



Figure 40-(a) Hawkins-designed, prototype, Apollo stereometric camera as fabricated (in February 1966) by machinist W.E. Fahey and colleagues with the Branch of Astrogeology (Flagstaff); showing details of film canister and wind-reel side; USGS photo P68, F26661

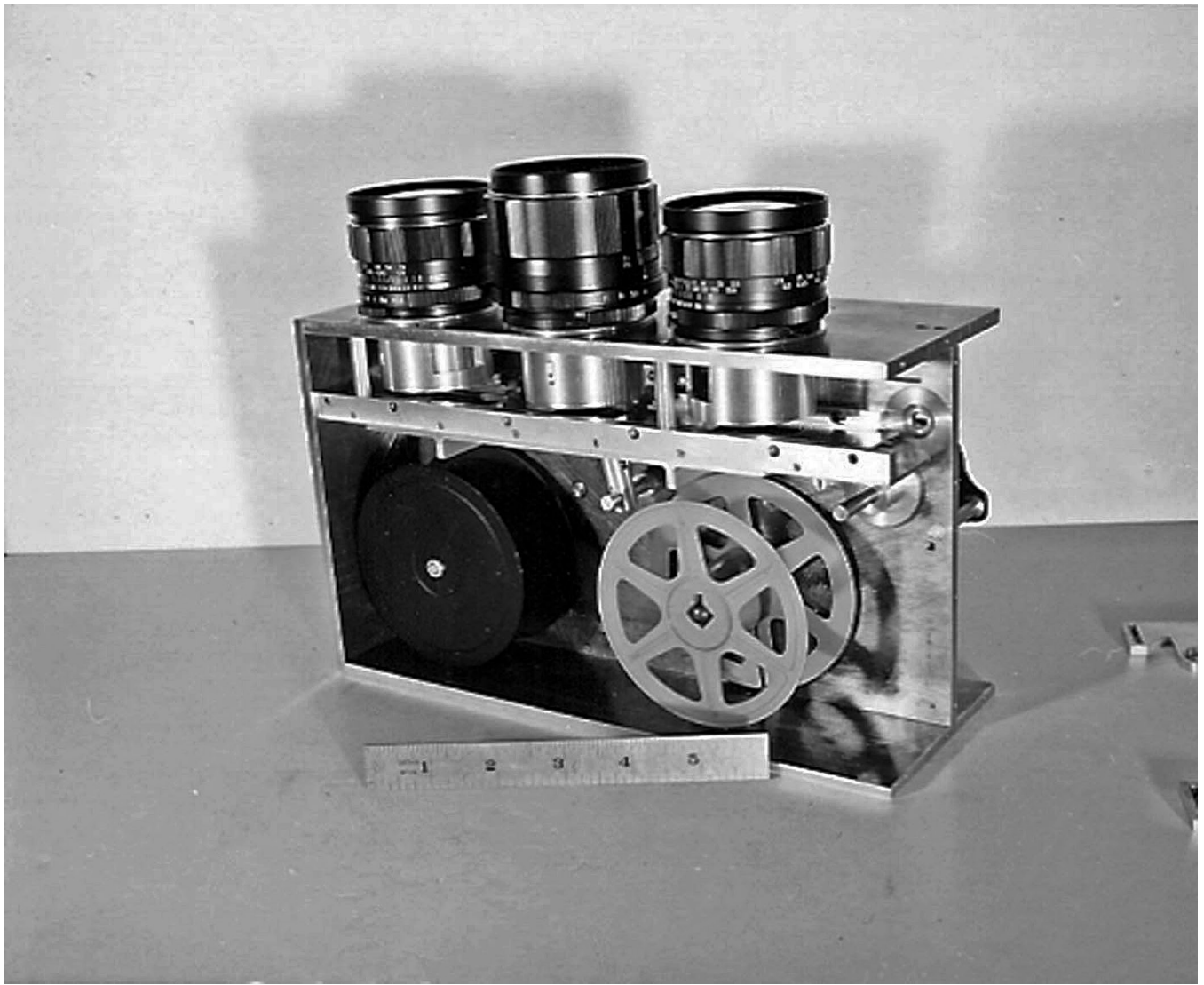


Figure 40-(b) stereometric camera showing details of mechanism on opposite side; USGS photo P68, F26663



Figure 40-(c) Dave Schleicher and Robert Sutton working in the field with an early, USGS-built, prototype Apollo Stereo Camera in May or June 1966.

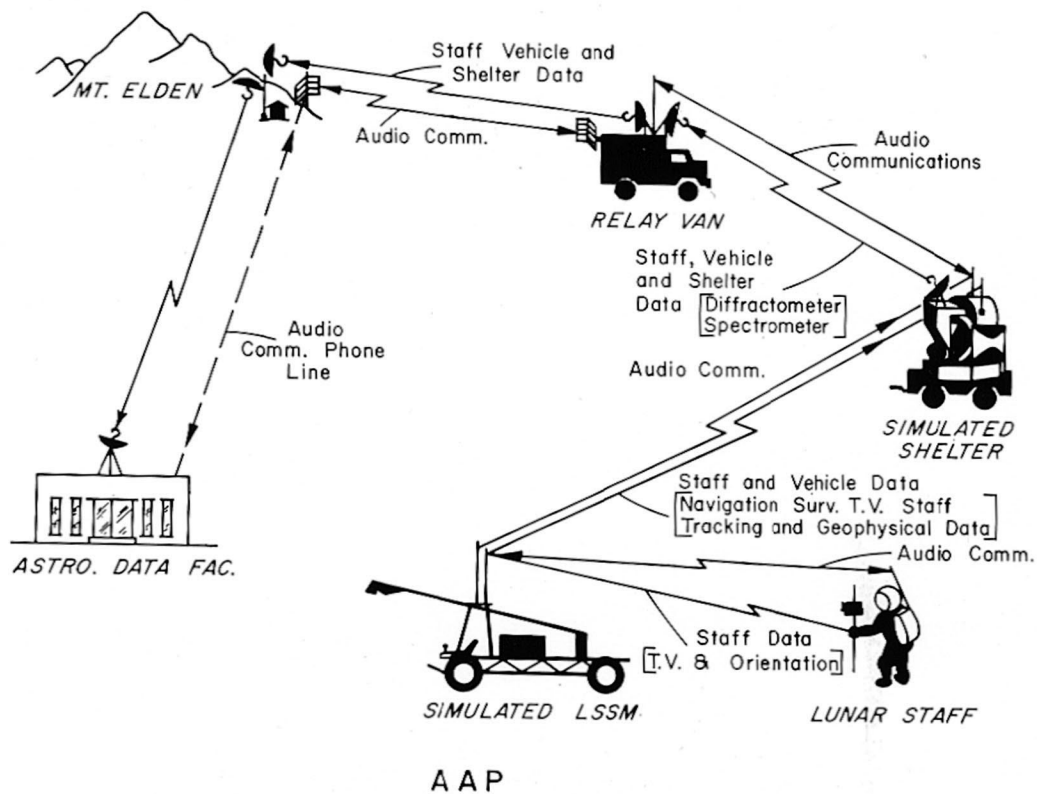


Figure 41-AAP Test 6 was carried out on the southeast side of Chezhin-Chotah Butte in the Hopi Buttes Volcanic Field, Arizona, 9-20 May 1966 to test Post-Apollo (Apollo Applications Program) analytical instrumentation and the telemetry from the field to personnel located in the Apollo Data Facility (5th floor of Arizona Bank Building) in Flagstaff; (a), Diagram showing of improved AAP, field-to-Flagstaff ADF audio, television--and recently FM/FM telemetry--links set up by the Branch of Astrogeology's Electronics Support Unit; USGS photo P475, F1167323



Figure 41-(b) general overview of test site showing complex of test and support vehicles from the Branch of Astrogeology; photo G. Schaber

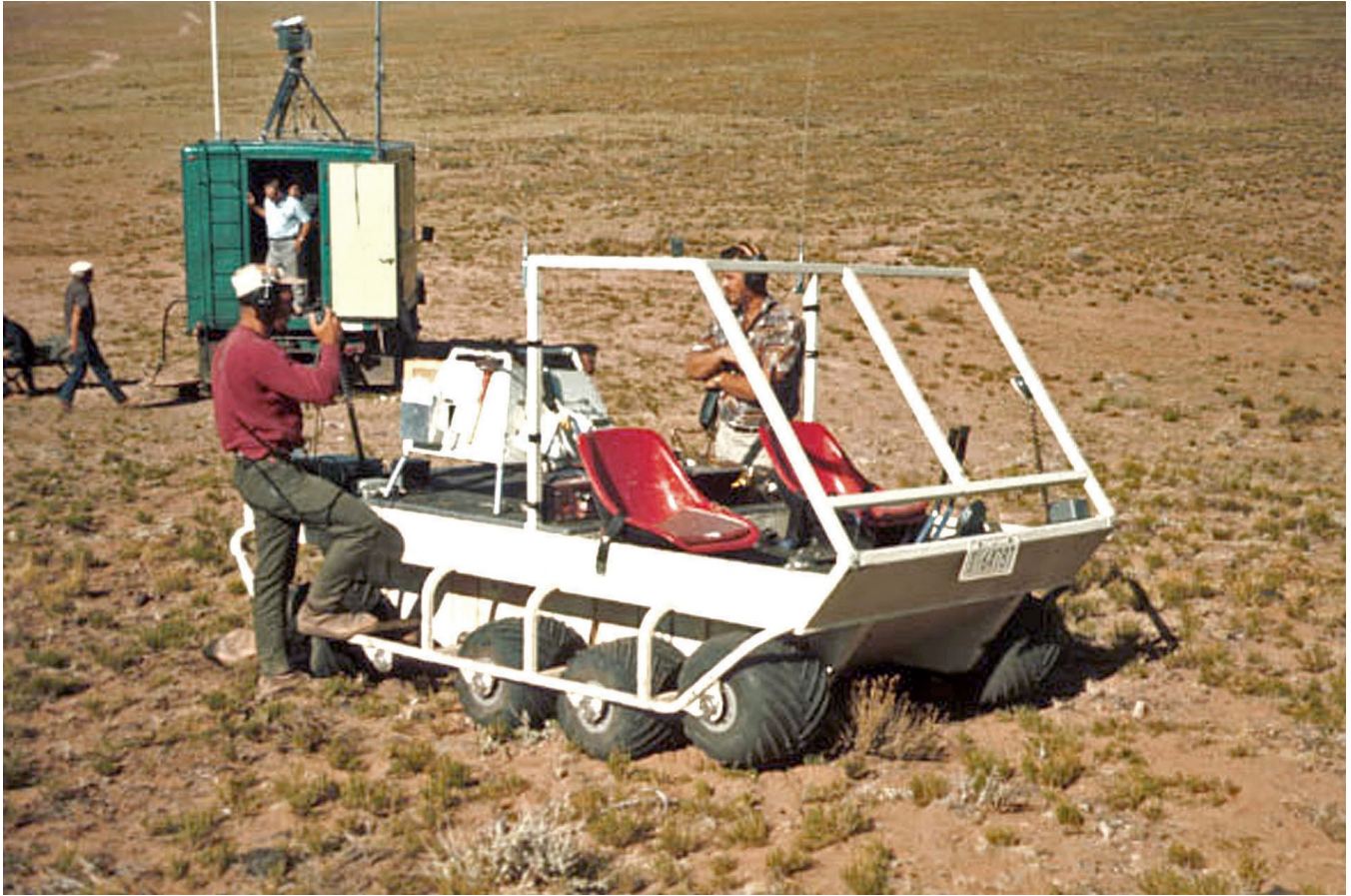


Figure 41-(c) Trespasser vehicle used during test; film documentation van in background; photo G. Schaber

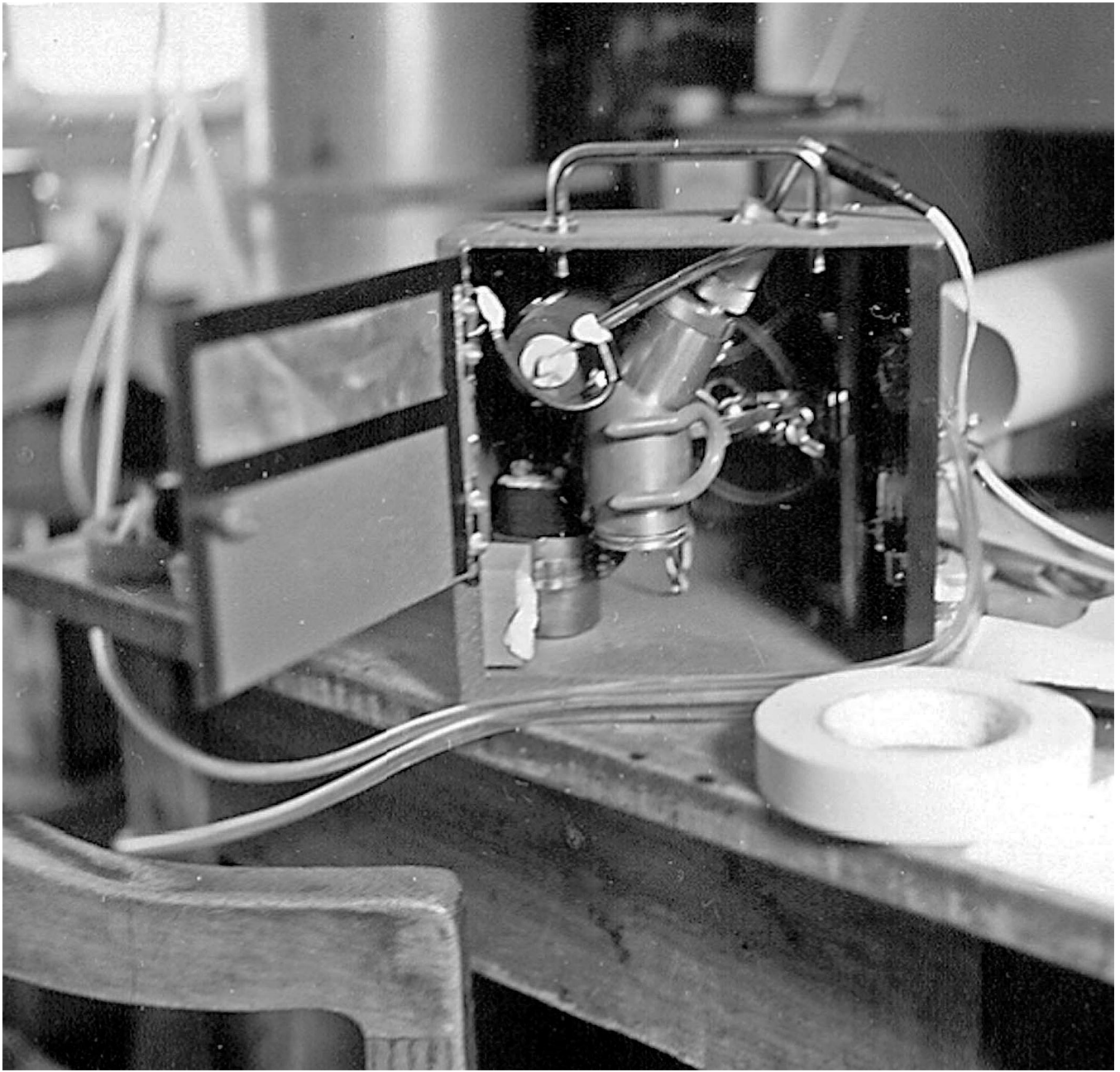


Figure 41-(d) alpha-source (Californium) x-ray analyzer used in field during test to telemeter instrument spectra to the ADF facility at the Arizona Bank Building in downtown Flagstaff; USGS photo P103A, F666462

