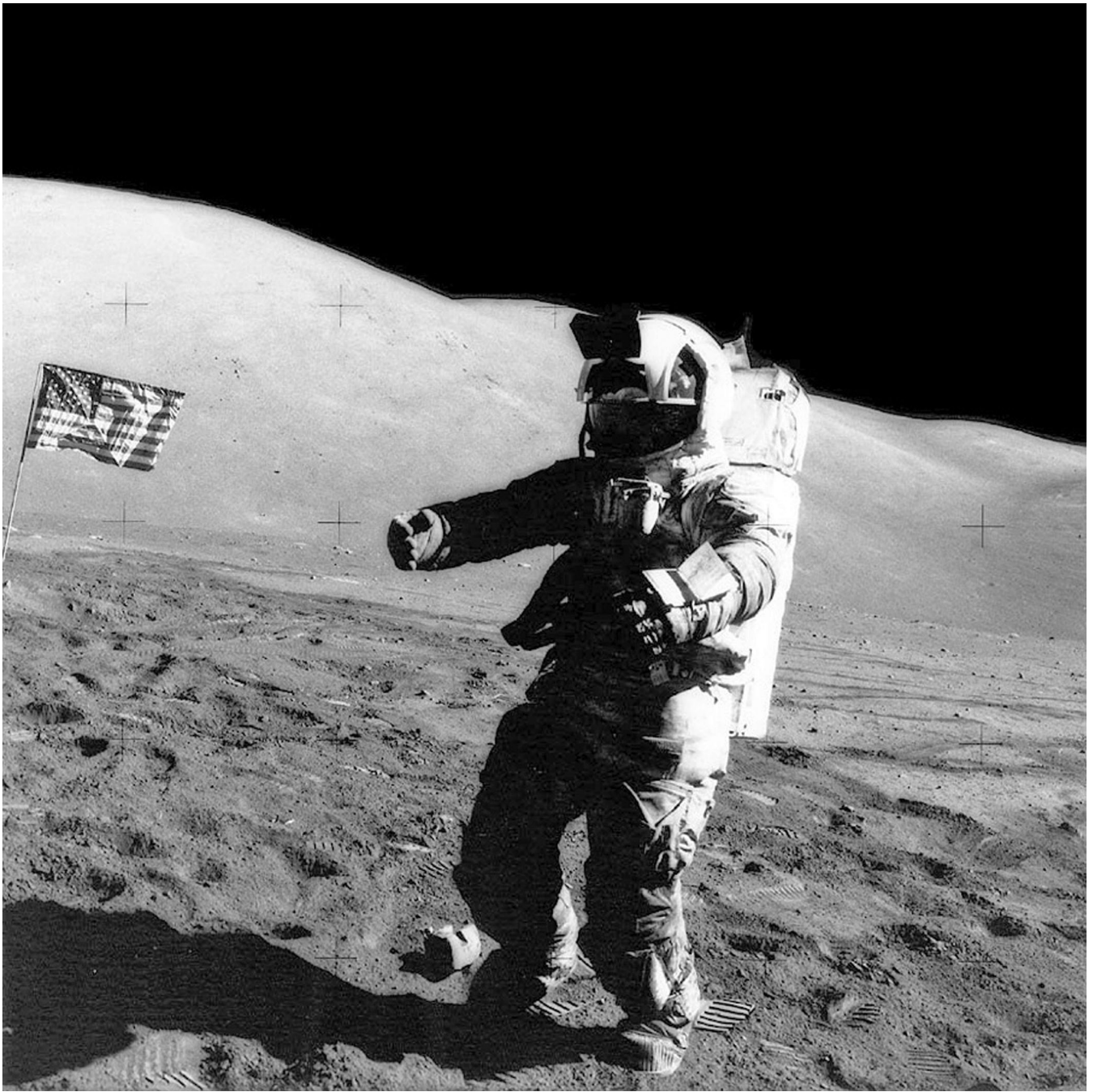


Figure 98-(n) likely the very last photograph taken of an astronaut on the lunar surface during the Apollo Era;
NASA AS17-143-21941

