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## II. Astronaut Geology Training

We began the geology training course with 29 astronauts. John Glenn attended some of the early classes, but was not formally included since he had other obligations and was not expected to fly in the Apollo program. We began with lectures by a variety of instructors. The topics were introductory physical geology, mineralogy, petrology, and the Moon. These were presented mostly by the MSC staff and the USGS geologists. The quality of the lectures was uneven—some were good, some were awful. Some of the class members complained about a few of the instructors, and the list of lecturers was revised accordingly. The astronauts were very busy people. They had many other training courses and things to do besides study geology. We could not afford to waste their time with poorly prepared or badly presented material—this was made abundantly clear. Furthermore, the crew were not really very interested

in general background; they wanted to get the information they needed for observing and collecting rocks on the lunar surface. My first lecture was delivered in February 1964. I had to cover everything they needed to know about mineralogy in a one-hour lecture. This was a tall order. I got through the material, leaving a lot of gaps out of necessity, but the astronauts seemed satisfied. I kept the roll sheet from this first class as a souvenir.

A wide range of academic ability, background, and interest existed among the group. Although we continued to lecture from time to time, we found that intensive instruction on field trips was more productive. Each instructor was assigned two or three astronauts as his students for each field trip or field exercise. That way the astronauts were not as shy about asking questions, and the instructor got to know the strengths and weaknesses of each one. We commonly made three field trips out of one. That is, all the geologist instructors, including an expert on the local area, took one trip to outline the work and compile the program. Then, usually two trips were taken with different groups of astronauts because all of them could not get together simultaneously. As crew members were named for the Gemini Program flights, we commonly lost students until after their flights. With five Gemini flights in 1965 and another five in 1966, each with a two-man crew, we were challenged to provide continuity in the instruction, but we did the best we could.

We chose a set of field trip sites where there would normally be two to three days of instruction. We started with basic sites and progressed to more complicated areas and exercises. For our first field trip we selected Grand Canyon. Although this area bears no resemblance to the moon, it provides an excellent "classroom" for teaching elementary principles of stratigraphy, geologic mapping, and air photo skills. In addition, the Grand Canyon is such a scenic place that we hoped to get even the most reluctant astronaut students "hooked" on the charisma of geology and field work. Also, we could count on the help and cooperation of the Park Service in a national park.

We were pressed for time to get the canyon field trip organized.

We flew to Flagstaff and drove to the south rim. We had only one day in the canyon to plan the exercises. This meant we had to hike down and back out on the same day. We made it, but by the time we changed airplanes in Phoenix, we were hobbling around with muscle pains, leg cramps, and blisters. We could only laugh at what we must have looked like.

The astronauts' better physical condition annoyed the geologists throughout the geology training course. Some of the instructors started running and exercising regularly, but it always seemed the astronauts were far ahead of us. It was particularly difficult to go from sea level in Houston to field trip localities at higher elevations. In the end, it was just a fact of life we had to accept.

Near the end of March 1964, the astronauts went on the canyon field trip, arriving with a NASA-MSC public affairs officer, Paul Haney, and a couple of NASA photographers. Several local news media representatives also were present. Everywhere we took the astronauts, the local press had to be accommodated with information, photographs, and press conferences—a continuing problem for the field trip instructors.

We hiked down the Kaibab Trail from the south rim and returned by hiking up the Bright Angel Trail to Indian Gardens, where we rode mules the rest of the way out. Mike Collins and Roger Chaffee were my students for this exercise (Photo 4).<sup>8</sup> They were willing students who had no trouble grasping the concepts we wanted them to understand. The weather was beautiful, as was the canyon. For the geologists and astronauts it was an enjoyable experience, and there was quite a bit of good-natured horsing around (Photo 5). The field work started on good footing. As we reached Indian Gardens on the way out, some of the astronauts decided to continue hiking and refused to ride mules. This small but determined group was led by Al Shepard.

Feedback from the first field trip was positive. The astronauts

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<sup>8</sup>For additional information and a more comprehensive view of the astronaut training program, see R. R. Gilruth, "The Making of an Astronaut," *National Geographic*, vol. 127, no. 1 (1965): 122-144.



Photo 4. Astronauts Mike Collins (left) and Roger Chaffee (right) at the "Great Unconformity" in the inner gorge of Grand Canyon. Thinly bedded Paleozoic sedimentary rocks unconformably overlie much older igneous and metamorphic rocks that are deeply weathered. (Photograph by the author)



Photo 5. Astronaut Walt Cunningham trying to use NASA Public Affairs Officer Paul Haney (with hat) as a "mule" for his descent into Grand Canyon. (Photograph by the author)

much preferred this form of instruction to formal lectures and classes. The geologist instructors agreed that a lot of teaching and learning had been accomplished in the field with relative ease.