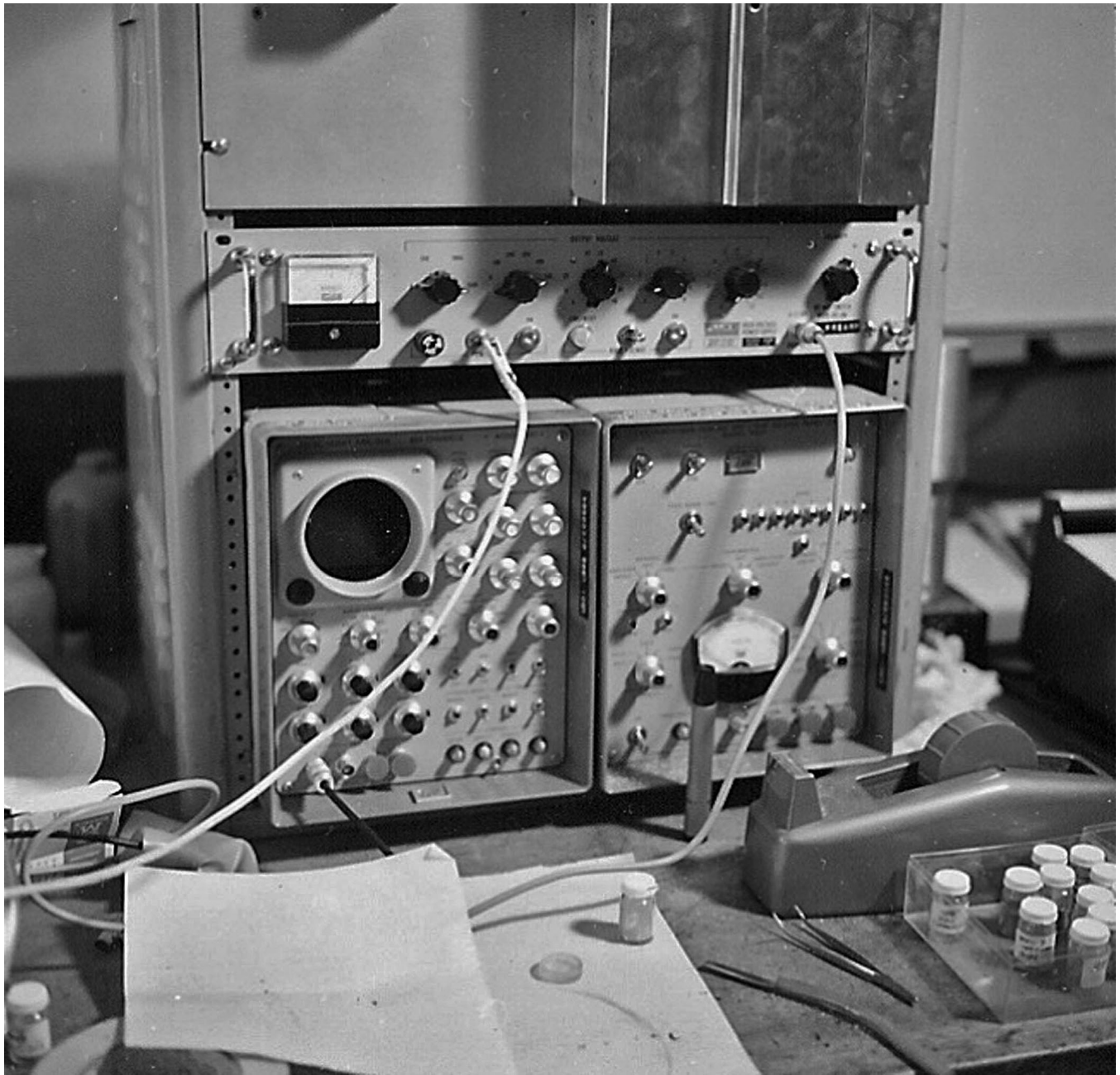


Figure 41-(e) multi-channel analyzer used in conjunction with the alpha-source X-ray spectrometer, shown in d;
USGS photo P103A, F666463

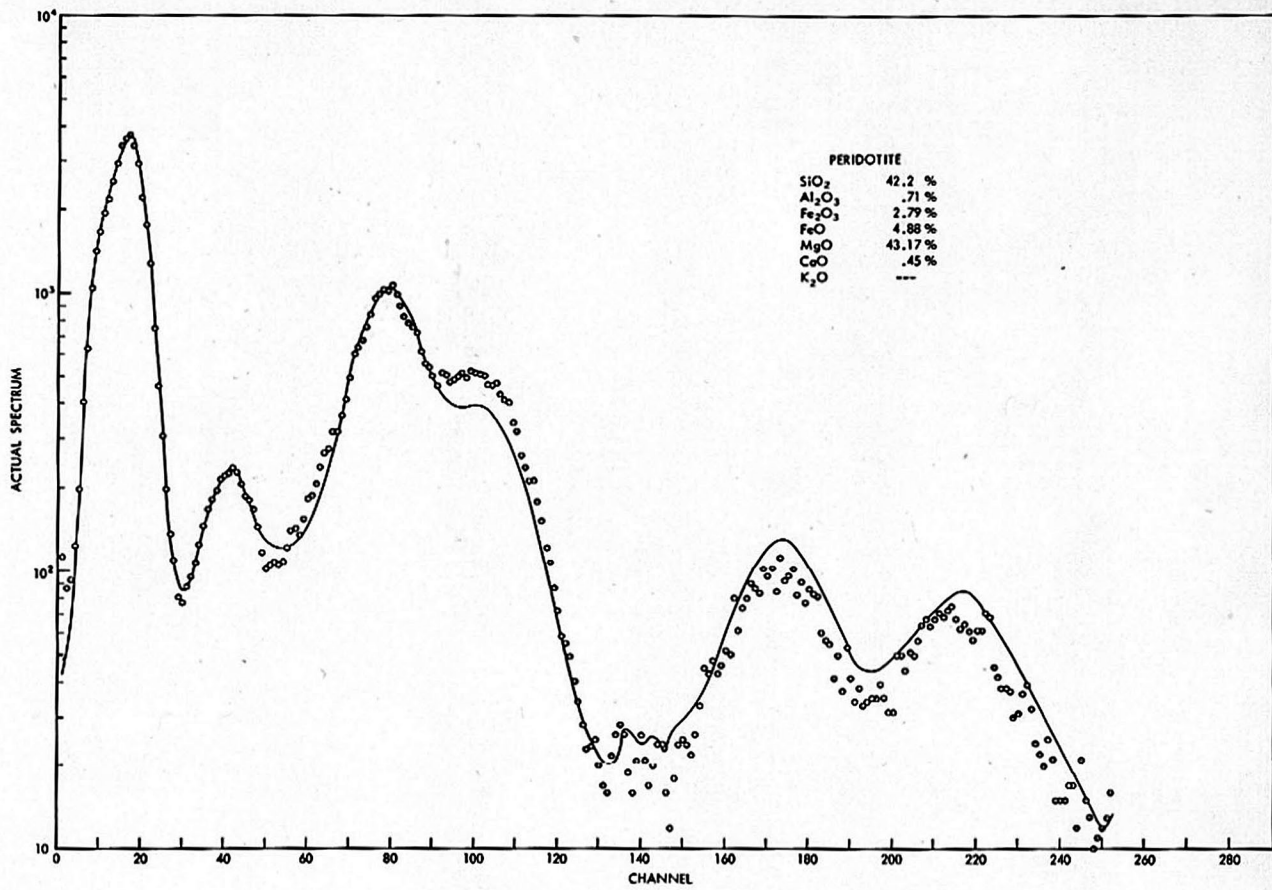


Figure 41-(f) An actual spectra obtained in the field setting from the alpha-source x-ray analyzer; USGS photo P477, F1167332



Figure 41-(g) Gerald G. Schaber in analytical van in field during test working with television-equipped petrographic microscope sending images of thin sections (made during the field test) via television link to personnel located in the ADF in the Arizona Bank Building in Flagstaff; USGS photo P103, F666442; also see Fig. 31a, b.

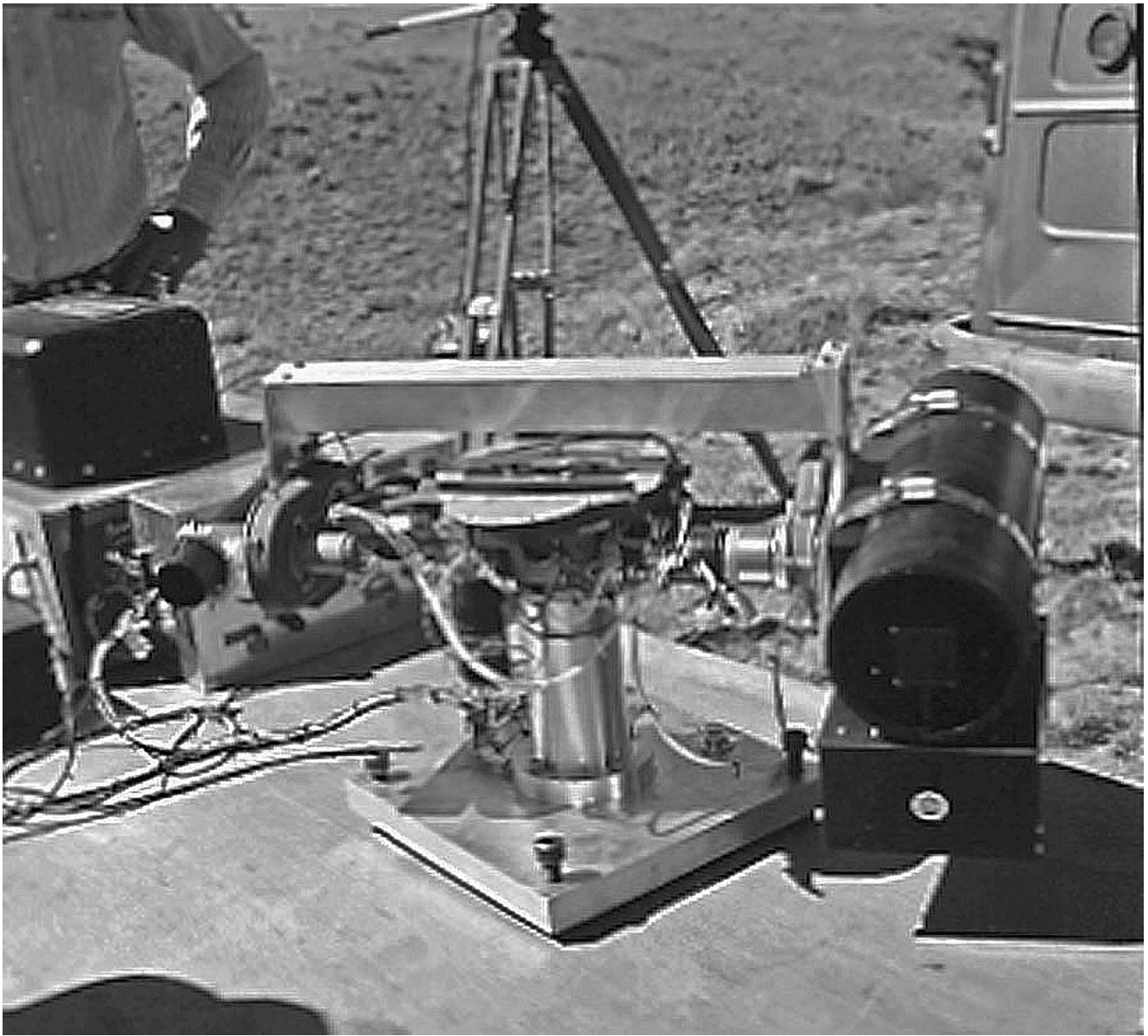


Figure 41-(h) laser ranging-tracking subsystem for Lunar Surveying Staff provided for AAP test 6 (May 1966) by Northrop Space Laboratories; USGS P103, F-666393.