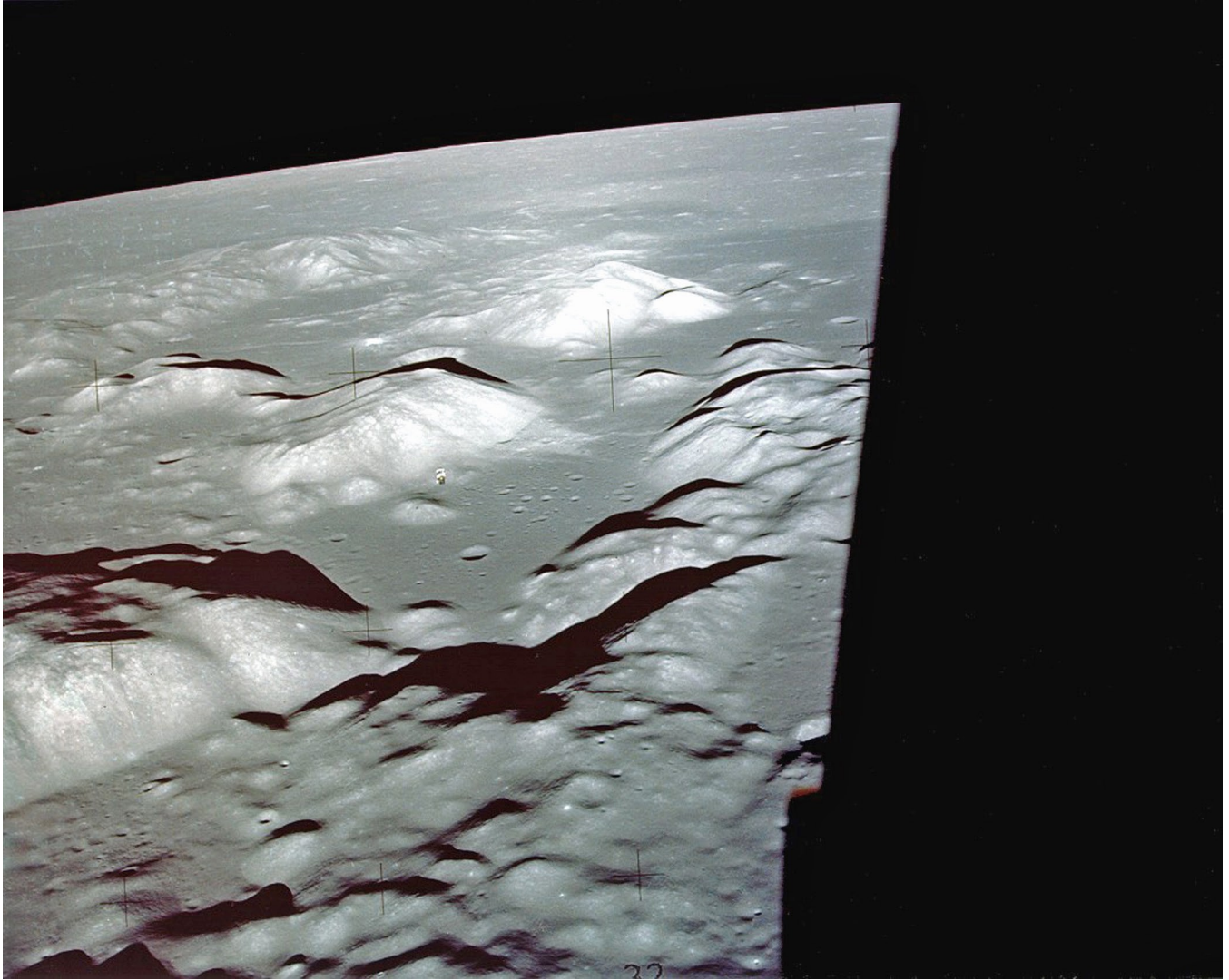


Figure 98-(o) Taurus-Littrow landing site area after lunar surface ascent; Lunar Module ascent stage (LM) seen out window of Command/Service Moduel (CSM) below; 10 December 1972; NASA AS17-147-22465

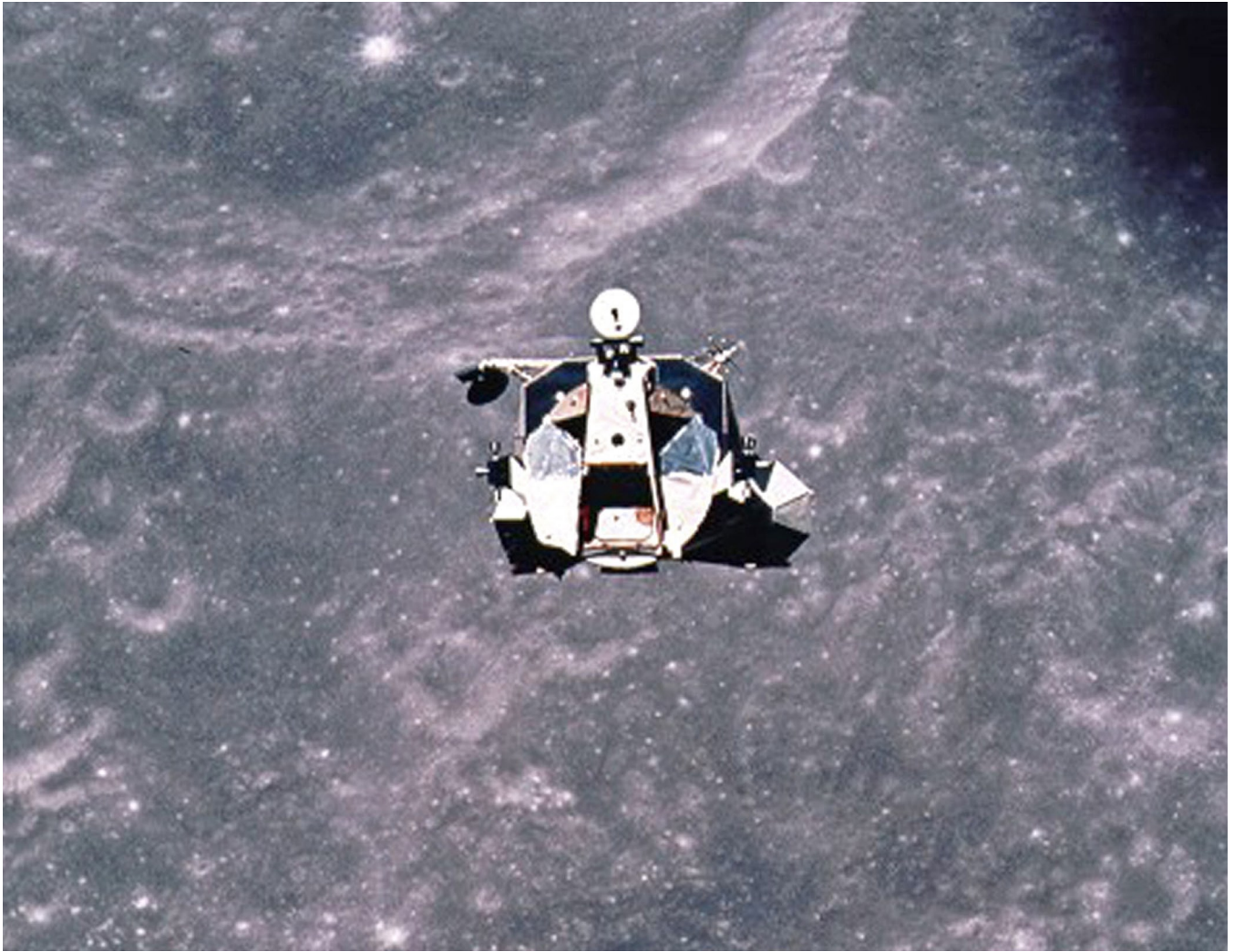


Figure 98-(p) AP 17 LM ascent stage returning from Moon for docking with CSM; NASA AS17-149-22847



Figure 98-(q) Schmitt and Cernan photographed aboard CSM by Ron Evans during return home; NASA AS17-163-24149.