In April, we held another field trip to the Marathon Basin and Big Bend of Texas, with Muehlburger as the local expert. The weather was already warm and sunny in far West Texas. There, we continued to emphasize stratigraphy, but also taught some structural geology and introduced volcanic rocks (Photo 6). Like the Grand Canyon, Big Bend is a beautifully wild place, particularly in

the springtime before the full heat of summer arrives (Photo 7). On the preliminary trip to Big Bend, I began to feel ill. I was having difficulty concentrating and was suffering



Photo 6. Field party of astronauts and geologist instructors examining an outcrop of ash-flow tuff near Three Dike Hill west of Big Bend National Park. (Photograph by the author)



Photo 7. Astronauts Ed White (left) and Tom Stafford (right) along the highway in the low desert of Big Bend National Park. (Photograph by the author)

from dizziness. When we arrived in Terlingua, an old ghost town that was once a mercury mining center, I drank a couple of cold beers, but they didn't help at all. I was eager for the day to end. It finally ended in Alpine, where I visited a local doctor who diagnosed my illness as mumps, which I never had as a child. This was not a popular diagnosis, since several of the geologists didn't remember ever having mumps. The group lined up for gamma globulin shots as a preventive measure! I was fortunate to experience no complications and was back in action in plenty of time for the trip with the astronauts.

Most of the NASA group arrived in one of the NASA aircraft at Marfa, Texas (Photo 8), where we had to make a low pass over the runway to frighten away the antelope before landing. We proceeded via rented cars to the field trip areas. The rental cars were standard four-door sedans, not well-suited for the unimproved roads, and were returned to the rental agency looking quite a bit worse than when we picked them up. The rental car agent was unconcerned. He simply said in a long, west-Texas drawl that he was "proud to be helpful to NASA."



Photo 8. NASA passenger aircraft on the runway at Marfa, Texas. Surrounding the Grumman Gulfstream are astronauts, geologists, onlookers, and rental cars. (Photograph by the author)



Photo 9. Local observers (right) watch geologists and astronauts making a "booze run" in a Mexican border town. Astronaut Scott Carpenter is seated on car fender at left, having already made his purchase. (Photograph by the author)

There were many lessons to learn in Big Bend. One was discovered by Neil Armstrong, who hit a basalt outcrop with his rock hammer and was cut slightly on the arm by a flying rock chip. This was not the correct way to collect rock samples, either on the Earth or the Moon. Even a small cut in a space suit could have serious consequences. Wally Schirra spent a lot of time with his Haselblad "documenting" samples he collected or photographing important rock outcrops. In the cool evening, we enjoyed a few beers, a good Tex-Mex dinner, and a couple of poker games. On our way back to Marfa to board the NASA aircraft, a number of us crossed the Rio Grande into Mexico to make a "booze run" (Photo 9), taking advantage of duty-free, low Mexican prices.

About mid-year we arranged a trip to the Philmont Ranch in New Mexico, another scenic locality with good local logistical support. Jeeps were reserved from a military motor pool, there were comfortable cabins where we could stay, and breakfast and dinner were served in the cafeteria. The ranch was operated as a retreat

and summer camp for Boy Scouts. The Philmont personnel were accustomed to catering to large groups, so our party would not strain their facilities. They were genuinely anxious to accommodate us in any way they could.

I was unable to arrive at Philmont with the rest of the group, due to a committee meeting I had to attend at the Jet Propulsion Laboratory, so I flew from Los Angeles to Albuquerque and drove to Philmont in a rented car. I had asked for the standard government-rate vehicle, but the agency was almost out of cars. They agreed to let me have a new Chevy Malibu super sport convertible for the same price. It was early evening of a clear cool night. On the radio I found Eugene Ormandy and the Philadelphia orchestra just beginning to play *Scheherazade*. With the top down and little traffic north of Santa Fe, the drive was memorable. Around one curve in the mountains I suddenly came face-to-face with eight deer crossing the highway. I braked and dodged—so did some of the deer. The others leaped straight up into the air. Somehow we missed each other, but I drove on at a considerably slower speed.

The geology at Philmont was pretty simple with excellent exposures of igneous and sedimentary rock types. The astronauts oriented themselves on geologic maps (Photo 10), measured and described stratigraphic sections (Photos 11–12), took strike-and-dip measurements, and recorded lots of field notes under close supervision (Photo 13). I spent most of my time working with Ed White, Jim Lovell, Roger Chaffee, and Al Bean, who were all good students.