Figure 42-Suited Early Apollo Test 8 in Hopi Buttes, Arizona 21-27 May 1966 immediately following AAP test 6; (a) general scene of what the branch referred to as “Apollo” dike where Early Apollo suited Test 8 was held in Hopi Buttes, Arizona 23-27 May 1966; USGS photo P105, F666587c



Figure 42-(b) liquid oxygen (LOX) wagon (provided by Manned Spacecraft Center, Houston, Texas) used to fill breathing tanks on spacesuits used by Astrogeology personnel (Gordon Swann and Joe, O'Connor) during test; USGS photo P109, F666761c (c) Joe O'Connor in Apollo suit at Hopi Buttes during AAP test 8 using TV camera on early prototype Lunar Staff. Kenna Edmonds (Astrogeology's time-and-motion specialist) shown on right; USGS photo P105, F666530c

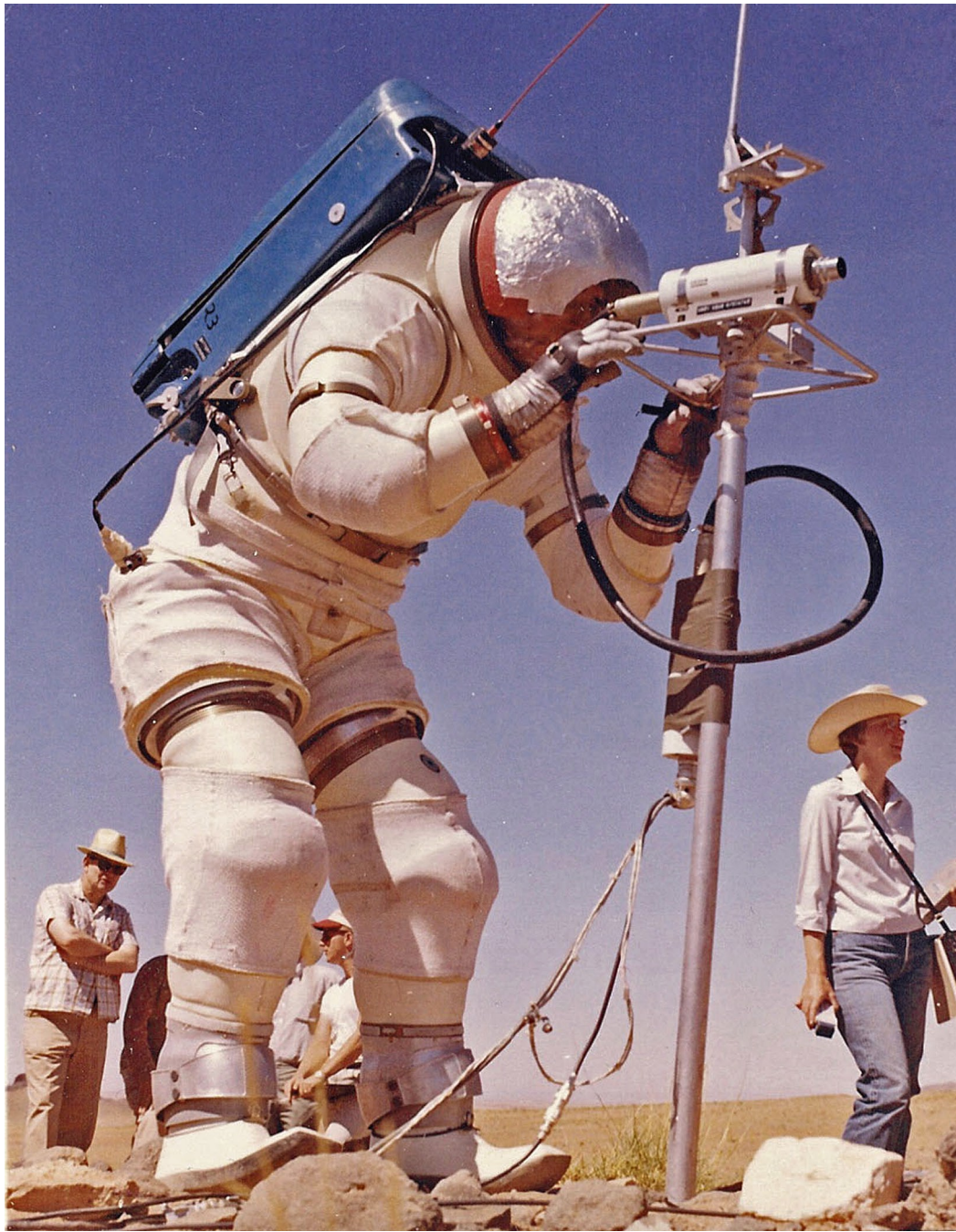


Figure 42-(c) Joe O'Connor in Apollo suit at Hopi Buttes during AAP test 8 using TV camera on early prototype Lunar Staff. Kenna Edmonds (Astrogeology's time-and-motion specialist) shown on right; USGS photo P105, F666530c

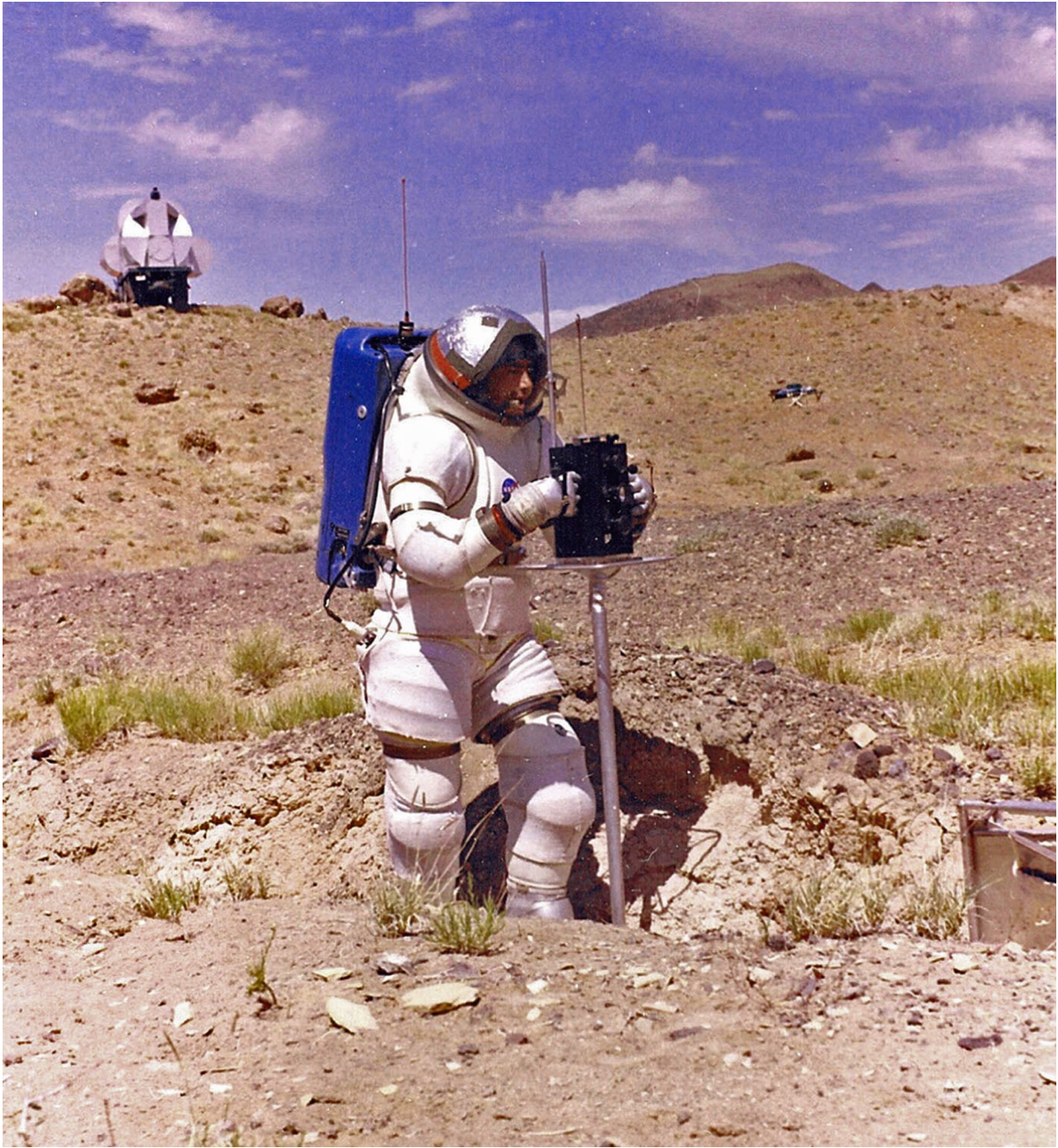


Figure 42-(d) Joe-Connor in Apollo suit with prototype Apollo stereometric camera on staff; simulated LM ascent stage in background; USGS photo P105, F666544c

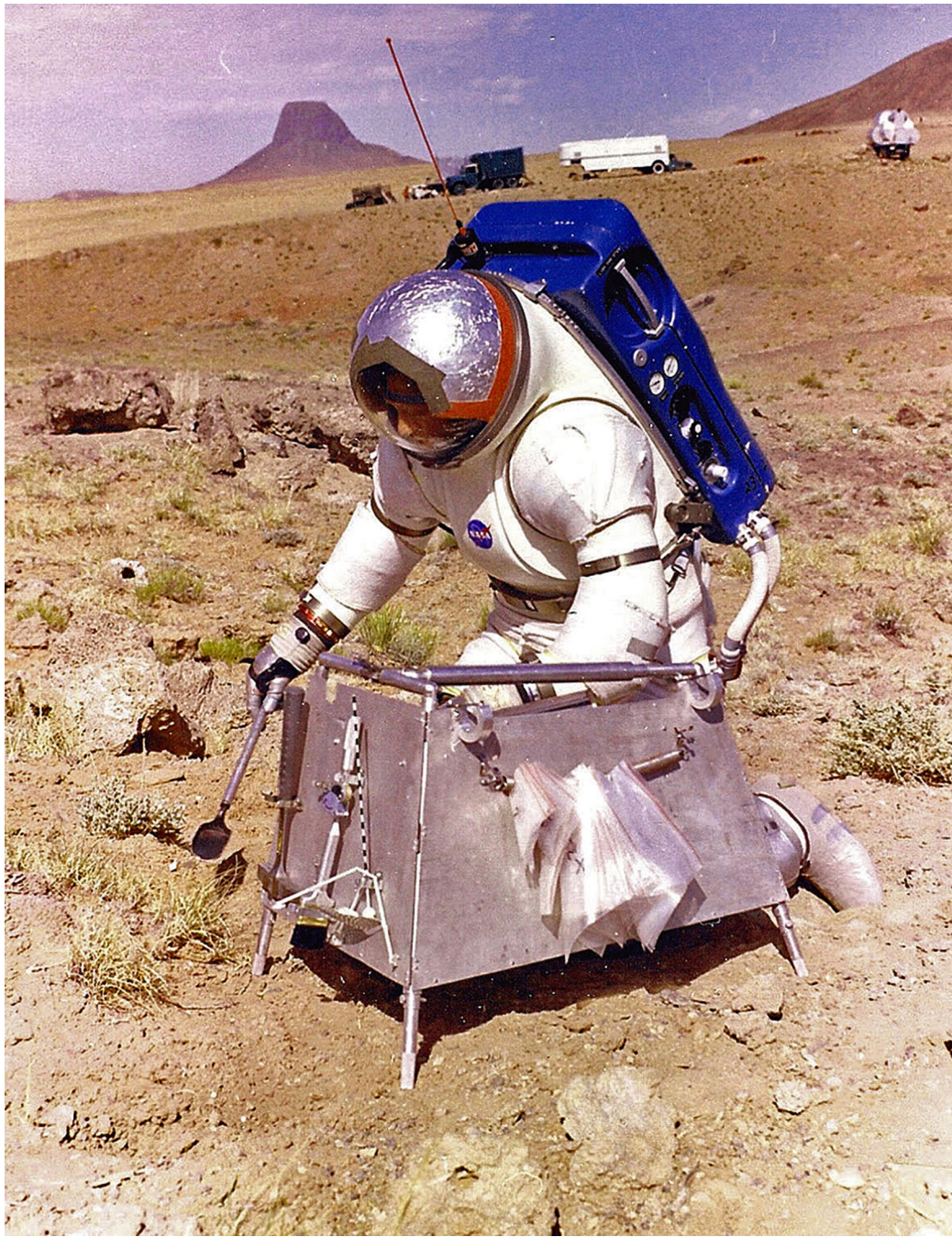


Figure 42-(e) Joe O'Connor working with early design of Apollo Tool carrier (Chimney Butte in background); USGS photo P105, F666539c



Figure 42-(f) prototype of the Apollo Stereo Camera being admired by Branch of Astrogeology geologist David Schleicher and photographer/film maker Walt Roeder, head of the Branch's Film Documentation Unit; photo G. Schaber



Figure 42-(g) seismic shot carried out by the Branch's In Situ Geophysics group in Chezhin-Chotah Butte area during AAP Test 6.



Figure 43-Bell Aerospace's Lunar Flying Vehicle (simulated Lunar Flying Vehicle, or LFV) being demonstrated for NASA and USGS personnel in Hopi Buttes, Arizona, on 2-3 August 1966; (a) Bell Aerospace's "Rocket Man" shown just before take off using their simulated LFV Vehicle; USGS photo P141, F866261CPR



Figure 43-(b) Bell's Rocket Man shown just after lift off with the LRV; USGS photo P141, F866259



Figure 43-(c) Rocket Man shown coming back down after 21 second flight around a dike at the test site: USGS P 141, F-866257CPR



Figure 43-(d) Rocket Man shown coming back down.

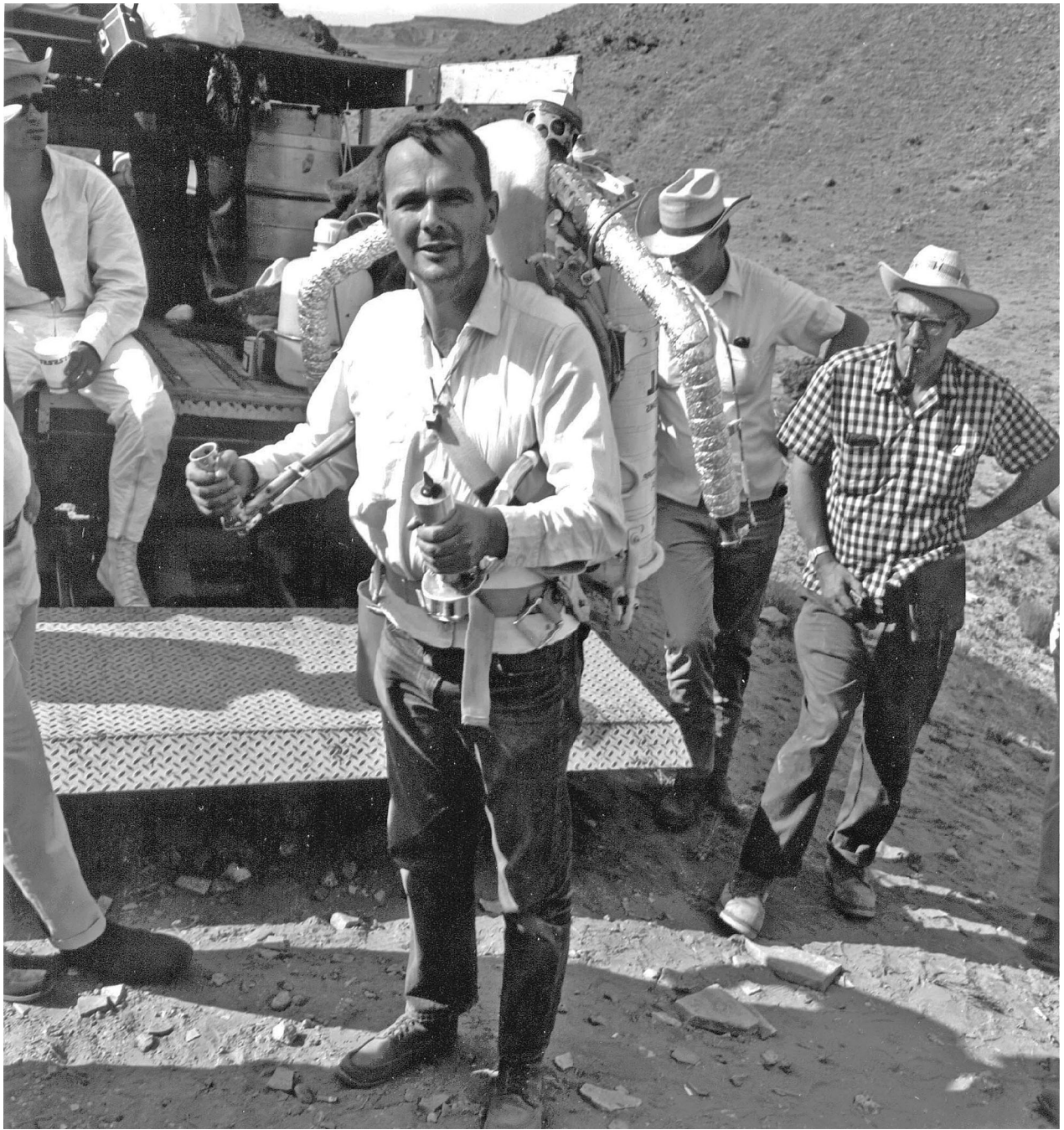


Figure 43-(e) Gene Shoemaker with Bell Aerospace rocket belt strapped on (only for show as he was not allowed to take off); Thor Karlstrom shown to right in plaid shirt and hat; USGS photo



Figure 43-(f) close-up of a happy Gene wearing the rocket belt; USGS photo P141, F866252.