Figure 99-Harrison “Jack” Schmitt returned to Flagstaff to visit with the USGS Astrogeology staff during March of 1973, just about three months following his return from the Taurus-Littrow Valley during Apollo 17 (December 1972); the following are all USGS photographs: (a) (l to r)-Ed Wolfe, Roger Carroll, Hugh Thomas, Jack Schmitt and Ray Sabala in Building Two on Switzer Mesa



Figure 99-(b) (l to r)-Gerald G. Schaber and Jack Schmitt in Schaber's office in the Arizona Bank Building (Flagstaff, Arizona)



Figure 99-(c) (l to r)-Jack Schmitt and Henry Holt at the Arizona Bank Building

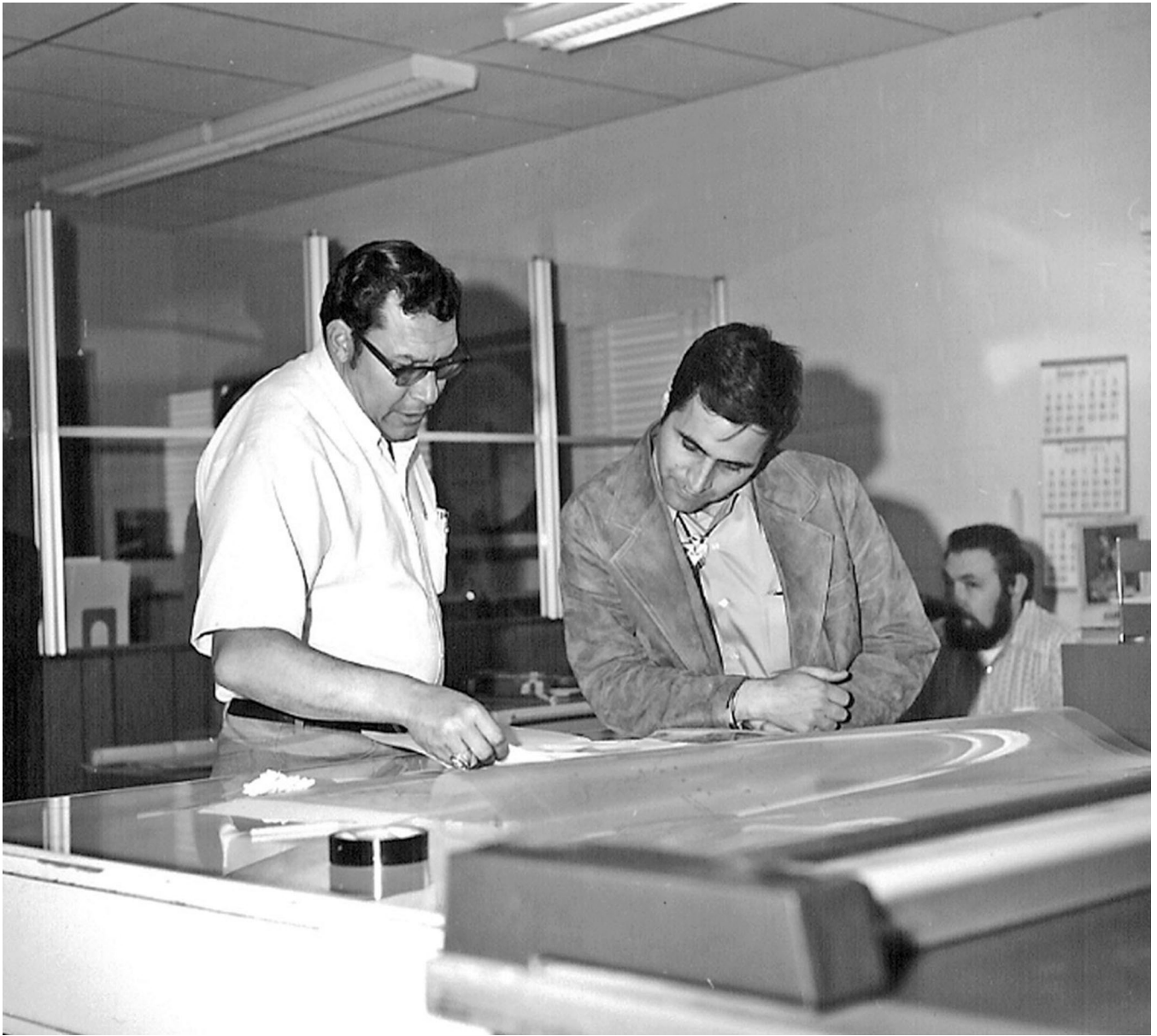


Figure 99-(d) (l to r)- Ray Sabala, Jack Schmitt and Hugh Thomas (seated) in Building Two on Switzer Mesa



Figure 99-(e) (l to r)- Gordon Swann, R.A. Henry (seated), Hal Masursky, Jack Schmitt, Hal Stephens, and Baerbel Lucchitta