Bean had heard tall stories from the locals about gold in the immediate area, and he wanted to try to pan. We didn't have any gold pans, but Bean improvised with an automobile wheel cover and an aluminum pie pan. Bean asked me to pick a place where I thought, as a geologist, that he could find gold. I told him that if I knew how to do that I would be cooling my heels on the French Riviera, rather than wandering around in the New Mexico woods. Undaunted, Bean found a place where he could pan without getting too wet (Photo 14). He was jubilant when he found some gold-col-





Photo 10. Geologists Dale Jackson (left) and Uel Clanton (light western hat) explain geological map to astronauts (left to right) Al Bean, Neil Armstrong, Bill Anders, and Roger Chaffee at the Philmont Ranch in northern New Mexico. (NASA photograph S-64-23876)

Photo 11. Astronaut Al Bean resting with his Jacob's staff at the top of a stratigraphic section that he has just measured and described near the Philmont Ranch in northern New Mexico. (Photograph by the author)



Photo 12. Astronauts Roger Chaffee (left) and Dave Scott look over the way to the top of a stratigraphic section they are measuring and describing as a field exercise near the Philmont Ranch in northern New Mexico. (Photograph by the author)

Photo 13. Astronaut Jim Lovell (left) taking a strike-and-dip measurement while the author observes. (NASA photograph S-64-23849)



Photo 14. Astronaut Al Bean attempting to pan for gold along a small creek near Philmont Ranch in northern New Mexico. (Photograph by the author)

ored flakes in his pie pan, but quickly came back to Earth when I identified his "gold" as weathered biotite, a black mica mineral that can weather to a soft yellow color but is much more brittle and much less dense than gold. During conversation at the side of the stream while "prospecting" for gold, Bean and I discovered that we had both gone through Navy ROTC at the University of Texas. Bean had been in the class two years ahead of me, but for some reason we never met during our two years of overlap at UT.

The lighthearted moments at Philmont were special. White dared the other jeeps to a race back down the mountain at the end of the day. He started off, and the challenge was quickly taken up by the other jeeps loaded with astronauts and geologists. This was not the most prudent activity for a narrow mountain road, especially with the lead jeep stopping quickly from time to time to roll a boulder or drag a dead tree into the road.

During one field exercise, Lovell suddenly pretended to be overcome with emotion over geology and the great outdoors. He placed a mountain lily behind his ear, clasped his rock hammer to his breast, and managed a most noble expression (Photo 15).

At the end of one day, we stopped at a little beer joint in Cimarron. We were tired and dehydrated, and a couple of beers caught up with us in a hurry. Pete Conrad started telling jokes and kept the group completely entertained for 40 minutes. We especially liked his pilot jokes, but he soon started telling geologist jokes adapted from Texas "aggie" jokes. He was hilarious. Conrad could always work as a stand-up comic if he decided to give up the astronaut business.

Another day we stopped at a private museum dedicated to Kit Carson. Armstrong and I had plenty of time, so we decided to see the exhibits. They were interesting enough, but the real find was an old airplane tucked away in a corner of an old building. The plane had a wooden frame, and most of the canvas was rotted off so all the control cables and other guts of the machine were visible. Inside was a tiny internal combustion engine that looked barely capable of turning the prop. Armstrong was fascinated. It was a strange con-

trast to see a former X-15 rocket pilot admiring an antique open-cockpit, stick-and-rudder craft. He clearly liked flying machines.

When the Philmont trip was over, I had to drive back to Albuquerque to turn in my rental car. It also happened that Mike Collins needed a ride to Albuquerque. He had flown a jet to the Air Force base in Albuquerque on the way out, and his ride back to



Photo 15. Astronaut Jim Lovell mugging for the camera in an "inspired" moment during a field exercise at Philmont Ranch in northern New Mexico. Note geologist's pick, hand lens on chain around neck, and flower. (Photograph by the author)

Albuquerque had to leave the trip early. We arrived at the Air Force base where I delivered Collins to his plane. I asked him some questions about airplanes, and he offered to show me a few things while he did his ground and cockpit checks. He performed a thorough check and then took off. I had never realized how simple small jet aircraft are. They are such elegant little craft, and it is easy for me to understand why some aeronautical engineers and pilots are so enthusiastic about them.