Figure 44-(a) Present-day exterior view of the Apollo Data Facility (ADF) building constructed by Flagstaff's Buttrum and Jamison Contracting Company on North Fourth Street in East Flagstaff, Arizona; digital photo by G. Schaber, 6 May 2002



Figure 44-(b) second, larger, building (2717 N. Fourth Street) built adjacent to the ADF (2717 N. Fourth Street) at the same time to house some of the Branch support groups, including photogrammetry, surveying, photography, and cartography from late 1967 through 1973; digital photo by G. Schaber 6 may 2002.



Figure 45-Construction phases of the Branch of Astrogeology's lunar Roving vehicle (LRV) called "Explorer;" (a) aerial view of the old Byrd Building at 1980 Huntington Road in Flagstaff, Arizona where the Branch of Astrogeology's "Explorer" simulated Lunar Roving Vehicle (LRV) was designed and constructed in spring 1967 by Putty Mills, Dick Wisner and Bill Tinnin of the Branch's Field Test Support Group in Flagstaff; USGS aerial photo



Figure 45-(b) present day appearance of the front entrance of the old Byrd Building at 1880 E. Huntington Drive, Flagstaff, Arizona, where Grover was constructed; currently occupied by Border Products Corporation; digital photo G. Schaber, 13 May 2002



Figure 45-(c) Putty Mills welding frame of new Explorer vehicle in shop on Huntington Road; USGS photo P309, F5673

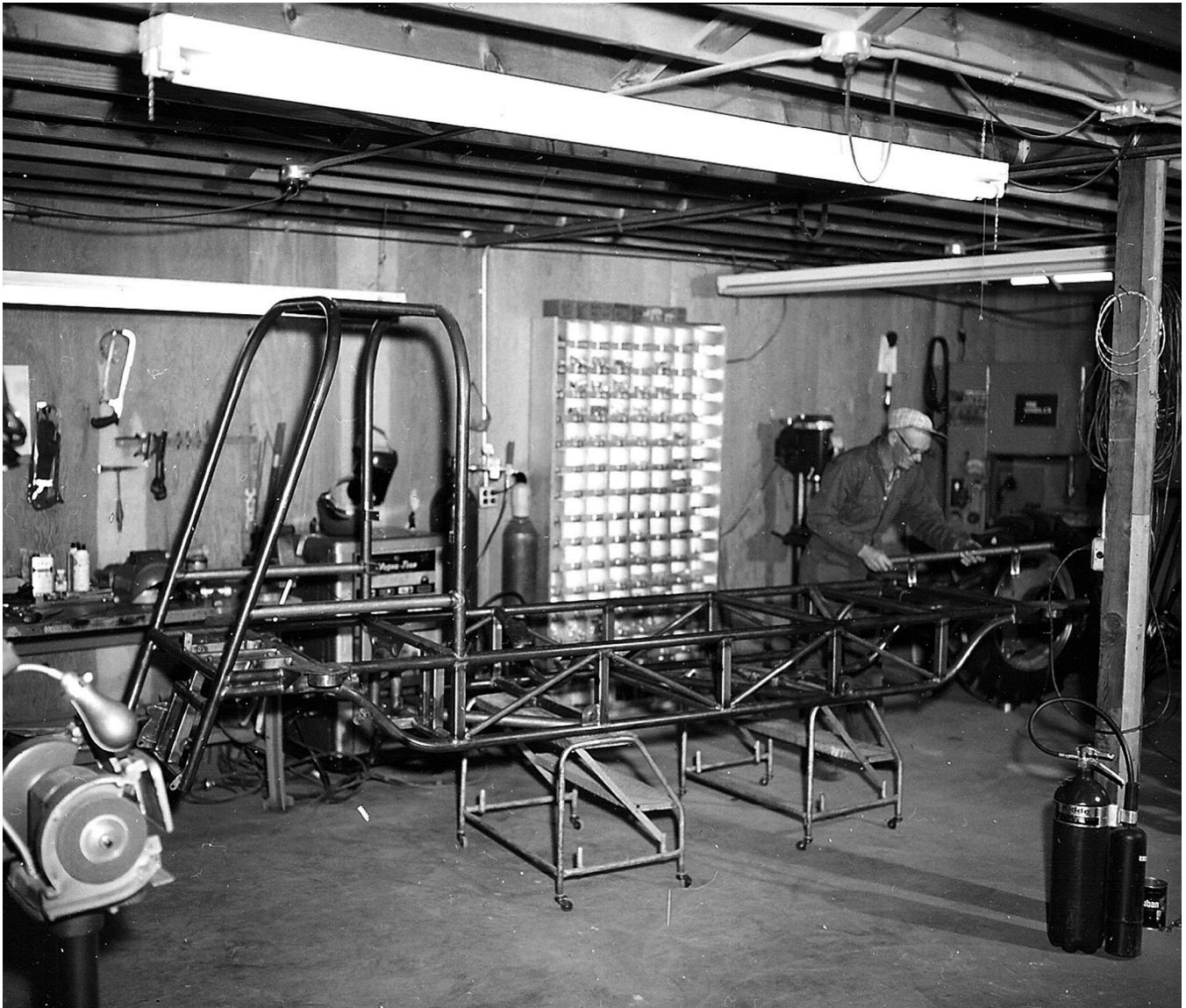


Figure 45-(d) Dick Wisner shown working on the basic frame work during the construction of the Explorer vehicle;
USGS photo P309, F56711A

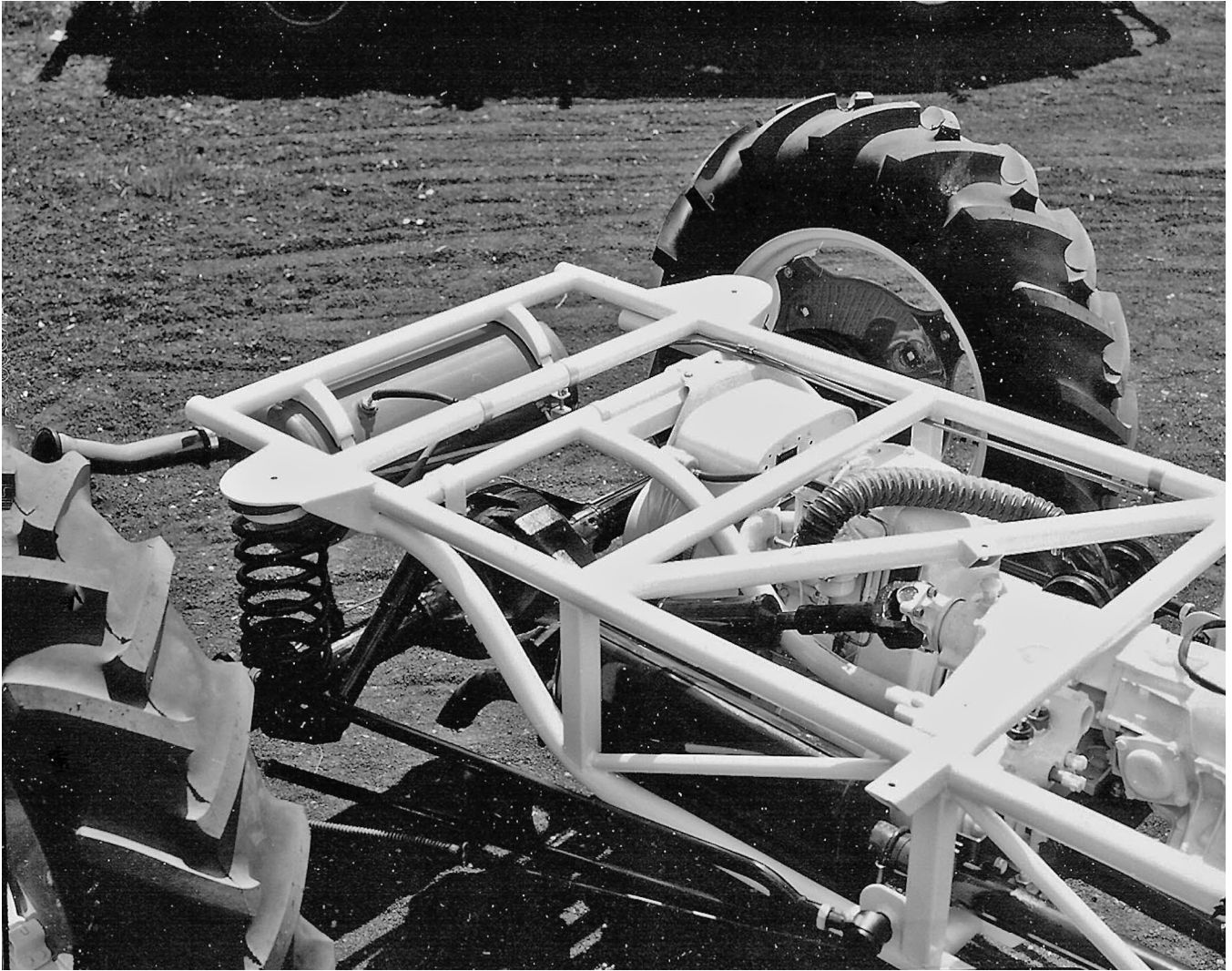


Figure 45-(e) details of the differential and rear wheels of Explorer; USGS photo P329, F567128



Figure 45-(f) Explorer frame with power plant engine installed; USGS photo P329, F567127



Figure 45-(g) details of the joy stick steering console and front seat (originally single seat, later double seats); USGS photo P329, F567126



Figure 45-(h) Bill Tinnin driving completed Explorer onto trailer during early field check of vehicle; USGS photo (November 1967).



Figure 46-Shoemaker-led astronaut training trip to Meteor Crater 16-19 May 1967; (a) Gene Shoemaker describing the geology of the rim ejecta of Meteor Crater to large group of astronauts during field trip on 16-19 May 1967; NASA S-67-31470



Figure 46-(b) Gene Shoemaker and group of astronauts by museum at Meteor Crater discussing Gene's geologic map of the Crater; USGS photo P324, F567108PR

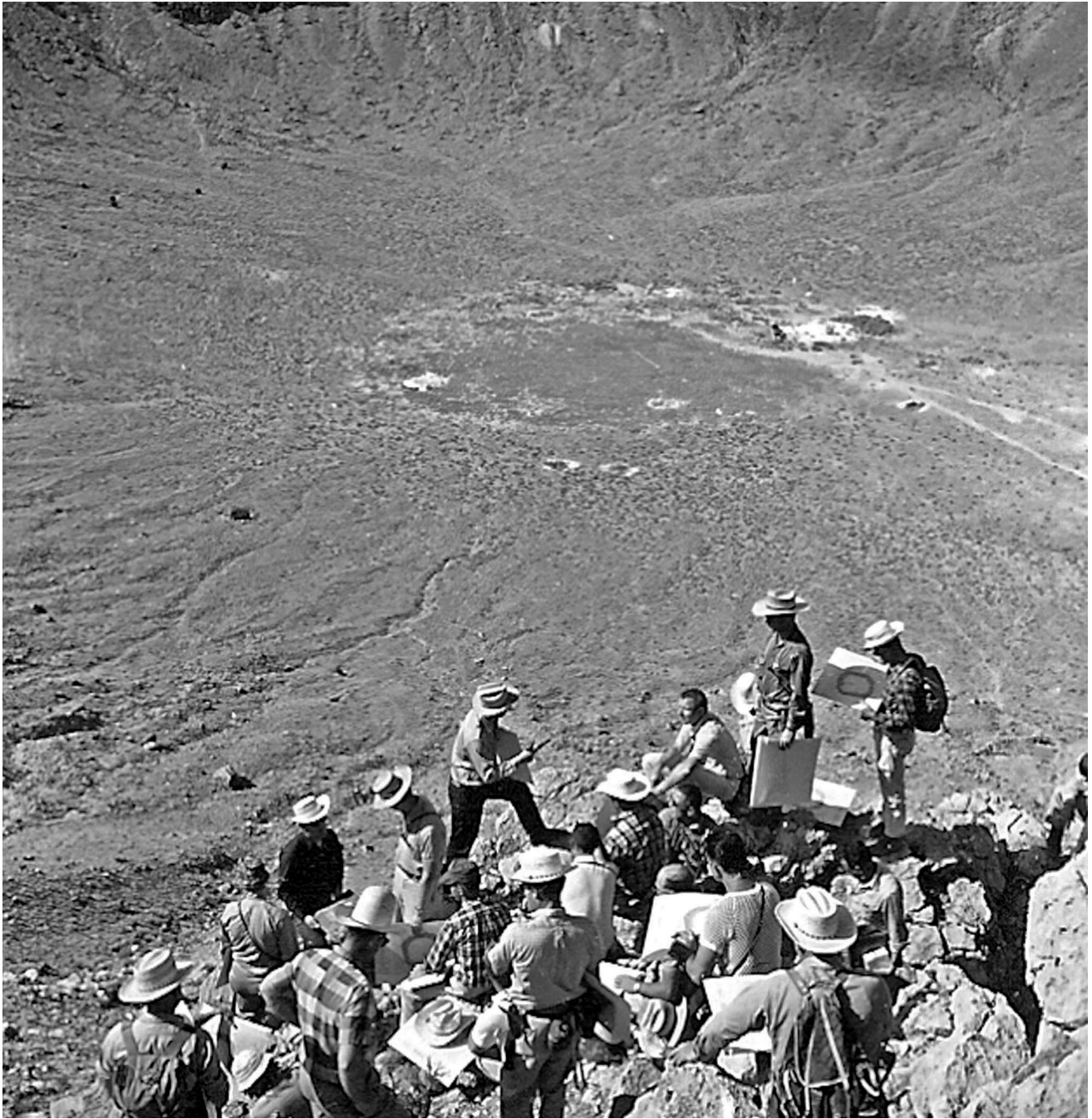


Figure 46-(c) Shoemaker lecturing to astronaut group on rim crest of Meteor Crater during field trip 16-19 May 1967; USGS photo P324, F56773PR.