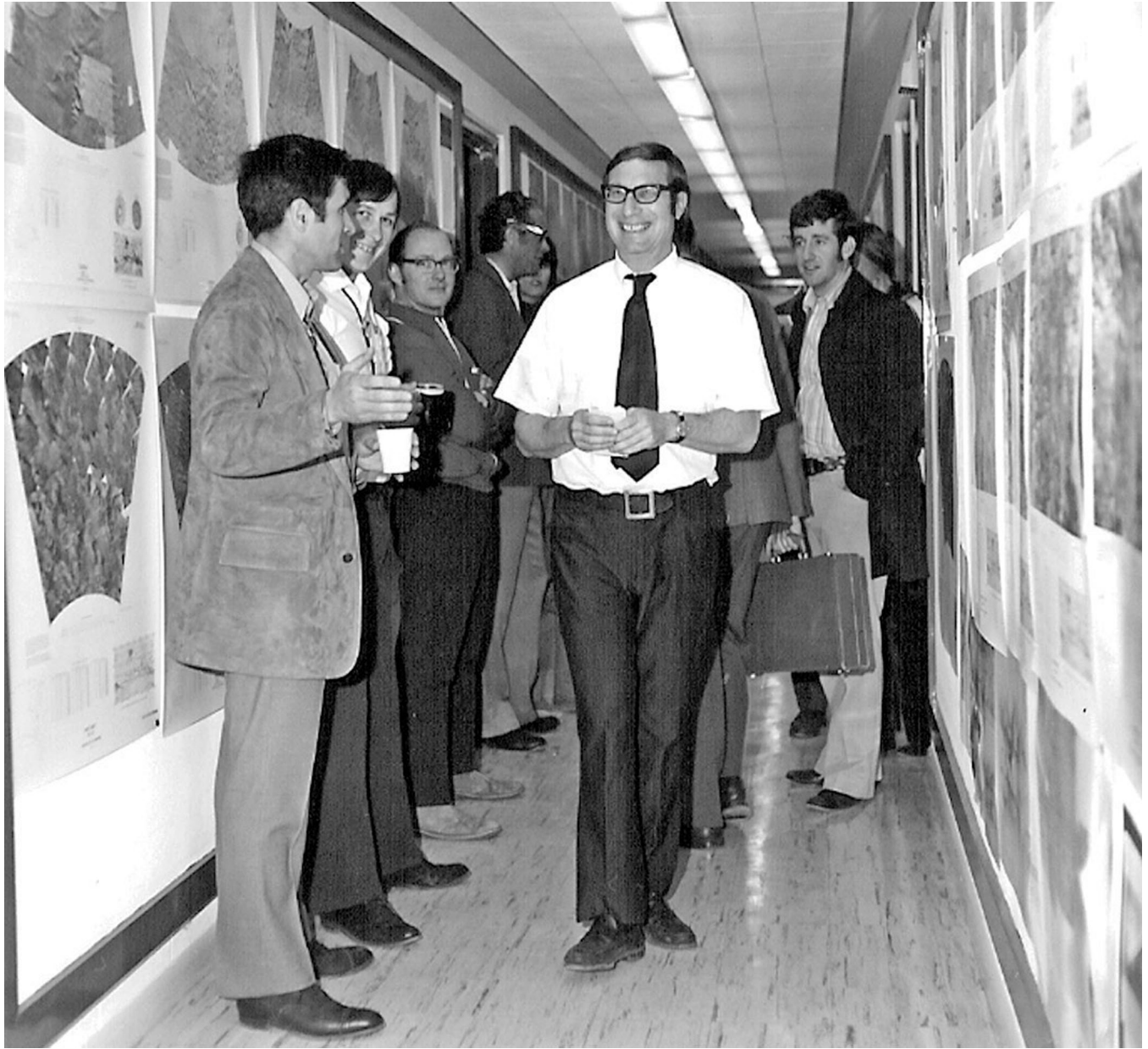


Figure 99-(f) (l to r)- Jack Schmitt, Larry Soderblom, Ed Wolfe, Gordon Swann, Hal Masursky and V.S. "Steve" Reed in hallway of Building One on Switzer Mesa