Field trips followed to the Bend, Oregon, area (Photos 16-19) and to Valle Grande, near Los Alamos, New Mexico, to study different types of volcanic rocks. Both were excellent study areas, but working in the Valle Grande region was especially strenuous physically. Astronaut Ted Freeman (Photo 20) sprained his ankle badly. A short time later, on October 31, 1964, Freeman was killed in a flight accident near Ellington Air Force Base when his plane collided with a flock of geese.



Photo 16.  
Astronaut Rusty  
Schwieckart  
examining a pumice  
fragment with a  
hand lens in the  
Newberry Caldera  
near Bend, Oregon.  
(Photograph  
by the author)

Photo 17. Geologist Dr. Aaron Waters (left) lecturing to group of astronaut students near Bend, Oregon. Astronaut students are Al Bean (rear, dark cap), Charlie Bassett (light western hat), Buzz Aldrin (bareheaded), and C. C. Williams (behind Aldrin in light parka). (Photograph by the author)



Photo 18. Group of astronauts and geologists examining a large lava tube near Bend, Oregon. (Photograph by the author)

Instruction at Meteor Crater, Arizona, and at the Atomic Energy Commission Nevada Test Site (NTS) helped prepare the astronauts for dealing with impact craters. Meteor Crater is the most recent and best preserved terrestrial impact crater, and the Sedan Crater at NTS showed many features peculiar to explosion craters, such as an overturned rim. Shoemaker, of course, was the local expert for the Meteor Crater trip. He did an excellent job of relating this structure to the impact craters on the Moon, despite the fact that Meteor Crater is formed entirely from sedimentary rocks. The overturned rim, surrounding ejecta deposits, and fall-back units could be clearly identified, and the astronauts performed independent exercises to identify and document these and other features (Photos 21-22). Some years later, a group of astronauts toured the Ries Crater in southern Germany to see the structures and breccia textures associated with a much larger (24-kilometer diameter) impact structure.

Photo 19. Astronaut Elliott See inside a large tree mold in a basalt flow in southern Oregon. (Photograph by the author)





Photo 20. Astronaut Ted Freeman discussing with a colleague the orientation of a layer of rock in Valle Grande near Los Alamos, New Mexico. (Photograph by the author)



Photo 21. Astronauts Charlie Bassett (left) and Roger Chaffee making and recording field observations on the rim of Meteor Crater, Arizona. (Photograph by the author)



The Hawaiian Islands offered an incomparable display of recent basaltic volcanic features. Here, except for the abundant plants and the lack of meteoritic impacts, both rough and smooth surfaces of lava flows could be compared to the Moon's surface. The landscape of the higher elevation portions of the "Big Island" could be matched only by that of central Iceland, which we visited some months later. The charm of Hawaii lured even the least interested student into remaining relatively alert and inquisitive. In January 1965, it was hard not to be excited about standing on an active volcano. Also, the astronauts were eagerly anticipating the first Project Gemini flight launch, with Gus Grissom and John Young on board, which was only two months away.

In order to study more silica-rich pyroclastic rocks, we went to Katmai National Monument in Alaska, where a huge explosive eruption of pumice and ash had filled the sky and river valley in 1912. Coming from the crater Novarupta, the eruption had drained support from under Mt. Katmai, causing the summit to collapse,

Photo 22. Group of geologists, geophysicists, and astronauts observing a geophysical data "shot" on the floor of Meteor Crater, Arizona. (Photograph by the author)





Photo 23. The author (left) with astronauts C. C. Williams and Bill Anders taking photographs on the rim of Novarupta Crater, Mt. Katmai National Monument, Alaska. (Photograph by the author)

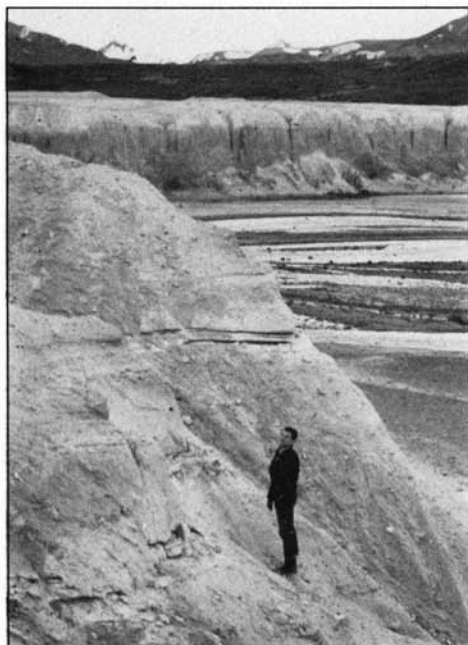


Photo 24. Astronaut Charlie Bassett observing layering and grain size in the toe of the ash-flow in the Valley of Ten Thousand Smokes, Mt. Katmai National Monument, Alaska. (Photograph by the author)

thereby reducing the height of the mountain by 1,500 feet (Photo 23). The ash flow deposit from the eruption had so many fumaroles and vents discharging steam that it became known as the "Valley of Ten Thousand Smokes," though no fumaroles from this deposit are active now (Photos 24–25).