Figure 47-The Branch of Astrogeology's hand-constructed Explorer vehicle being field tested (June 1967) on the extremely blocky S.P. Lava Flow north of Flagstaff just west of Hank's Trading Post on U.S. Highway 89 North; (a) Putty Mills, Astrogeology's Field Test Support Unit, driving Explorer on S.P. Lava Flow P358 F667141; USGS photo P358, F667141



Figure 47-(b) Putty Mills driving Explorer vehicle on S.P. Flow; photo USGS P 358, F-667145



Figure 47-(c) Personnel from Astrogeology's Documentation Unit filming (for NASA) the June 1967 testing of Explorer on S.P. Lava Flow; USGS photo P358, F667153. The Explorer vehicle could be tested on top of the rugged S.P. Lava Flow because of a remarkable, crude, bulldozer "road" that was constructed onto the flow in 1965 by Red Bailey and a local contractor in order to transport the In Situ Geophysics Group's drilling rig to the top of the flow to facilitate drilling through the lava flow into the bedrock below



Figure 47-(d) The drilling rig belonging to the Branch of Astrogeology's In Situ Geophysics Group shown sitting on the bulldozer road on top of S.P. Lava Flow north of Flagstaff, Arizona in 1965

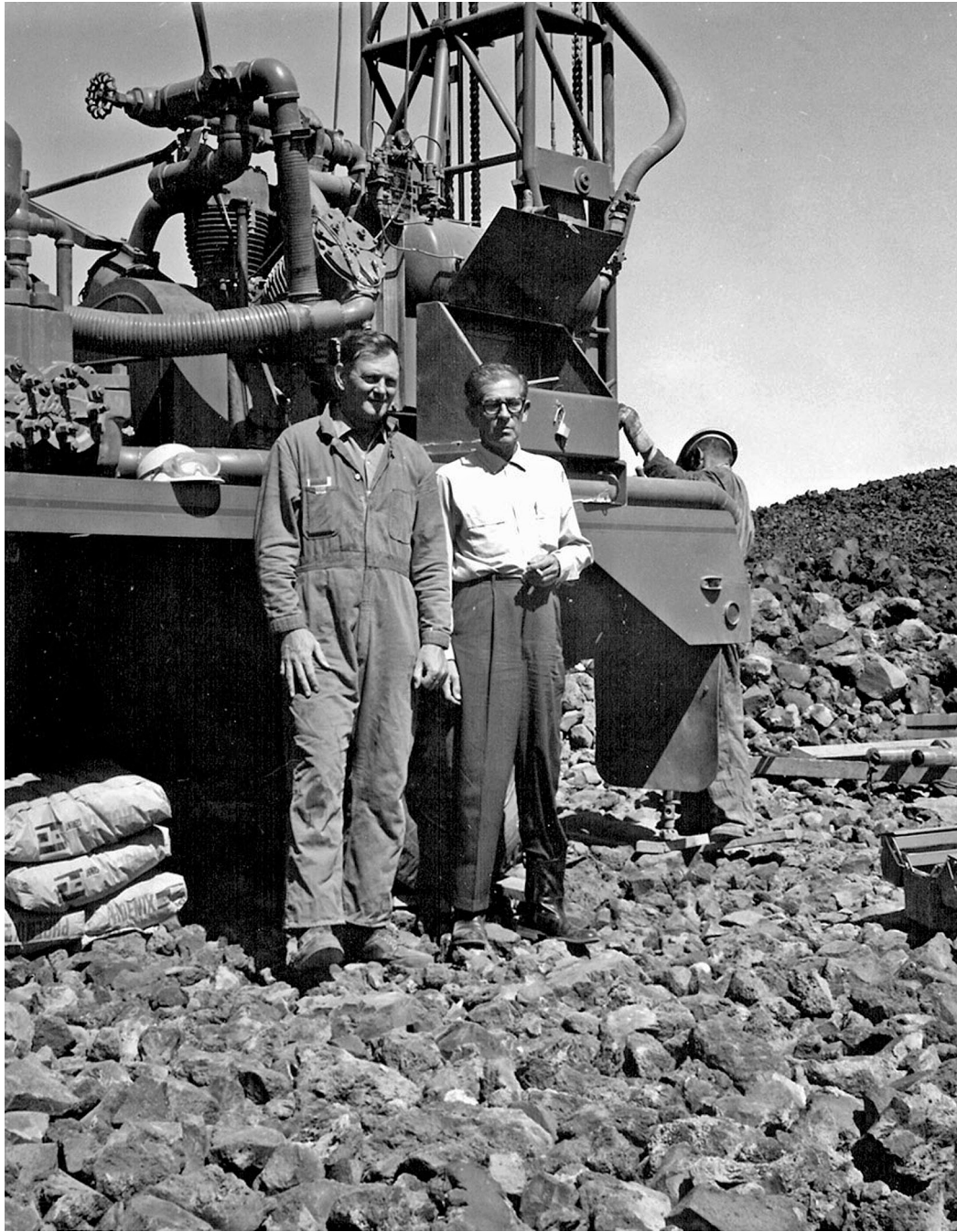


Figure 47-(e) (l to r)- Red Bailey (USGS) and Bud Floyd, E.T. Failing Company sales/service representative, standing by drilling rig on top of S.P. Lava Flow in 1965. The Survey's Bob Elmer is drilling.



Figure 48-Construction on 27-28 July 1967 of Cinder Lake Crater Field # 1 just northeast of Flagstaff, Arizona
(a) backhoe digging of 47 holes to precise depths, and in which to bury precisely-measured explosives at each surveyed crater site; red bailey back to camera P447, F106754



Figure 48-(b) loading of holes with dynamite (312.5 pounds) and ammonium nitrate (13,492 pounds) (trade name Nitro-Carbo-Nitrate; mixture of common agricultural fertilizer and fuel oil) (l-r) unknown, George Ulrich and Red Bailey; USGS photo P447, F106757



Figure 48-(c) one of several test explosions at Cinder Lake to establish the relationship between amount of ammonium nitrate and dynamite vs. crater size; USGS photo P447, F106756



Figure 48-(d) large explosion carried out at the request of Gene Shoemaker (who witnessed the blast with others) following the construction of Crater Field #1 using left-over explosives



Figure 48-(e) final appearance of first stage Cinder Lake Crater Field #1 with simulated Lunar Module ascent stage (LM) sitting atop a ramp made for that purpose to approximate the actual height of the Apollo ascent stage windows; USGS photo P448, F106763

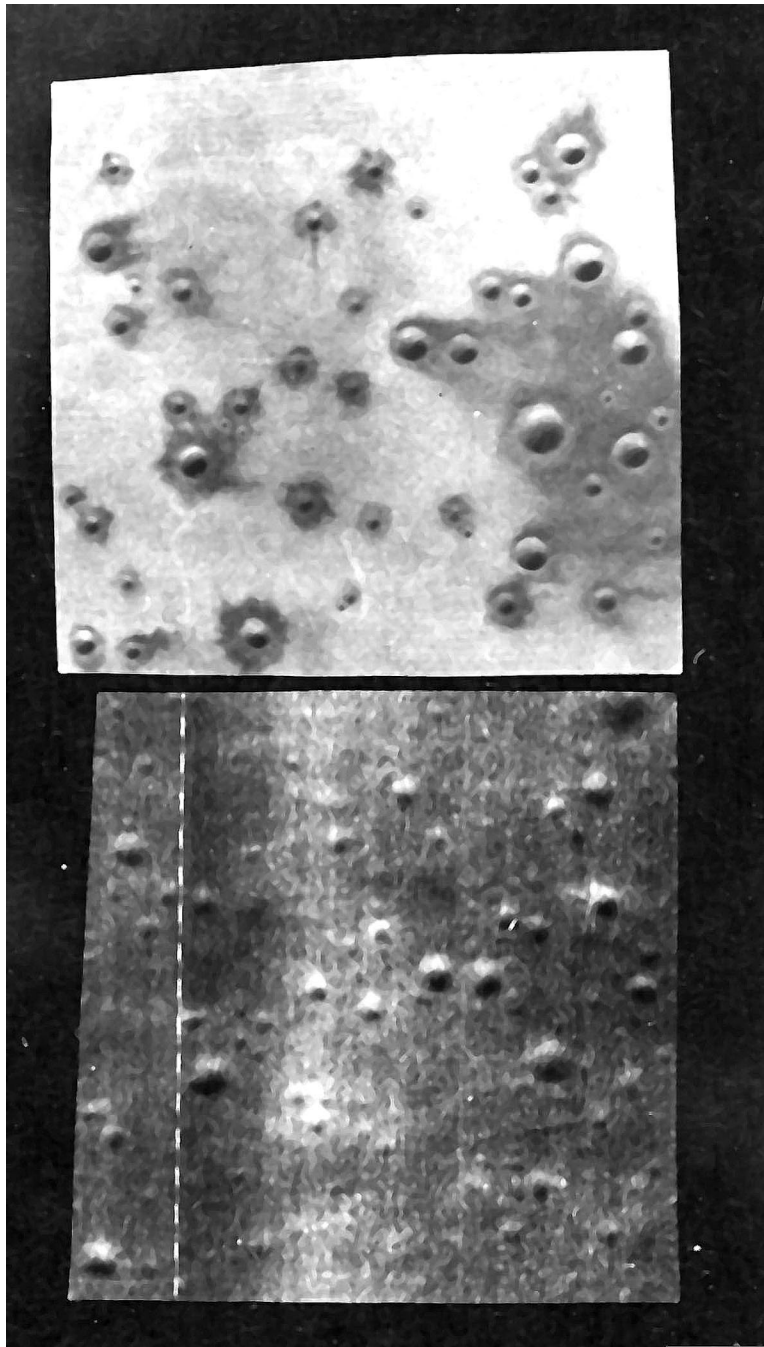


Figure 48-(f) comparison of the first stage of Cinder Lake Crater Field (top) and the small area of the Apollo 11 landing site that was to be simulated, as shown on a Lunar Orbiter frame; USGS photo P421, F867187



Figure 48-(g) crater field #1 after an additional 96 craters were added 3-12 October 1967—for a total of 143 craters for the entire (expanded) crater Field #1



Figure 48-(h) geologic map made of Cinder Lake Crater Field # 1 by Branch of Surface Planetary Exploration personnel for use in planning astronaut EVA traverses; USGS photo P549, F36846A.



Figure 49-Transportation (courtesy of the U.S. Air Force) of the Branch of Astrogeology's MOLAB/MGL, Explorer lunar concept vehicles, and various display panels to the July 1967 Boy Scout World Jamboree at Philmont Scout Ranch near Cimarron, New Mexico; (a) Explorer and MOLAB on tarmac waiting to be loaded aboard a U.S. Air force C-124 cargo plane for the trip to Philmont Boy Scout Ranch; NASA photo



Figure 49-(b) MOLAB being loaded aboard the rear of the giant C-124 Globemaster II aircraft; NASA photo

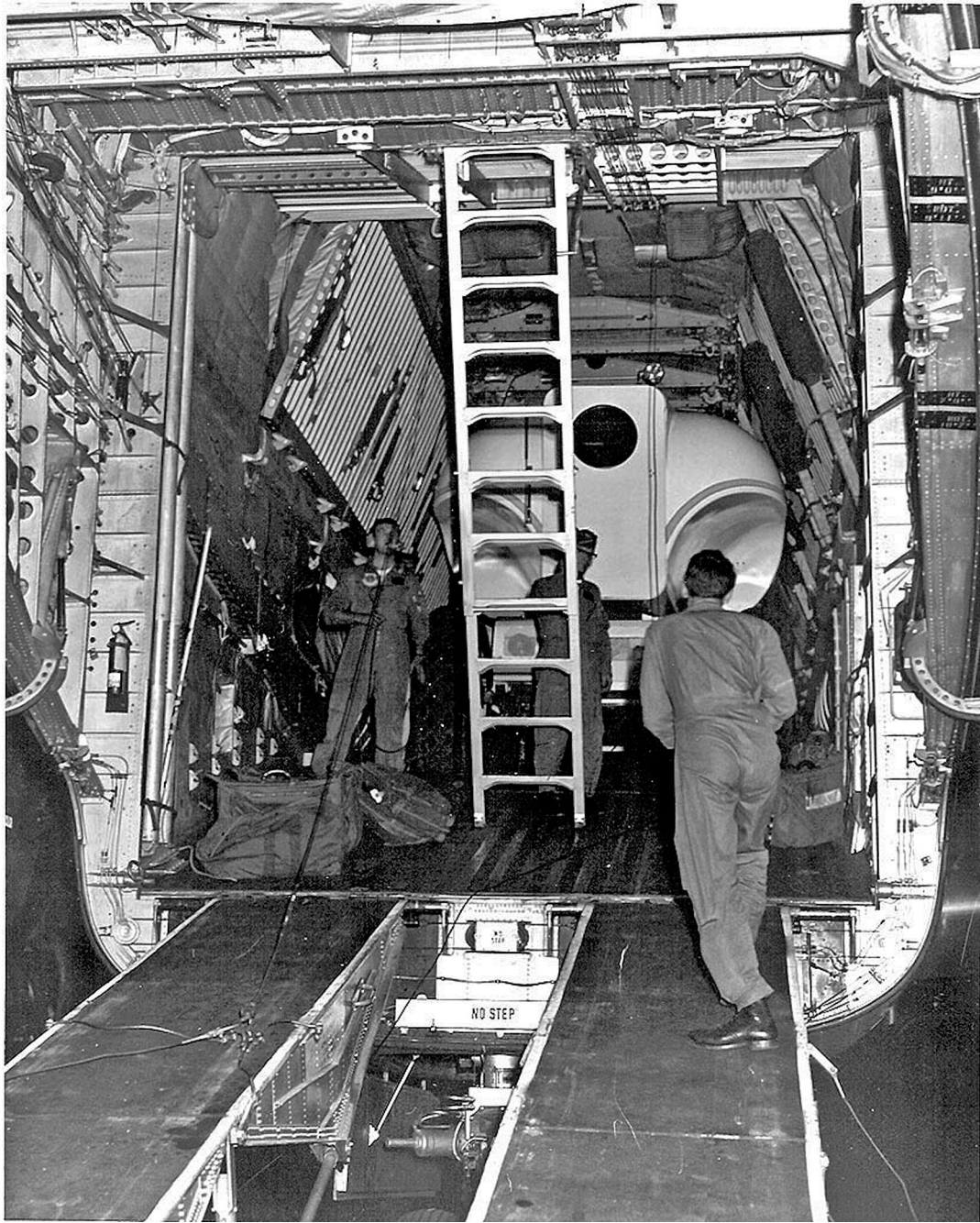


Figure 49-(c) MOLAB after loading in C-124; NASA photo.