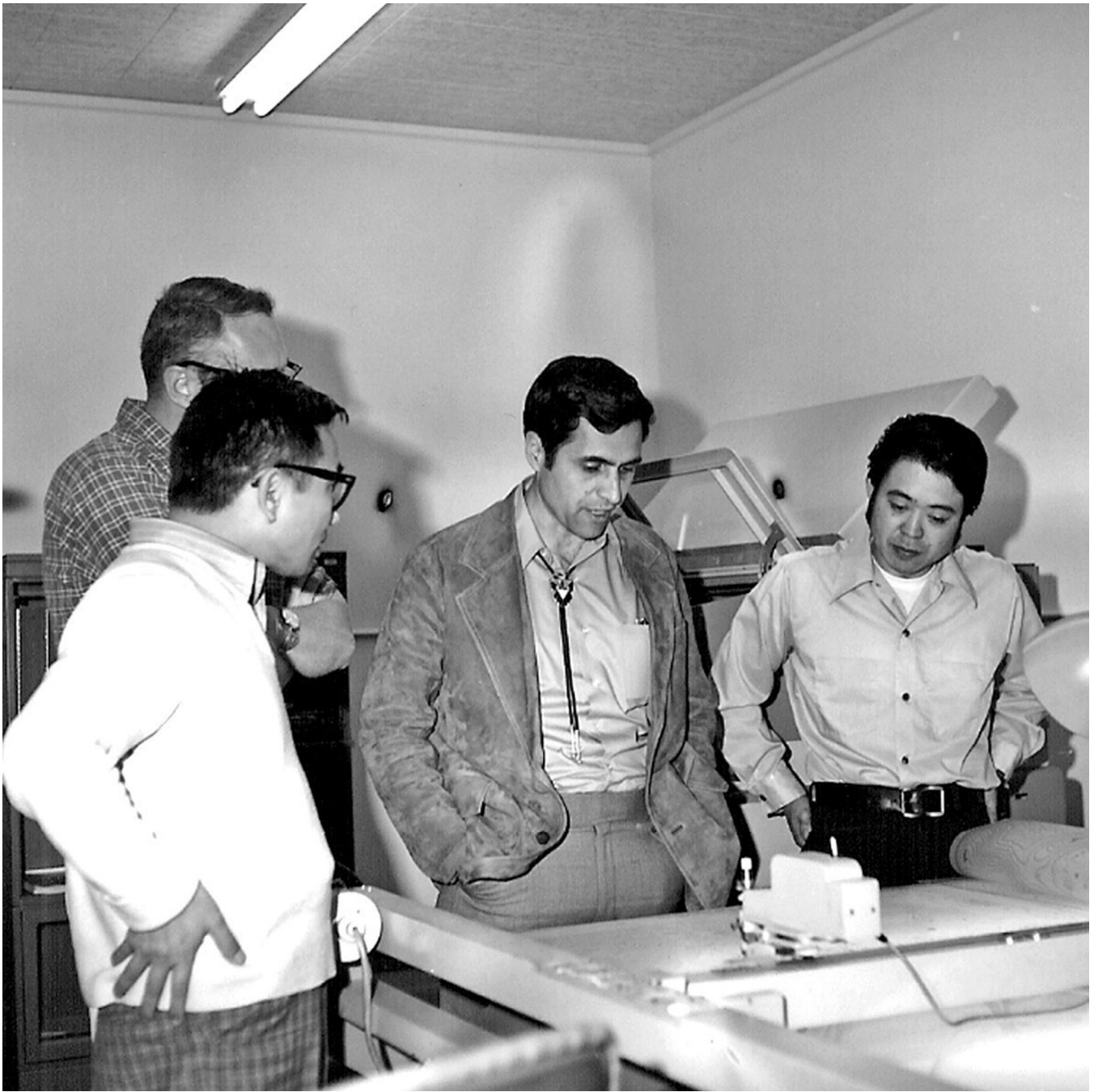


Figure 99-(g) (1 to r)- Ray Jordan, Sherman Wu (front), Jack Schmitt and Gary Nakata of SPE's Photogrammetry Group

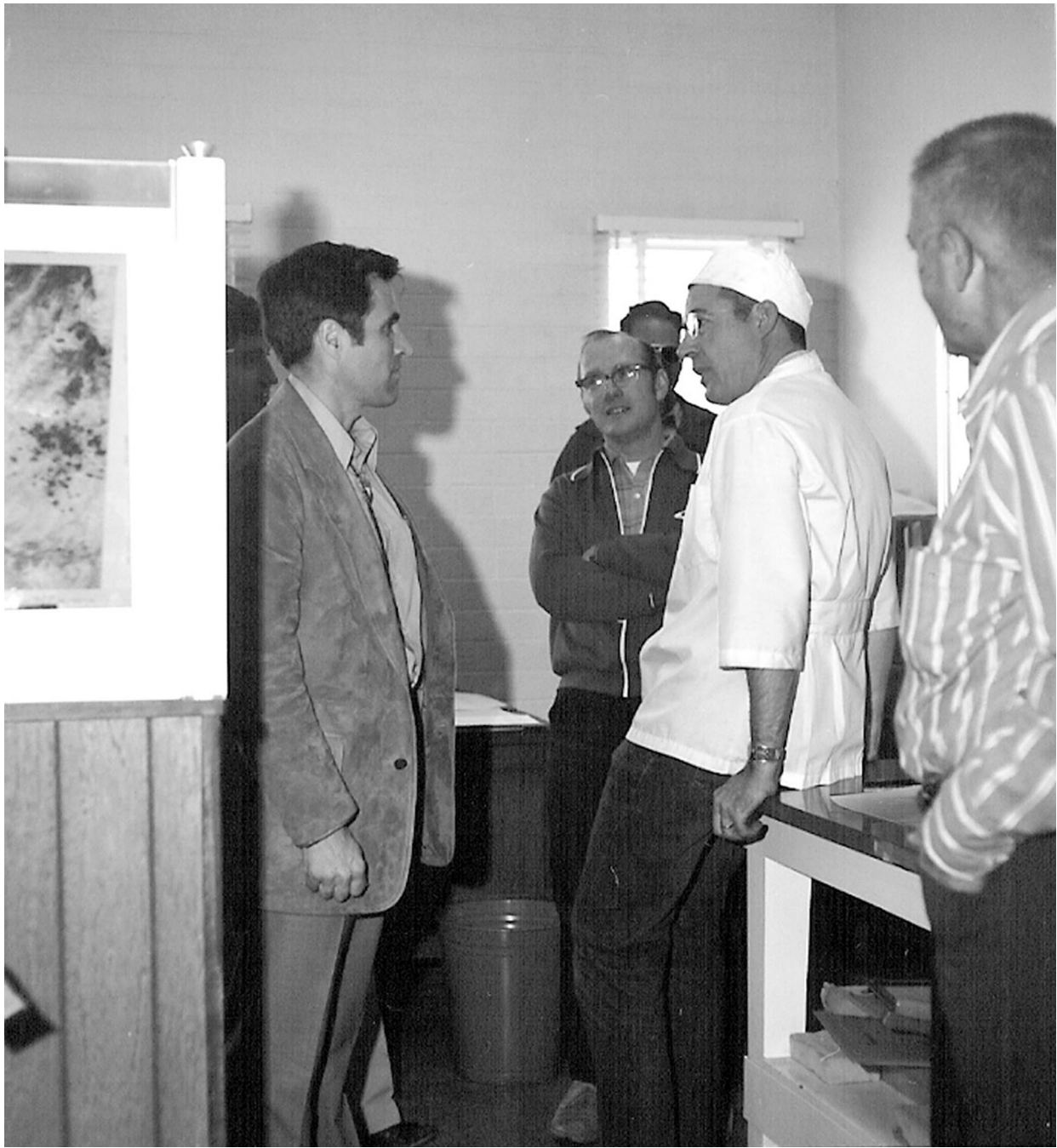


Figure 99-(h) (l to r)- Jack Schmitt, Ed Wolfe, Gordon Swann, Karl Zeller and Walt Roeder.