We stayed at Brooks Lake Lodge and were flown each day to our exercise area on the ash flow deposit. Transportation was provided by helicopters of the Air-Sea Rescue Group based at King Salmon (Photos 26–27). Some of the flight equipment made me a little nervous because it had been pretty badly shot up, probably in southeast Asia. Though neatly patched, it was clearly stenciled "UNFIT FOR COMBAT SERVICE." The pilots knew their business,

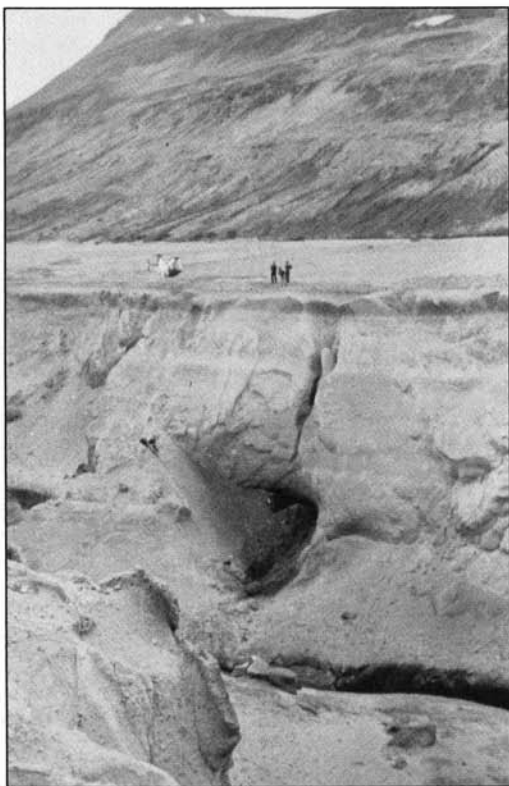


Photo 25. Field party of astronauts with instructor observing structure of the ash-flow visible in the wall of a steeply eroded arroyo on the top of the ash-flow in the Valley of Ten Thousand Smokes, Mt. Katmai National Monument, Alaska. (Photograph by the author)



Photo 26. The fleet of air-sea rescue helicopters that provided the field transportation in Mt. Katmai National Monument, Alaska. (Photograph by the author)

however, and our helicopter rides to and from the field areas were uneventful.

The locality itself was also not without its hazards. Each evening a large bear made its way through the camp on the way to the garbage dump. We looked around carefully before walking between the dining room and the cabins. Although the bear probably would have ignored us, avoiding confrontation seemed the best policy.

One of the photographers was an avid fisherman, and with a brook full of rainbow trout and arctic grayling nearby, he was up at six every morning, tickling the water with dry flies. We all appreciated his rapport with the fish when, with the help of the cook, he provided us with a rainbow trout breakfast.

As on previous trips, we had the astronauts play the "Moon game." A pair of astronauts were placed in a field location and instructed to pretend they were on the Moon. Then they had to carry out the most important field observations: planning traverses and collecting samples. The astronauts spoke into a radio-microphone while we taped their transmissions for critical evaluation. It was an instructive exercise, and some competitive spirit quickly developed between different pairs of students. Some of the astronauts were



Photo 27. The astronauts and instructors taking a lunch break near the helicopters on top of the ash-flow in the Valley of Ten Thousand Smokes, Mt. Katmai National Monument, Alaska. (Photograph by the author)

convinced they would have a better chance of being selected for a lunar surface mission if they performed well in the geology training course. While this perception was perfectly reasonable, I never found any evidence of this factor in the crew selection process. Comments regarding the abilities of different astronauts were off the record and were only informally passed among the geology instructors. The flight crews appeared to be selected by Deke Slayton and Al Shepard, with Dr. Chuck Berry, the chief medical officer, empowered with final veto. Little other input seemed to bear on the selection process.

In June 1965, the selection of six "scientist astronauts" was announced by NASA, yielding to increasing pressure from the scientific community. The candidates selected had been nominated by the National Academy of Sciences and had passed numerous medical examinations. Among the group was my old schoolmate from Harvard, Jack Schmitt, the only scientist-astronaut in the group whose scientific training was in geology. The scientist-astronauts had to take jet flight training as their first task, an activity that caused considerable anxiety for some of them. We didn't see much of them for the first few months.