Figure 50-Suited test (with liquefied air backpacks) at Cinder Lake Crater Field #1 on 24-26 October 1967; (a) Astrogeology geologists Tim Hait (with towel around neck) and Dave Schleicher bending over in suit, being helped into their spacesuits prior to a traverse exercise; background l to r are John Running and Red Bailey; USGS photo P466, F1167151c



Figure 50-(b) Tim Hait and David Schleicher in spacesuit during first Apollo Field Test-13 at Cinder Lake Crater Field #1 with simulated LM ascent stage mockup on ramp in background; USGS photo P463, F11067199



Figure 50-(c) Hait and Schleicher investigating small crater during Apollo Field Test-13 at Cinder Lake Crater Field #1; USGS photo P466 F 116779CPR)



Figure 50-(d) Astronaut subject (Hait or Schleicher) on Explorer vehicle with Red Bailey (upper right) and Putty Mills (?) on back of vehicle; USGS photo P466c F1167153CPR



Figure 50-(e) Close up view of suited subject (Hait or Schleicher) driving Explorer vehicle during test; also in vehicle are Putty Mills (left) and Red Bailey (right); USGS photo P464F, F116743PR.



Figure 51-(a) Display by the USGS Branch of Astrogeology set up at the Arizona State Fair in Phoenix, Arizona 3-12 November 1967; (a) MOLAB and display panels inside Fair building; USGS photo P487, F1167407PR



Figure 51-(b) Lunar Orbiter and Surveyor display panels at Fair; USGS photo P487, F1167415PR



Figure 51-(c) Mars Exploration display panel at Fair; USGS photo P487, F1167416PR



Figure 51-(d) Miss Navajo (for 1967) shown during Fair standing by the Branch of Astrogeology's "Explorer" lunar concept vehicle; USGS photo F1167402PR.



Figure 52-(a) six members of the USGS Branch of Astrogeology Surveyor Project Television Experiment team members in January 1968. Shown (l-to-r) are Ray Batson, R.A. Henry (seated), Henry Holt, Ken Stice (seated) Gene Shoemaker and Elliot Morris; USGS photo P503, F1685PR

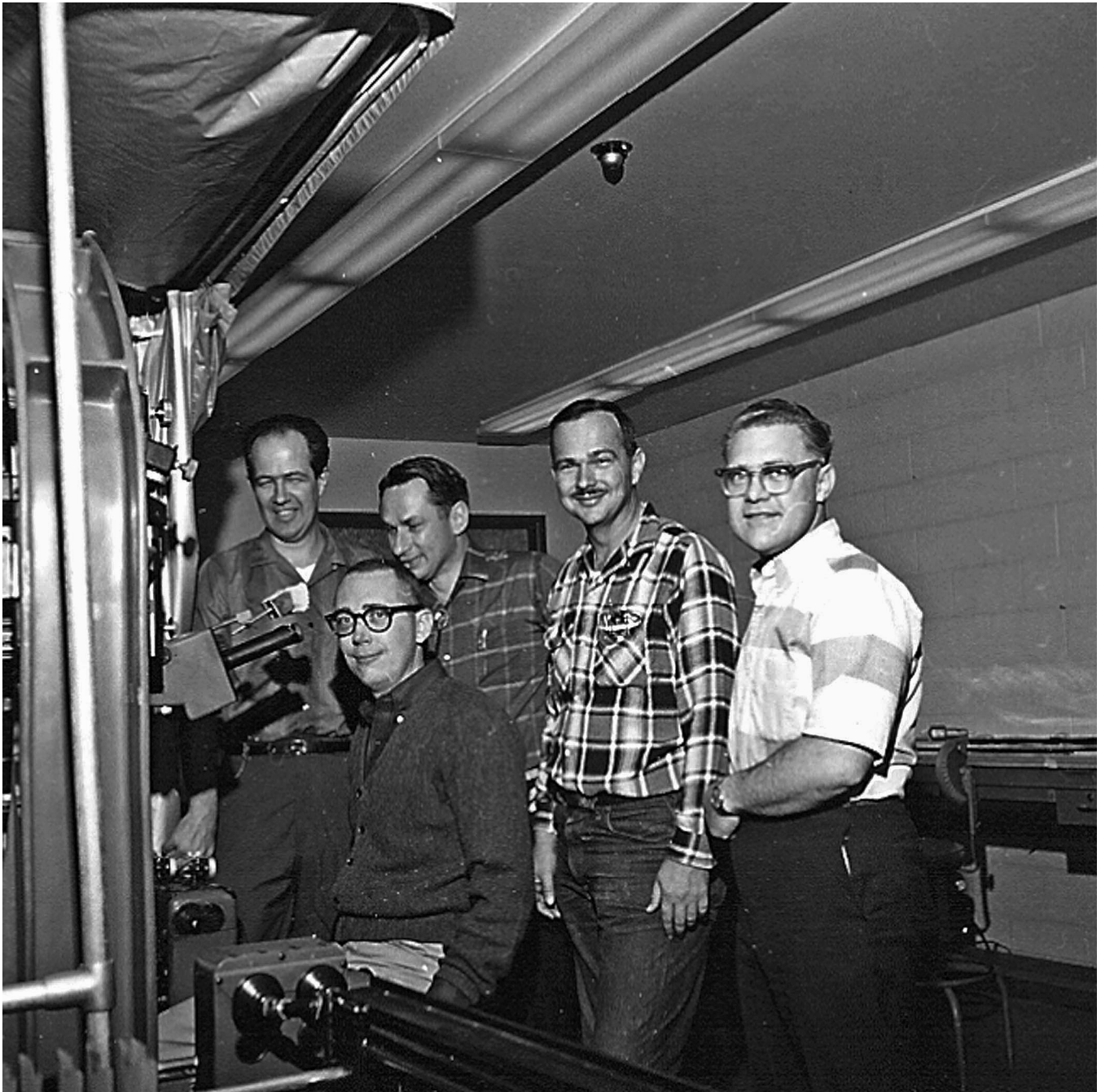


Figure 52-(b) Ray Jordan (seated at analytical stereoplottor) and other members of the Surveyor Project Television Experiment Team from Flagstaff; (1-to-r in back) Ray Batson, Henry Holt, Gene Shoemaker and Elliot Morris; USGS photo P503, F1687PR.

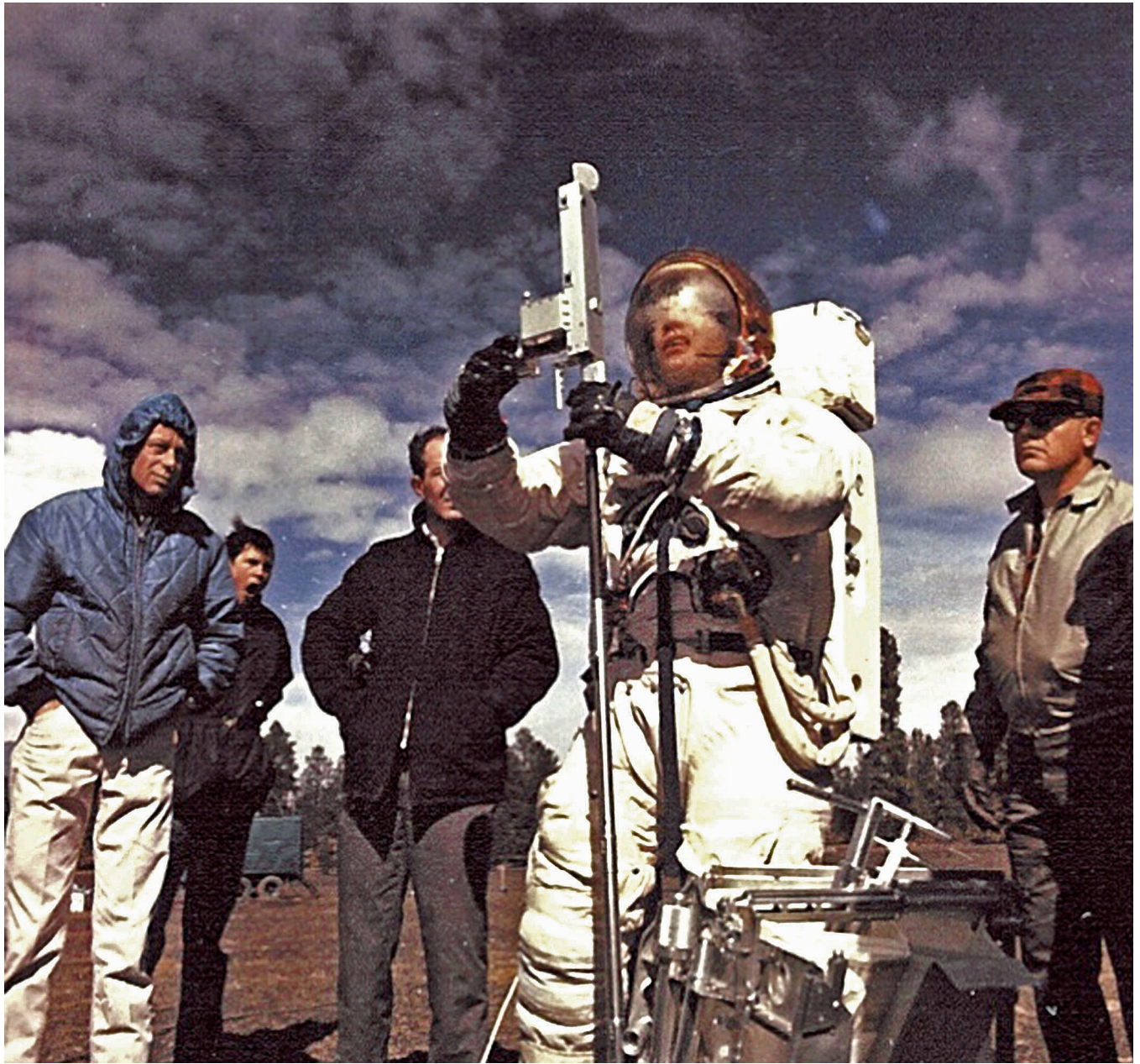


Figure 53-(a) Early Apollo demonstration test (14,15 and 21 March 1968) for NASA with Astrogeology's Tim Hait in suit; shown working with Lunar Staff concept; Gordon Swann at far left; USGS photo P564, F368172c



Figure 53-(b) Tim Hait taking drive tube soil ample on wall of crater at Cinder Lake Crater Field #1 during Apollo Demonstration test; tool carrier prototype in foreground; USGS photo P564, F36819c

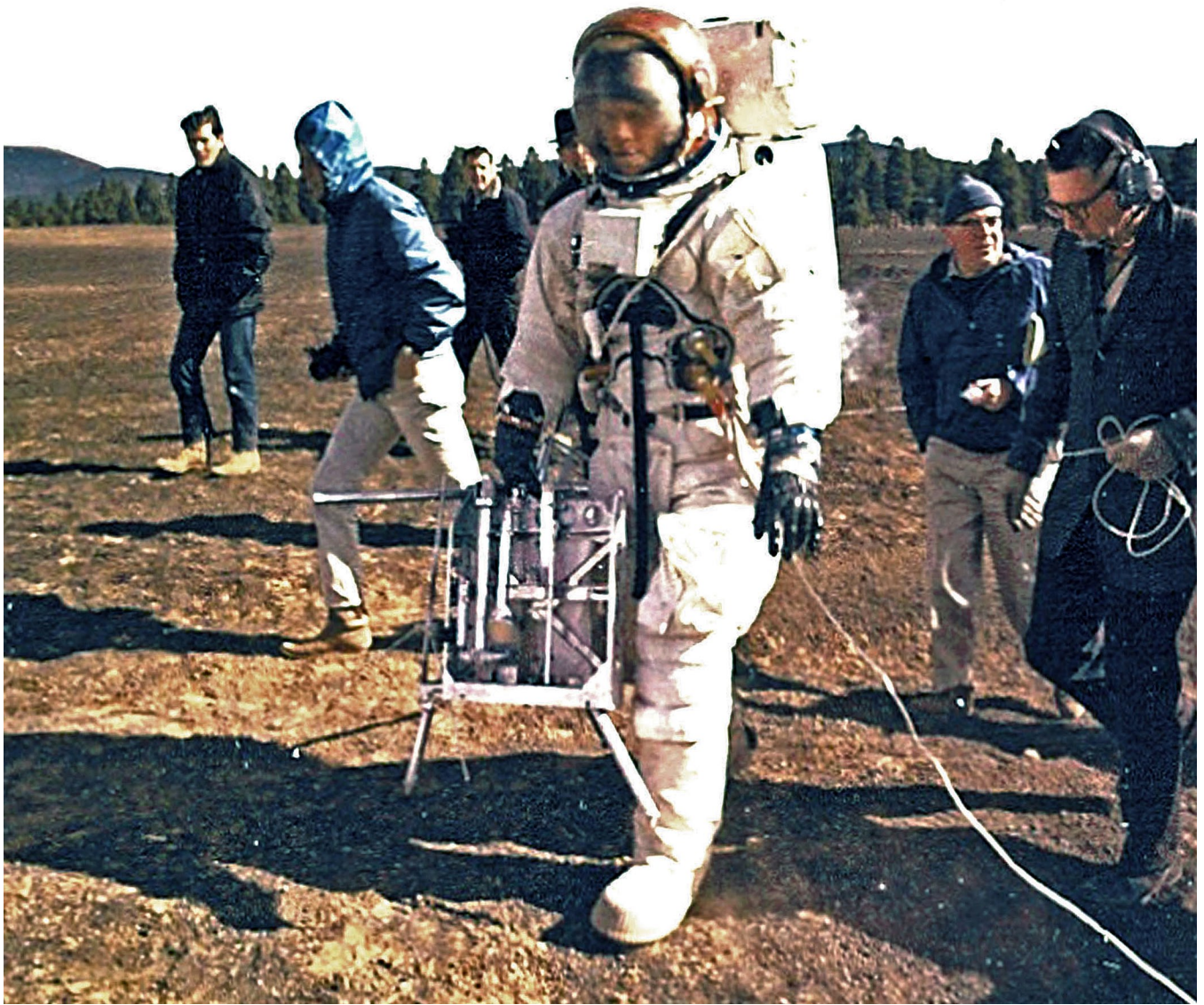


Figure 53-(c) Tim Hait in suit carrying tool carrier; with usual entourage of observers and support personnel; USGS photo P564, F368178



Figure 53-(d) Tim Hait with tool carrier; USGS photo P557, F36883.