Figure 100-Selected images from the historic impact on Jupiter's upper atmosphere by 21 larger fragments from Shoemaker-Levy-9 comet on 16-22 July 1994; (a) Gene and Carolyn at the 18-inch Schmitt telescope at Mt. Palomar in California

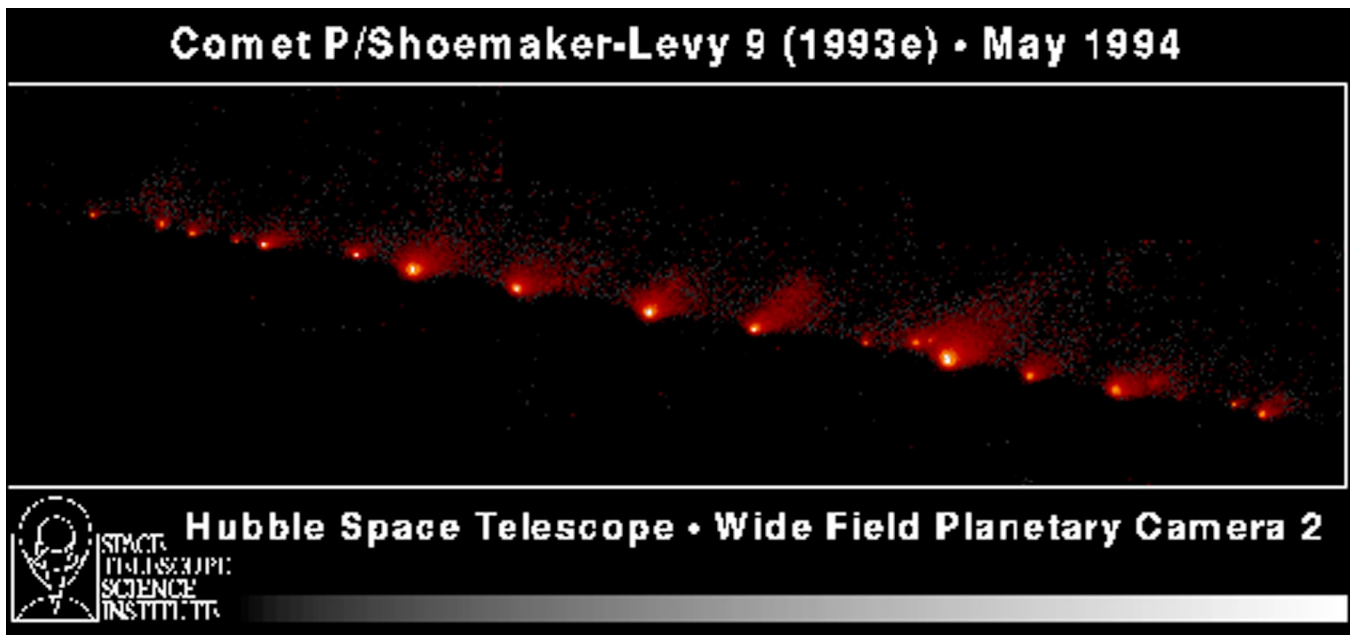


Figure 100-(b) the “string of pearls” (as it was deemed) Shoemker-Levy-9 photographed by the Hubble Telescope’s Wide-Field Planetary Camera-2 in May 1994



Figure 100-(c) Gene and Carolyn Shoemaker and others watching the TV monitors the day the many fragments of Shoemaker-Levy-9 struck the atmosphere of Jupiter releasing unimaginable energies and chaos