Early in September 1965, we camped out with a group of astronaut students in the highlands near Medicine Lake, California. Dr. Aaron Waters was the local expert in this area, as he had been in Oregon. Field exercises included the standard "Moon game" and some independent mapping. Because we were camped a long way from civilization, we had a lot of time on our hands in the evenings. Poker games became the standard recreation. You can tell a lot about a man by how he plays poker—at least you think you can. For most of us, playing poker was nothing more than diversion, with too little money at stake for anyone to take it seriously. But Buzz Aldrin came from somewhere else. He could not believe that Chaffee or I could bet 50 cents foolishly, with a pot of three dollars on the blanket, just to try to confuse him. Aldrin had earned a doctorate in astronautics from MIT, and he played poker with the same logical, methodical technique that he had pursued academics. We had to cut the Medicine Lake trip short because a hurricane was approaching Houston and we needed to get back in time to secure our homes and families.

We took one of our best field trips to Iceland. If you want to go to a place on earth that looks like the Moon, central Iceland should be high on your list, as it beautifully displays volcanic geology with virtually no vegetation cover. The summer climate is mild and cool—particularly enjoyable if you just walked off the plane from Houston.

It was a long flight from New York to Iceland, and the airline was very generous with the liquor. We got off the plane in dense fog and stumbled around until someone found the way to the terminal. We checked into the Bachelor Officer's Quarters (BOQ) at the air base, got a few hours sleep, and went to a cocktail party and reception hosted by the base commander. It was a great party, but seemed to go on a long time. Several times I looked out the window to find that it was still daylight. So, I thought, it can't be too late, but I had forgotten how far north we were. Finally, I just couldn't party any longer and made my way back to the BOQ, feeling low in spirit because I didn't have the "staying power" the astronauts had.

When I arrived at the BOQ, I found Charlie Bassett—clearly out of it—talking to himself in the hall. I helped him find his room and a cot and then went to my own room feeling much better.

Our field exercises on the rim of the Askja Caldera went very well. I spent most of my time working with Dave Scott, Gene Cernan, and C. C. Williams. Scott and Cernan were especially adept at

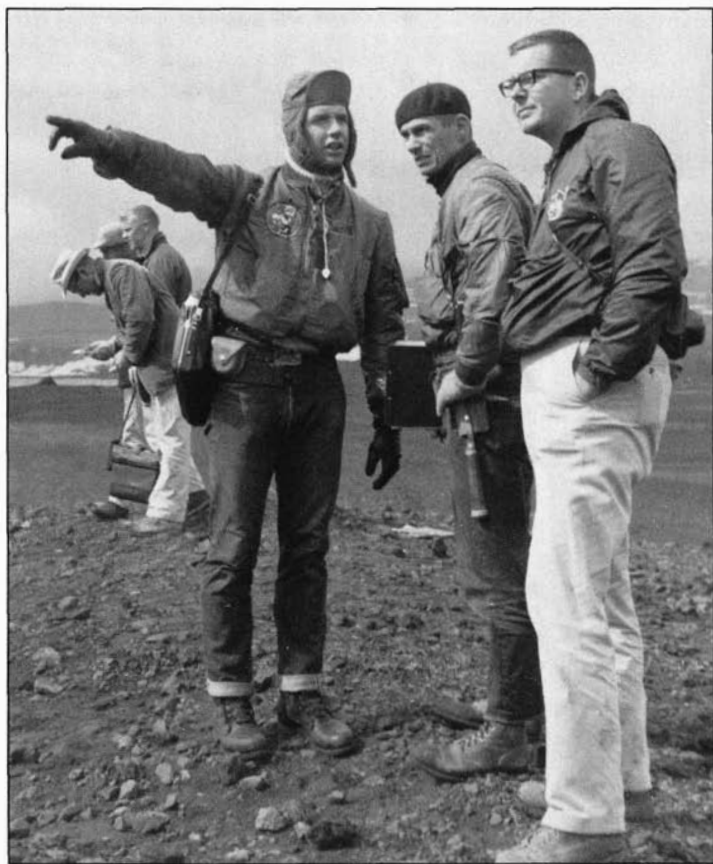


Photo 28. Astronaut Dave Scott pointing out a geologic feature to astronaut Gene Cernan (center) and the author on the rim of the Askja Caldera, Iceland. In the background, geologist-instructor Dr. Don Wilhelms (stooped over) with astronaut Rusty Schweickart and unidentified person. (NASA photograph S-65-39245)