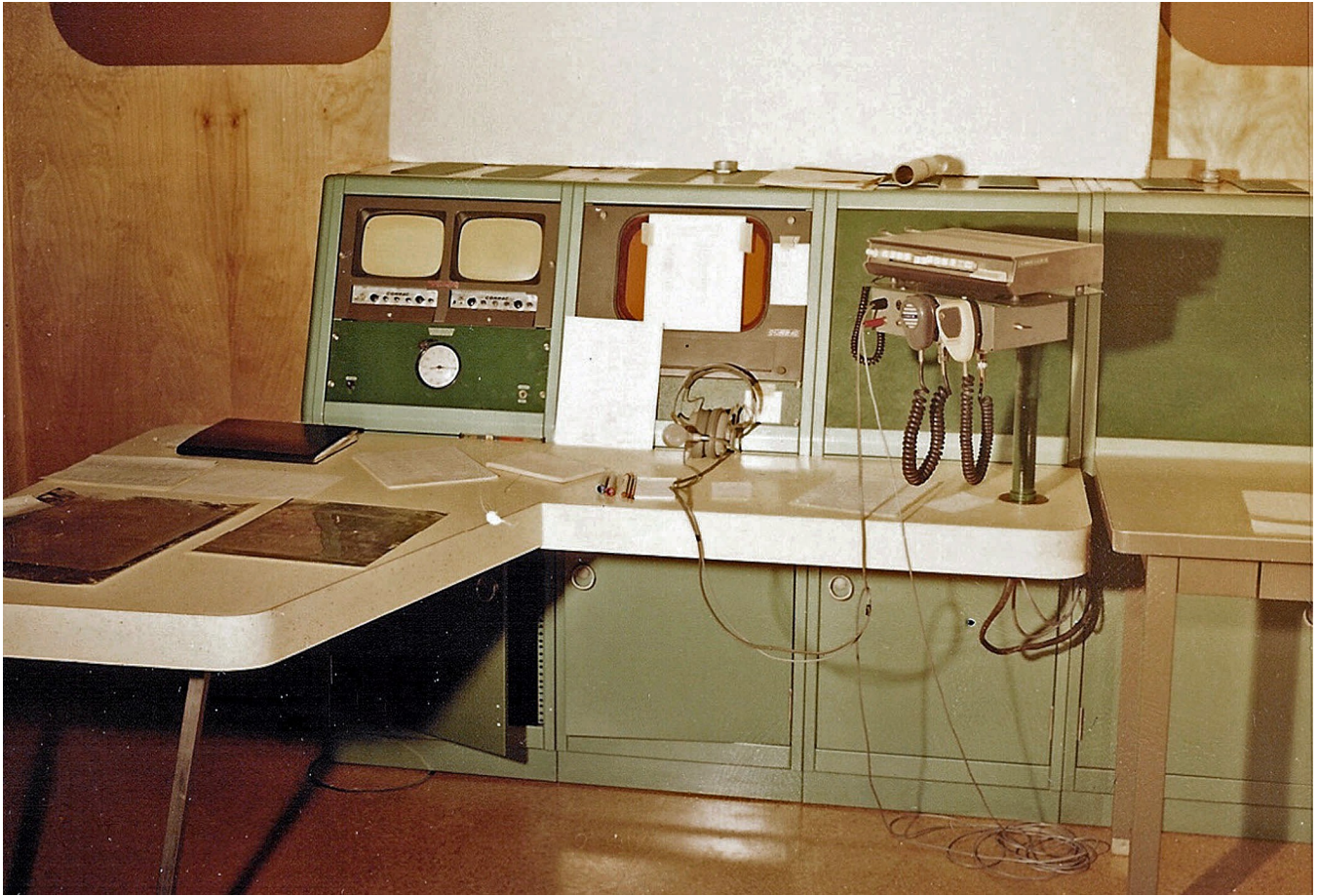


Figure 54-(a) Views of typical work stations within the new ADF on Fourth Street in East Flagstaff during the 3-5 June 1968 ADF test; USGS photo P620, F668301c

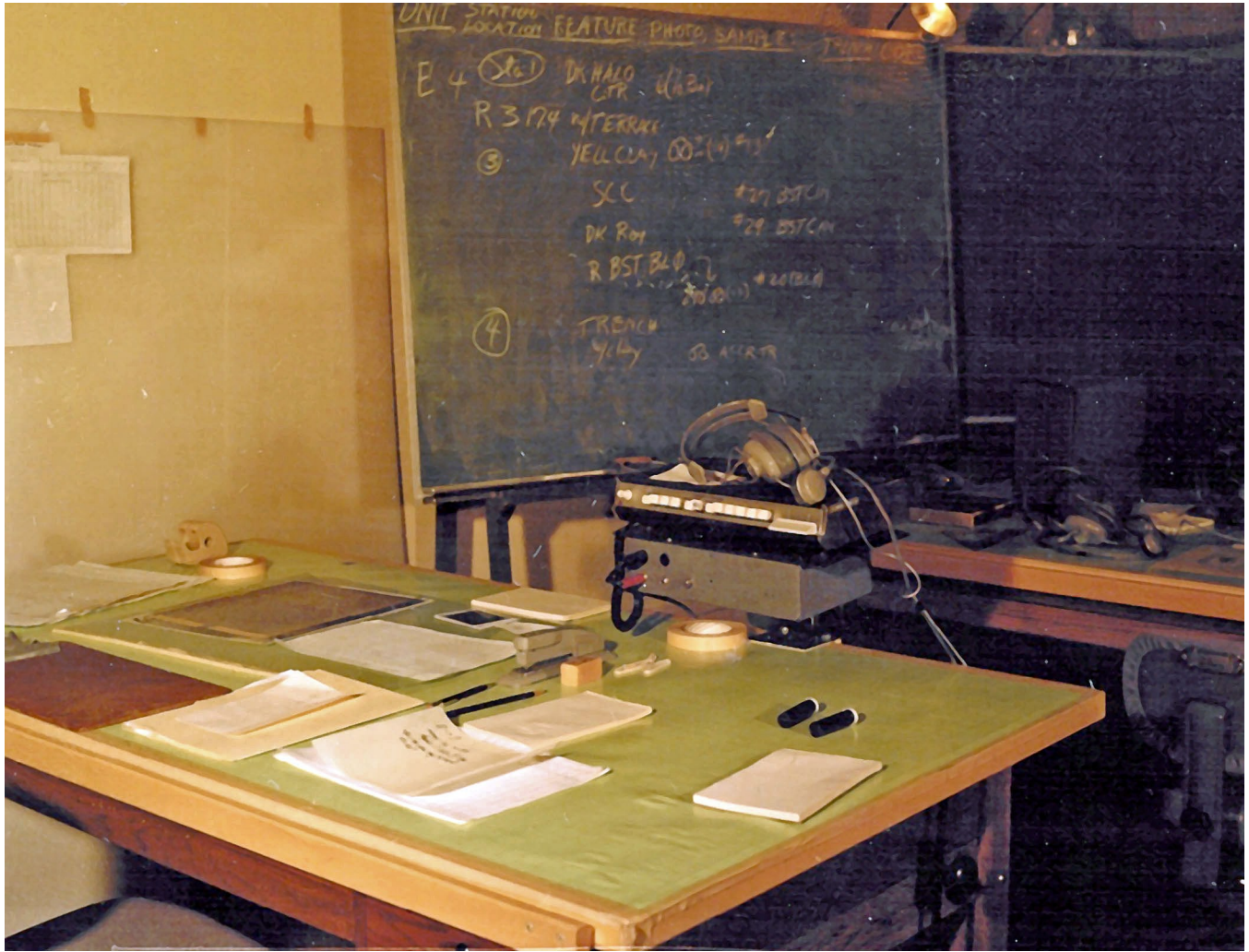


Figure 54-(b) blackboard and drafting/plotting tables for plotting on maps inside the ADF; USGS photo P620, F668300c



Figure 54-(c) overhead projector and screen for real-time sketching during field traverses; USGS photo P620, F668297c

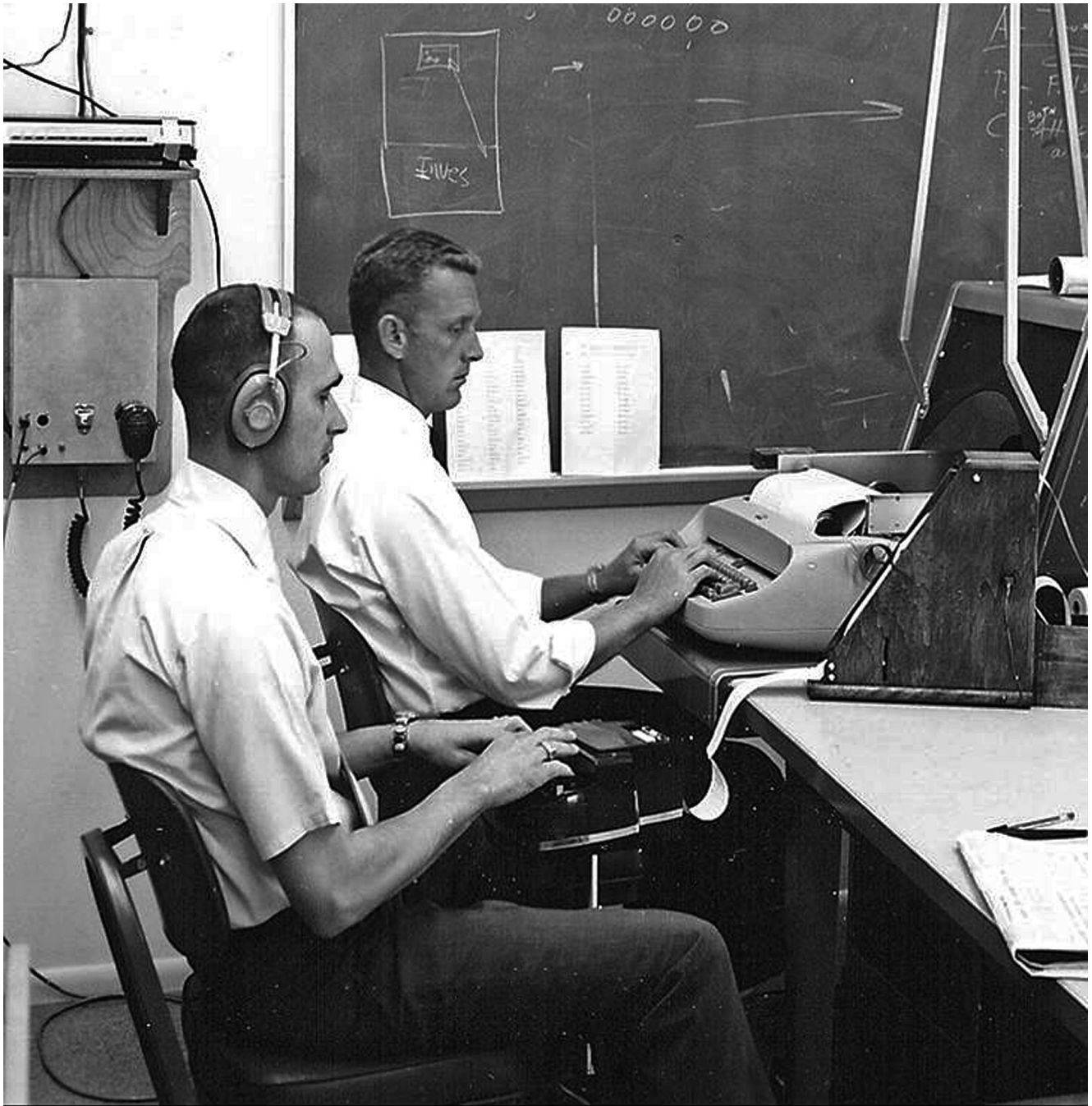


Figure 54-(d) Flagstaff Superior Court Reporters Keith Welsh (at typewriter) and Don Thacker (hidden from full view) at Stenography machine; they both were used with the USGS Apollo Geology Field Experiment Team during all Apollo lunar-landing missions at Mission control, Houston; USGS photo P599, F66811.



Figure 55-Gyrocompass-powered navigational system installed on Explorer vehicle at Flagstaff in July 1968; (a) Dick Wiser from the Branch of Surface Planetary Exploration's Field Test Support Group (Flagstaff) driving Explorer with gyrocompass navigation X-Y plotting board installed in front; USGS photo P629, F76846



Figure 55-(b) Close-up of navigation X-Y plotting board on Explorer; USGS photo P629, F76845

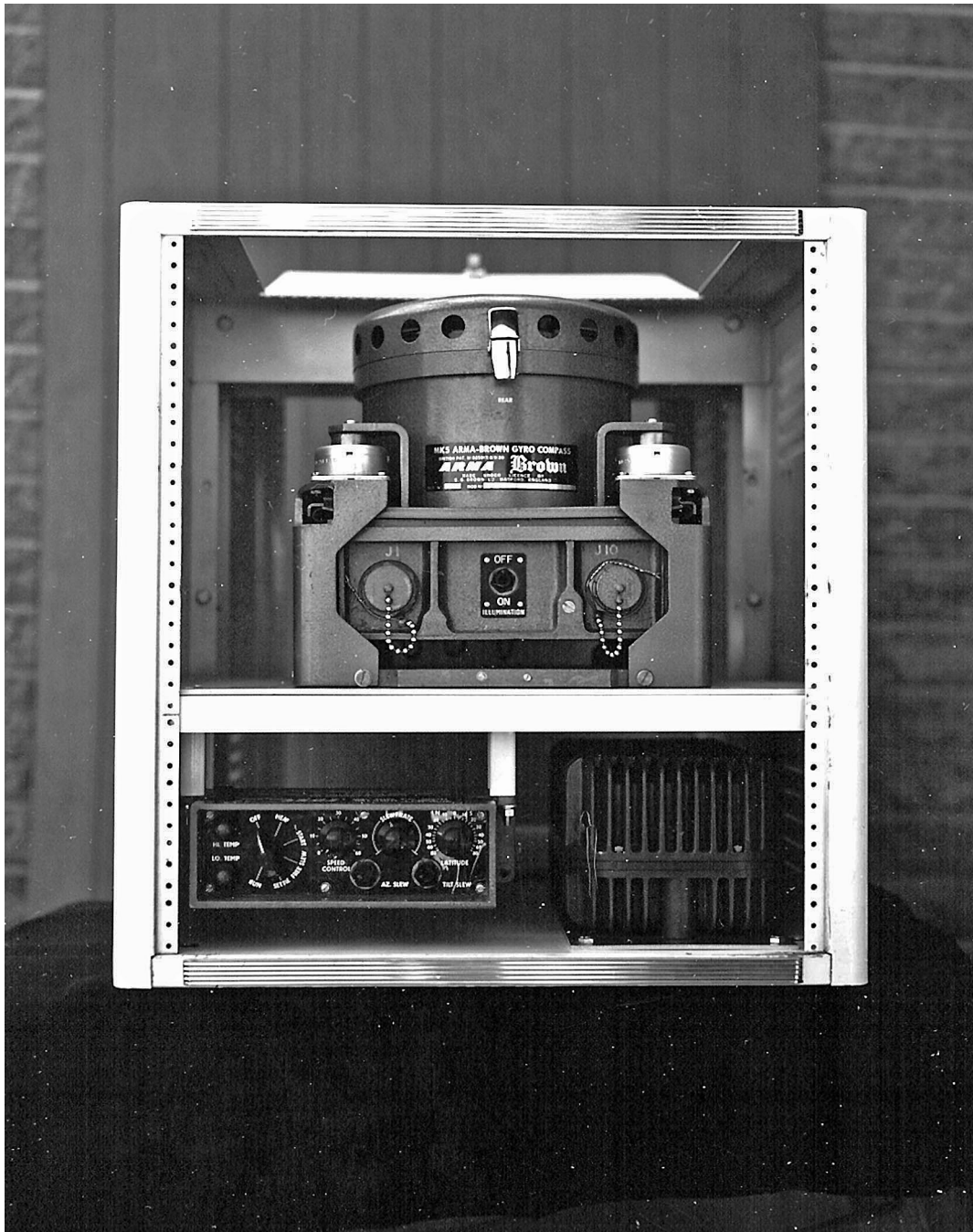


Figure 55-(c) View of gyroscope and other electronics that control navigation system; USGS photo P629f, F76843.