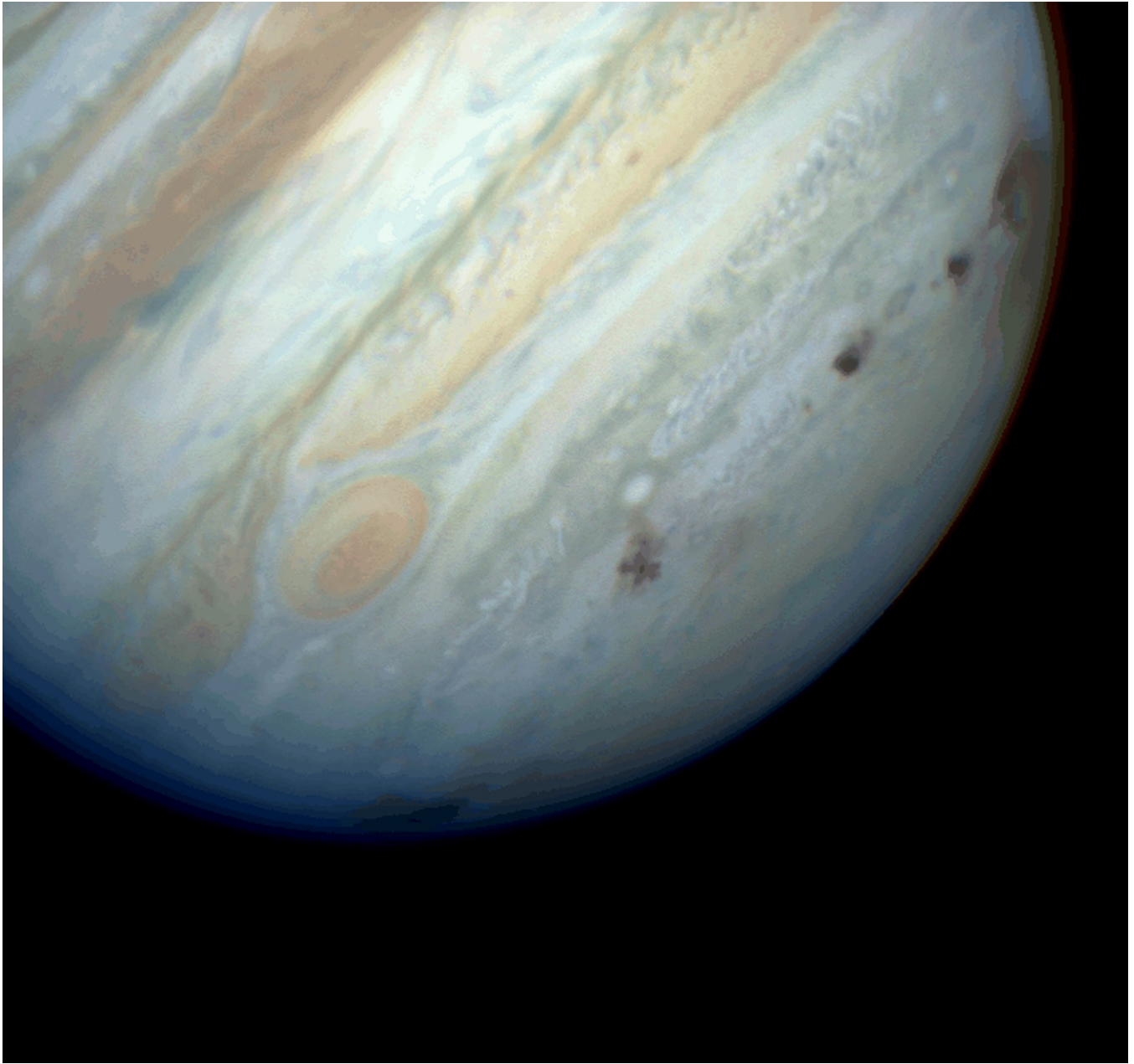


Figure 100-(d) image of Jupiter with the Hubble Space Telescope Planetary Camera. Eight impacts sites are visible. From left to right are the H site the impact sites for tiny N, Q1, small Q2, and R, and on the far right limb the D/G complex. The smallest features in this image are less than 200 kilometers across; Courtesy of the Hubble Space Telescope Comet Team

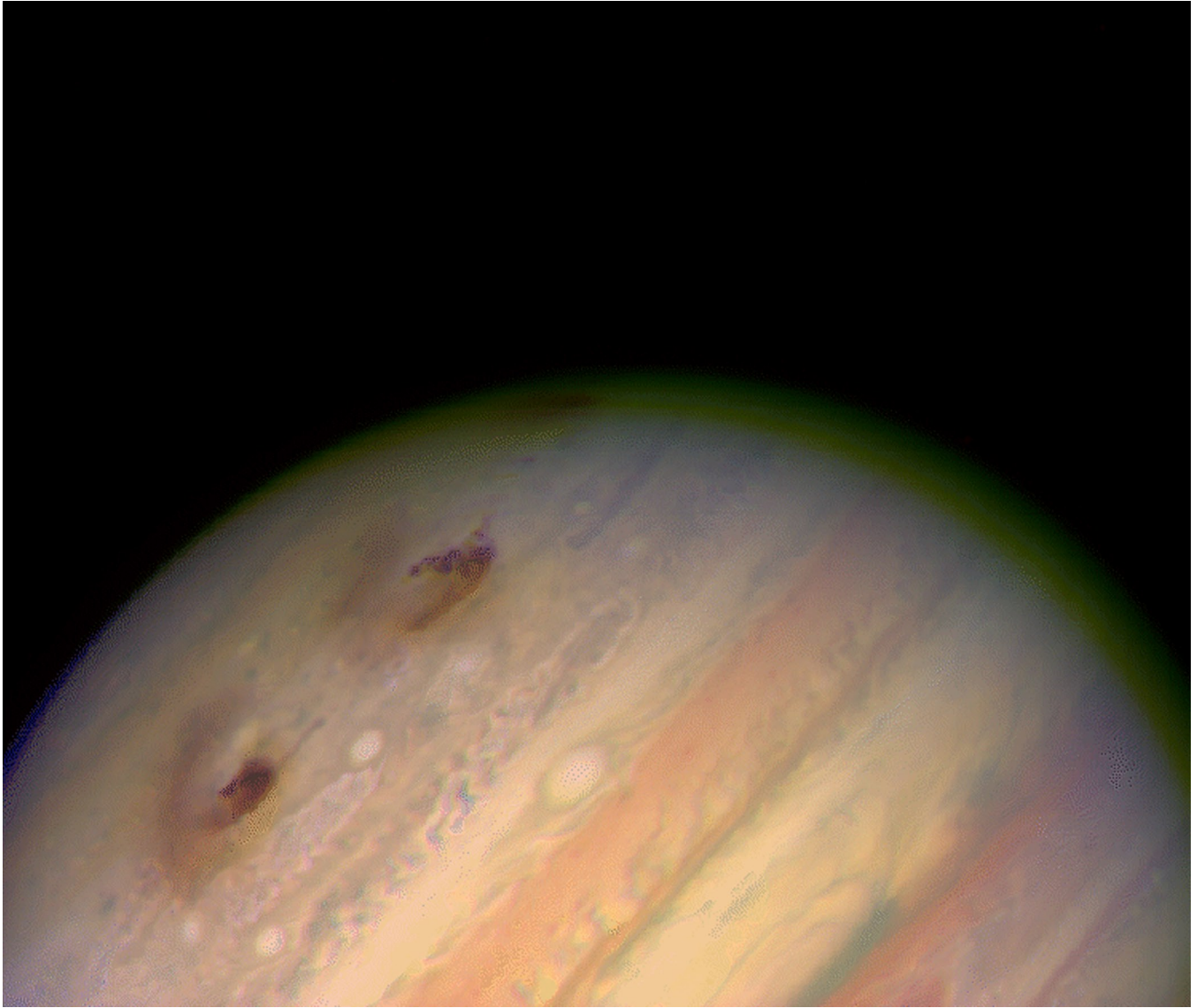
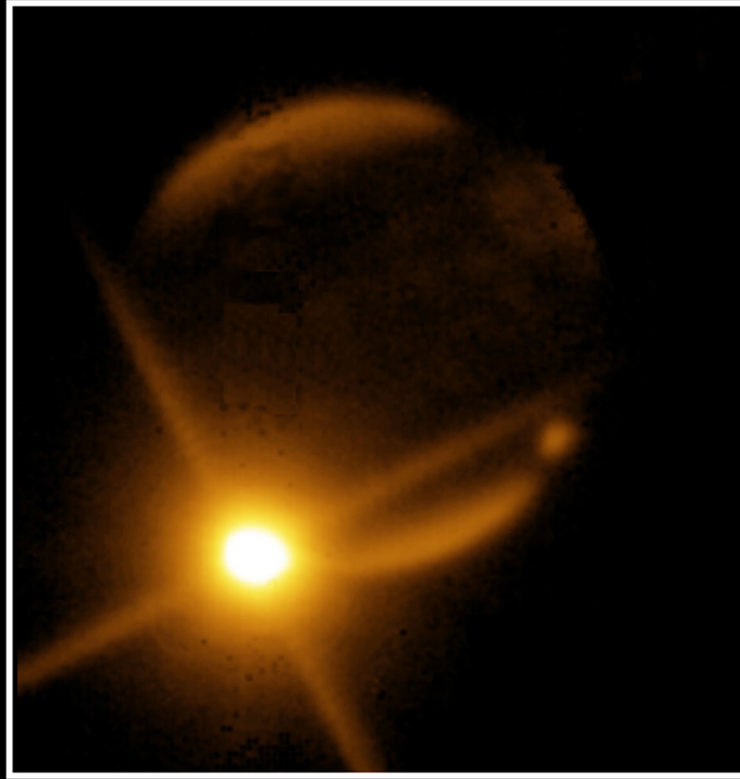