Photo 29. Astronauts Dave Scott (right) and Gene Cernan (black beret) on the steep rim of a small volcanic crater in the Askja Caldera, Iceland. (Photograph by the author)



Photo 30. Astronauts and instructors along steep rim of a small volcanic crater in the Askja Caldera. Field parties are along the same rim as shown from a different vantage point in photo 29. (Photograph by the author)



Photo 31. Astronaut Al Bean climbing up a pile of steaming volcanic cinders in central Iceland. (Photograph by the author)

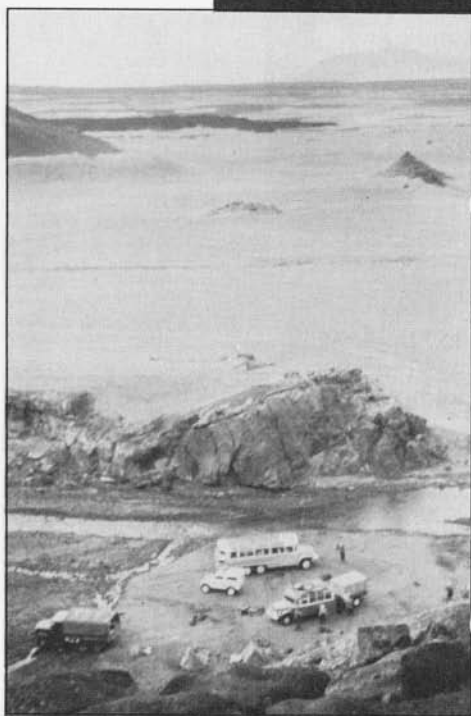


Photo 32. Field parties unloading the bus and supply trucks to set up camp at Drekgil. (Photograph by the author)

unraveling the sequence of geological events along the caldera rim (Photos 28–31). In addition, they knew quite a bit about the rocks.

We spent one night in sleeping bags in a little shelter hut and another night camped out in pup tents at a place called Drekgil (Photos 32–33). While erecting the pup tents, Williams read the proper procedure to us from his Marine Corps manual. He always seemed to have it with him. We had air mattresses to put under our sleeping bags, but the spiny pumice punched holes in them. Consequently, we got very little sleep that night. We also took some trips closer to Reykjavik, where we observed pillow lavas and features of basalt flows (Photos 34–35).

One advantage of working at MSC during missions was having access to the visitor room at Mission Control. However, several thousand NASA employees wanted to enter the visitor room, too. During the most interesting parts of many flights, access to the visitor viewing room was limited to a short period of time. When I mentioned my frustration over this to Ed White, he suggested I try to get into the director's conference room because it had all the most



Photo 33. The finished tent camp at Drekgil, central Iceland. (Photograph by the author)

Photo 34.  
Dr. Gottmunder  
Sigvaldessen (left)  
and astronauts Al  
Bean and Rusty  
Schweickart (right)  
examine the  
detailed structure  
of Icelandic pillow  
lavas. (Photograph  
by the author)



Photo 35. Astronaut  
Bill Anders makes a  
friend in a small Ice-  
landic village. (Photo-  
graph by the author)

important displays and voice circuits. I was reluctant to do so, but discovered if I just went in and sat down everyone assumed I belonged there. An "access list" existed but was rarely checked during the excitement of mission operations. The director's conference room furnished a great seat for following the Gemini orbital rendezvous in December 1965.

The increasingly frequent Gemini flight schedule made it hard to get many astronauts together very often. The pace of the field trips slowed, and we initiated a "tutorial" system. Whenever an astronaut had an unexpected schedule gap, we tried to fill it with some practical rock identification exercise or other lab practice. I was assigned to tutor astronaut Roger Chaffee. Chaffee was an eager and good student. He wanted to keep a petrographic microscope at home, so I procured one for him from the lab. My boss was concerned that we were violating law or policy by placing government equipment in private homes, but we did it anyway. We spent hours going through sets of thin sections and hand specimens, mostly of volcanic and shock-metamorphosed rocks. I was encouraged. If Chaffee landed on the Moon, he would be a capable scientific observer.

On February 28, 1966, astronauts Elliot See and Charlie Bassett were killed in a plane crash in St. Louis. While trying to land in poor visibility, their plane hit a building. Both men were well-liked and had worked hard to prepare themselves for Moon exploration. That didn't seem to matter now, but we knew other crew members would make it for them.