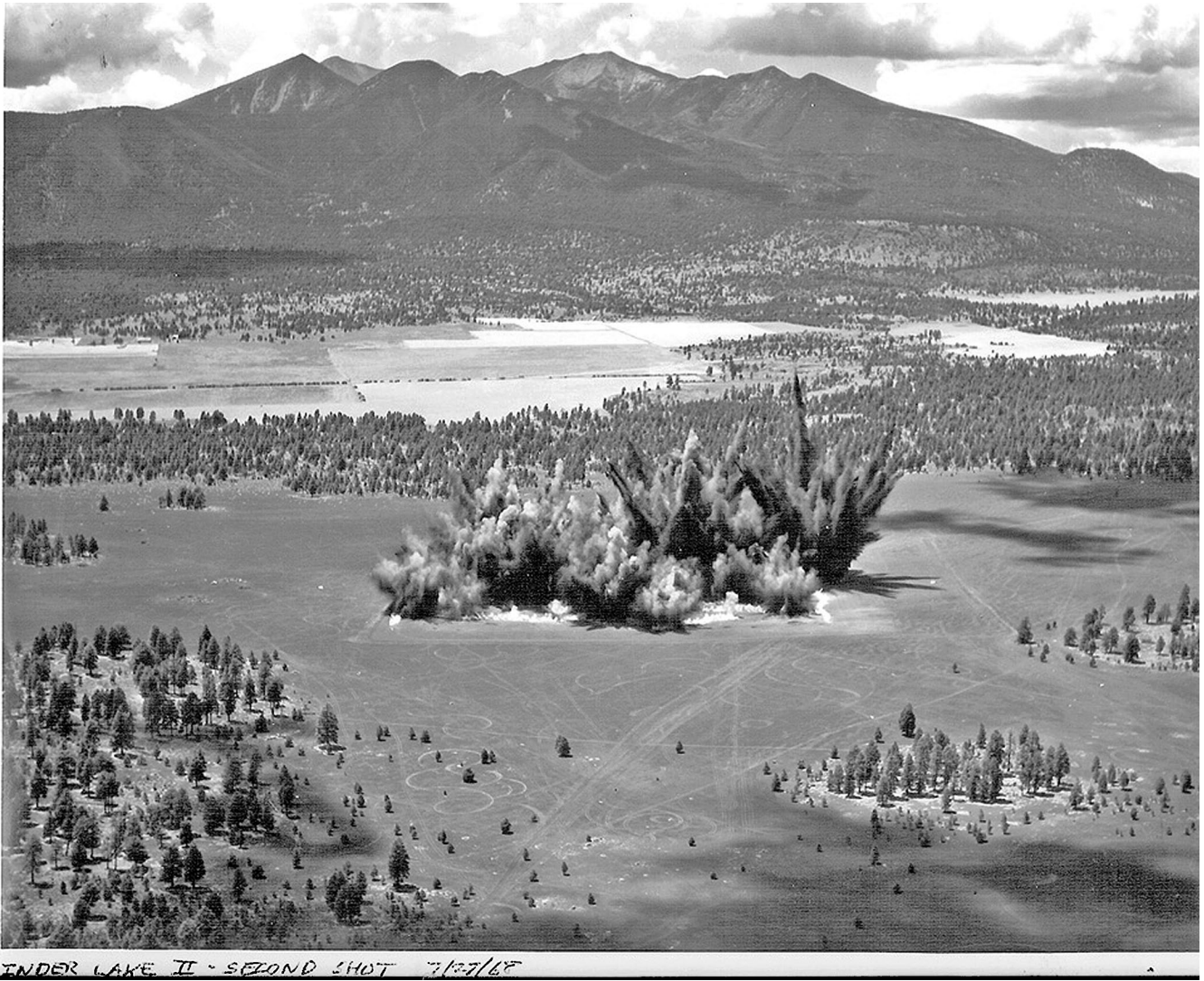


Figure 56-Construction of Cinder Lake Crater Field #2 on 27 July 1968; (a) aerial view of firing of sequence one of 354 craters during construction of Cinder Lake Crater Field # 2; USGS photo 768227-3



Figure 56-(b) surface view of the firing of sequence two (61 craters) of “intermediate age” during the construction of Cinder Lake Crater Field 2; USGS photo P642 F768215



Figure 56-(c) aerial view of the firing of sequence three of 11 craters in Cinder Lake Crater Field 2; USGS photo P645, F768228-8

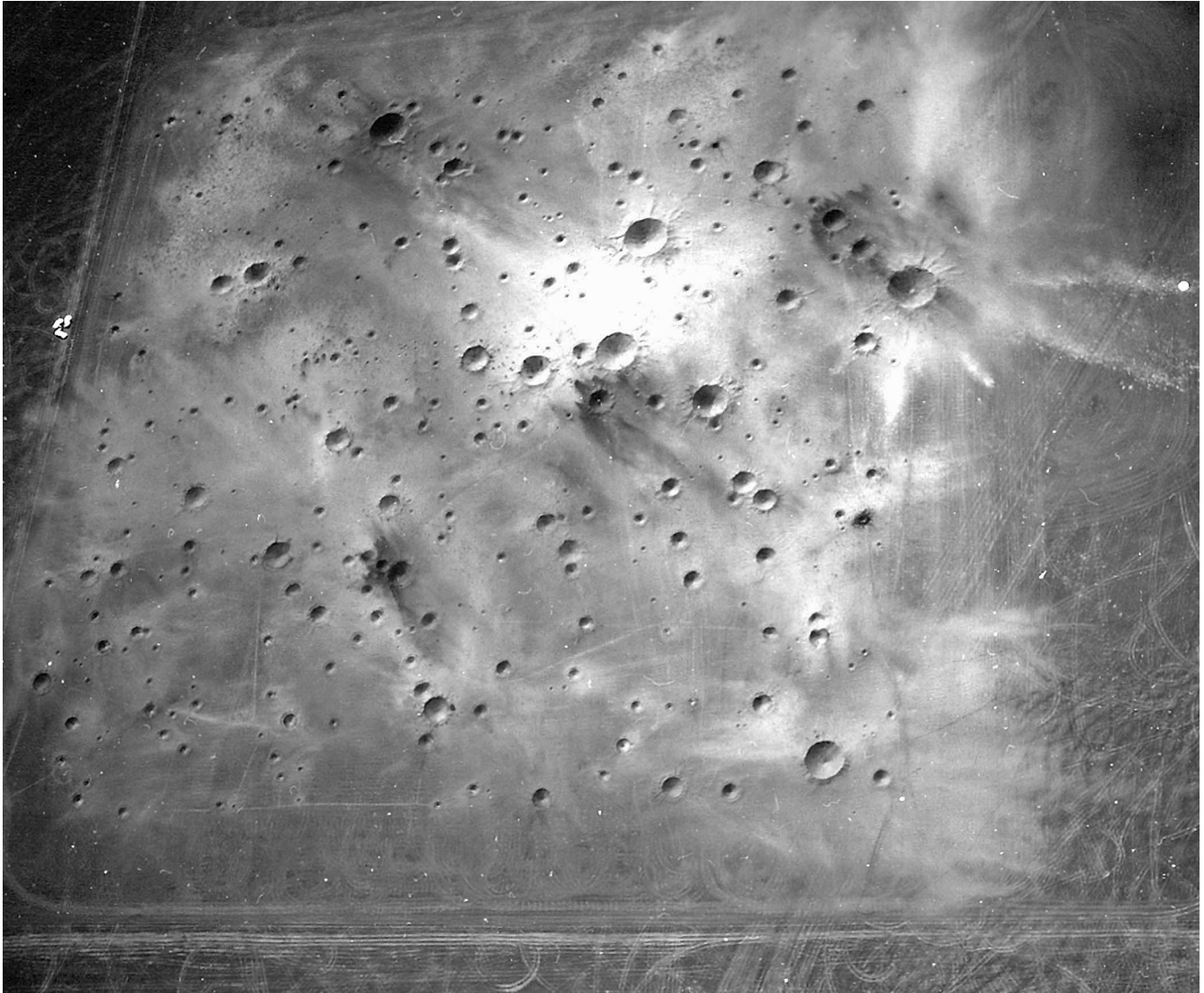


Figure 56-(d) post-explosions aerial view of the completed Cinder Lake Crater Field 2, showing very light ejecta caused by excavation of clay beds immediately below black, basaltic, cinders deposited during the last eruption from nearby Sunset Crater in 1064 AD; USGS photo P645, F768228.

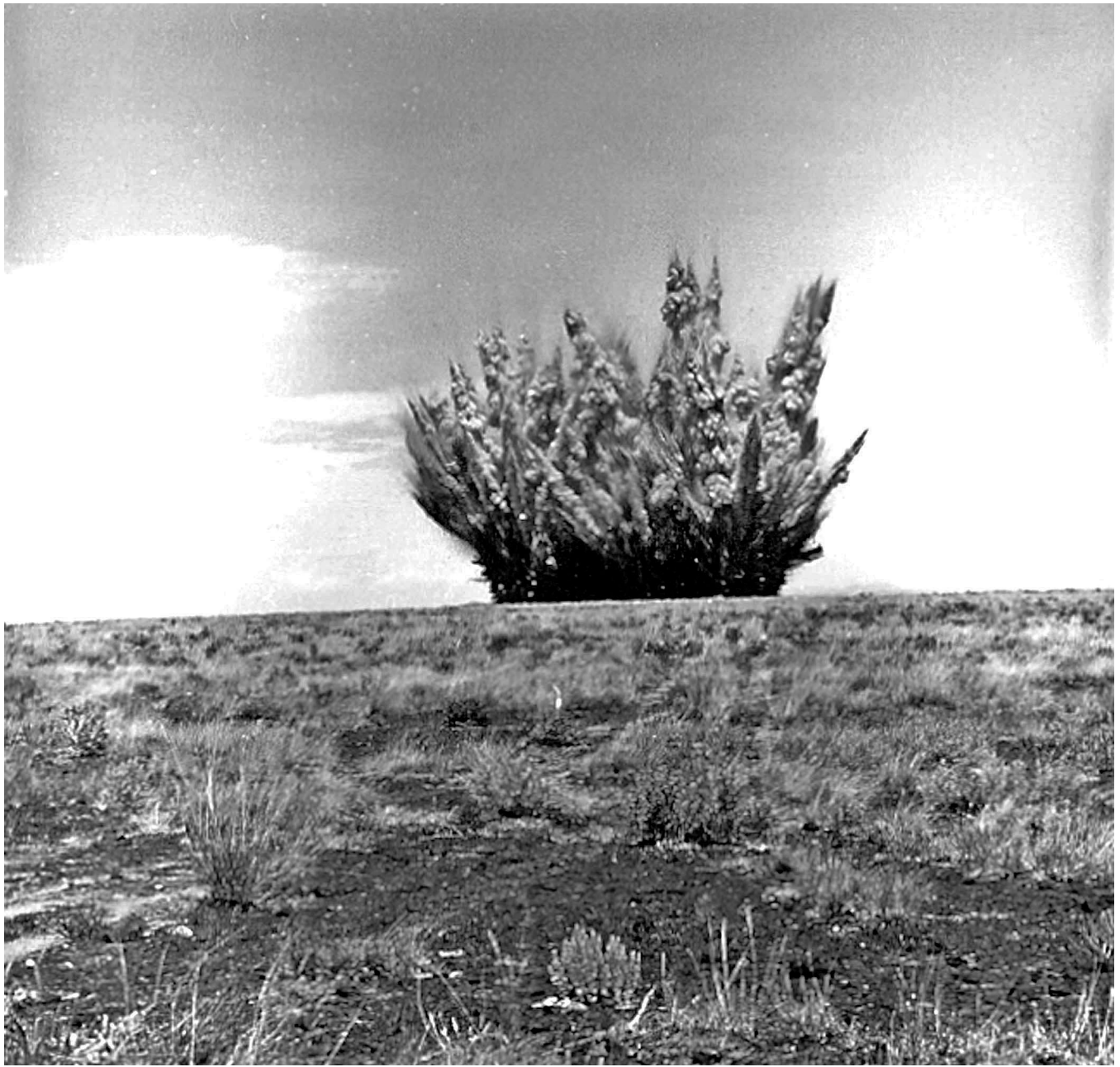


Figure 57-Explosion on 1 August 1968 of large test crater on the surface of Black Point Lava Flow; Black Point Flow, located along the Little Colorado River on U.S. 89 N. north of Flagstaff, Arizona, in part of the Spider Web Ranch managed by Flagstaff's Babbitt family; USGS photo P669, F868147.



Figure 58-Explorer geophysics test at Cinder Lake Crater Field, Arizona in December 1968; (a) John Hendricks, being fitted in Disney “space suit” by Bill Tinnin (Field Test Support Unit of SPE Branch); USGS photo P726c, F126846c



Figure 58-(b) John Hendricks (in suit) along with l-to-r, Dick Wisner, Bill Tinnin and Putty Mills (all Field Test Support Unit of SPE Branch) standing by Explorer vehicle with San Francisco Peaks in background; USGS photo P726c, F126845c



Figure 58-(c) John Hendricks attending to Explorer vehicle; USGS photo P726c F126842c.



Figure 59-Gene and Carolyn are shown at the going away party thrown for them by the City of Flagstaff when they left for Caltech in the fall of 1969. Gene had recently accepted the position of Chairman of the Geology Division; USGS photo.