Figure 100-(e) Hubble color image of fragment G impact site; Courtesy of Hubble Space Telescope Jupiter Imaging Team



**Impact of Fragment G of Comet Shoemaker-Levy on Jupiter
The fireball is seen 12 minutes after impact at 2.34 microns.
The impact A site is seen on the opposite limb of the planet.**

**Image at 2.34 microns with CASPIR by Peter McGregor
ANU 2.3m telescope at Siding Spring**

Figure 100-(f) impact of Fragment G; photographed by Peter McGregor at Siding Springs Observatory, Australia.

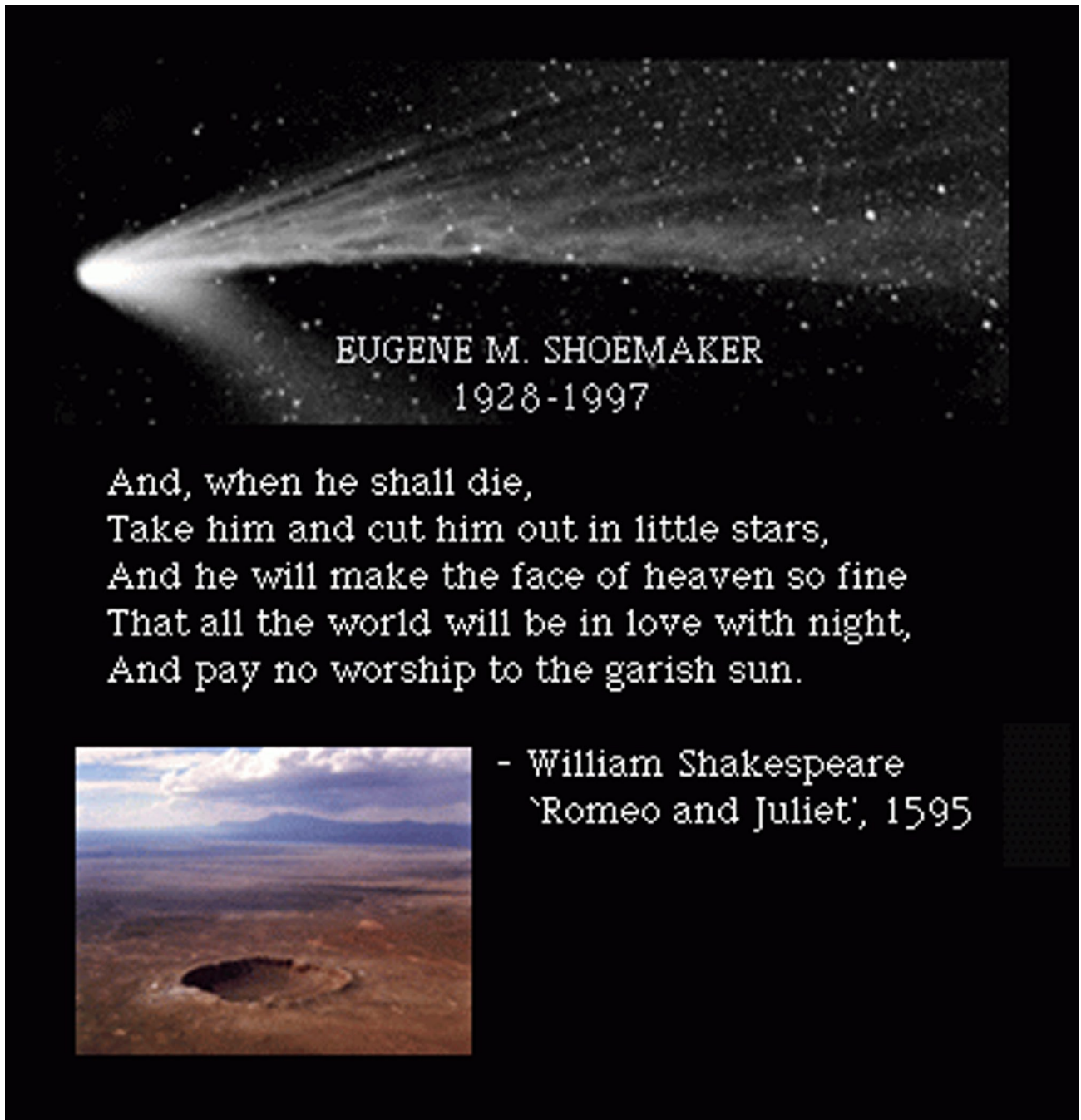


Figure 101-On 6 January 1998, a small polycarbonate capsule carrying an ounce of Gene Shoemaker's remains traveled to the Moon aboard NASA's Lunar Prospector spacecraft. Wrapped around the capsule was a 1.5-inch- (3.8-cm-) square piece of brass foil laser-inscribed with a composite image designed to commemorate Shoemaker's scientific legacy; see text for description of features on the commemorative foil.