The Gemini Program ended with the flight of Lovell and Aldrin on board Gemini XII in November 1966. As with Project Mercury, Gemini was an almost flawless success. Orbital rendezvous was not only possible, it was practically routine. The Apollo-Saturn "Moon rocket" hardware would soon be prominent at the Cape. The Moon was getting closer.

A routine pad test in January 1967 at the Cape resulted in utter tragedy. Grissom, White, and Chaffee (Photo 36) were killed in a flash fire that swept through the pure oxygen atmosphere of their

spacecraft cabin—a particularly claustrophobic and nasty way to die. We were outraged. It should have been clear to any engineer or scientist that, under high pressure, a pure oxygen cabin atmosphere would turn the slightest flame into a holocaust. It was a terrible error in judgement. I attended a funeral service in Seabrook for Ed White. The church was packed. Virtually all the teary-eyed faces were familiar. We all-too-clearly remembered White and his daring

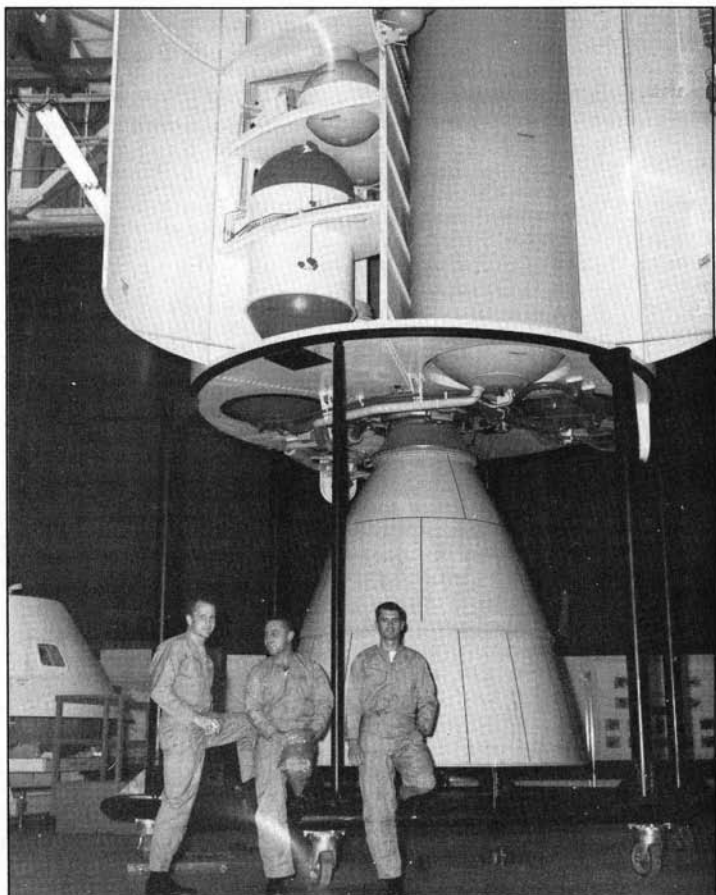


Photo 36. The crew of (left to right) Ed White, Gus Grissom, and Roger Chaffee shortly before the fire that took their lives. (NASA photograph S-66-40190)



Photo 37. Field test of space interface with geology hand tools for lunar missions on a cinder field near Flagstaff, Arizona. (Photograph by the author)



Photo 38. Space-suited technician tests use of prototype geology hand tools for lunar surface missions. Then-future astronaut Jack Schmitt is at the center (hands in pockets) near Flagstaff, Arizona. (Photograph by the author)

space walk. Overhead, a group of jet planes flew in formation with one plane missing. It was one of the saddest occasions I can recall.

Redesign for use of more non-flammable materials delayed the Apollo launch significantly, with the first manned flight scheduled in October 1968. In August, NASA announced the selection of a second group of scientist-astronauts, which included Brian O'Leary, a young planetary astronomer from Berkeley. O'Leary was excited to be at the space center, but his enthusiasm did not last. Only seven months later he resigned from the astronaut corps.<sup>9</sup>

Now and then I was involved occasionally with some lunar surface mission planning for science experiments and experimental space suit interface testing (Photos 37-38), but most of my time was spent with the Lunar Receiving Laboratory and other duties. My association with the astronaut geology training program slowly dwindled as the Apollo program moved ahead.

In October 1967, we heard that C. C. Williams lost his life in a flight accident over Florida. Once again, we were brutally reminded that flying machines are forgiving of neither pilot error nor equipment failure.

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<sup>9</sup>B. O'Leary, *The Making of an Ex-Astronaut* (Boston: Houghton Mifflin Co., 1970).

