APOLLO'S LAST FLIGHT

Poised for lift-off on December 6, Apollo 17 gleamed in the greenish white glare of spotlights. It stood upright like a 36-story white arrow on the launch pad next to its umbilical tower. The only visible movement was oxygen boiling from the tanks and condensing into a vapor trail that undulated lazily before evaporating in the black night beyond the glare.

Suddenly clouds of orange steam and smoke exploded from the pad. The orange became brilliant white and slowly the great bird lifted, the growing white tail illuminating like daylight the surrounding flatlands, lagoons, and estuaries.

There were spontaneous cheers at the news site three and a half miles from the launch pad. The lift-off was beautiful after an unprecedented two-hour and forty-minute delay.

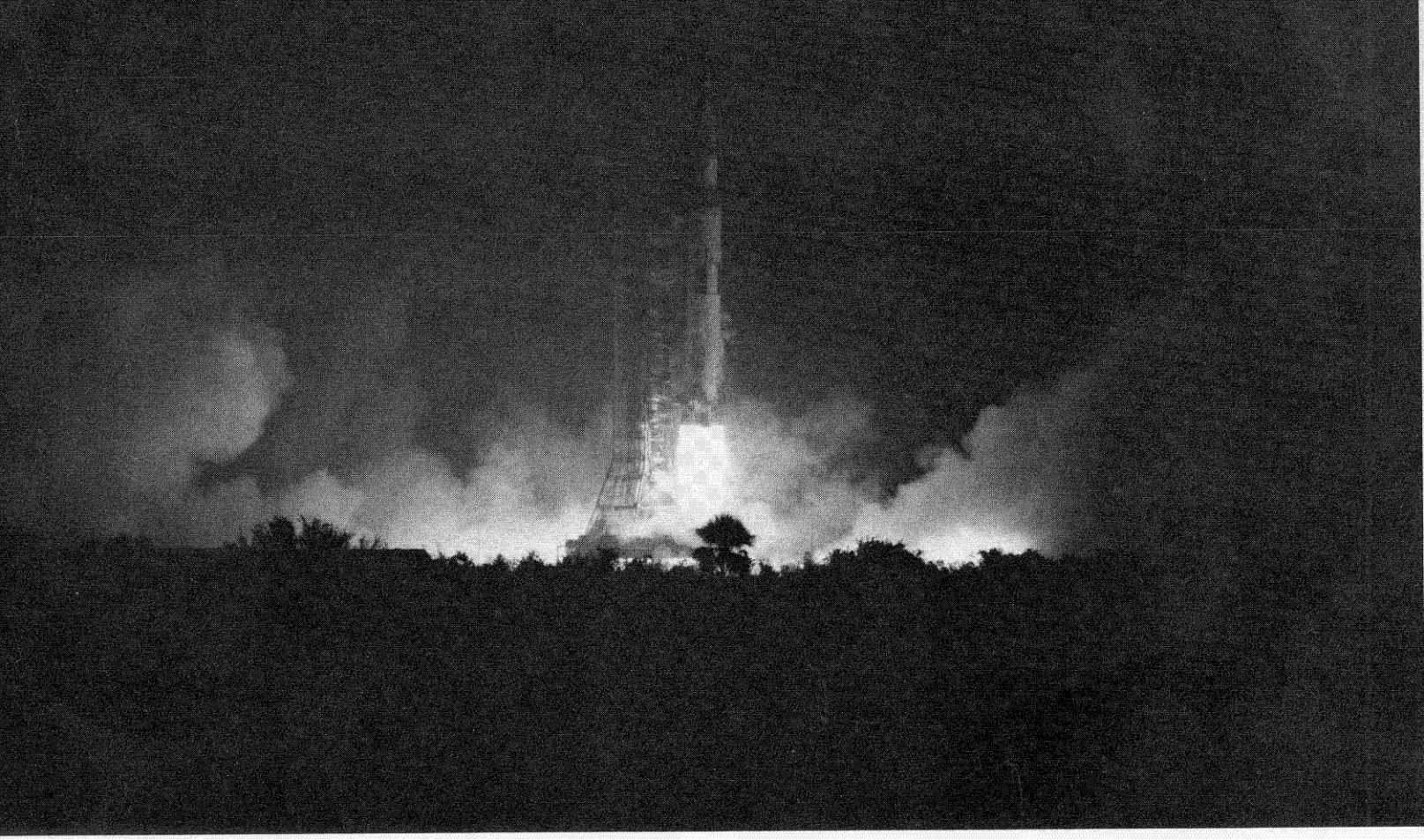
Some neophytes wondered why the lift-off was silent. The wonder was cut in mid-thought as the ground began shaking, accompanied by a low rumble. It was a Cape Kennedy earthquake. As the bird climbed higher, the rumble broke into a great roar that cracked into a thousand fragments like the snapping of countless bullwhips, as shock waves from the Saturn nozzles lashed at each other. It was stimulating and awesome to see, hear, and feel the power required to carry three men far from the earth.

Apollo 17 continued to stream upward ahead of its half-mile trail of white fire, and soon became visible to a half million people crowded along the causeways and estuaries around the Kennedy Space Center. They had come in autos, campers, trailers, motor homes, trucks, buses, planes, and boats from everywhere. The highways were lined with parked vehicles and all the big parking centers on the Cape were jammed with buses.

As Apollo 17 continued to climb, it could be seen over much of the southeastern United States, the Bahamas, and northern Cuba. It arched over slowly as it climbed, its unique broken roar barely audible. It was visible for six minutes before disappearing into the night.

More than 2,000 people at the Apollo news site began pouring out avalanches of words and pictures about the spectacular departure and the significance of this last of the great Apollo flights to the moon.

The exhilaration of the lift-off pushed thoughts and emotions swiftly through one's mind. It was clear that the event was emphatic evidence that America, torn with self-criticism and inner hostilities, is capable of great achievement. This certainly was one. In fact, to be able to send men to another cosmic body with the great expectation of getting them back safely is a momentous accomplishment in itself. Even those who see the Apollo program as a "moon-doggle" and say it is of no practical value must



admit that is a great engineering and technical endeavor.

It is, of course, that and more. Much more. The Apollo program marks a historic point in the earth's history comparable to that when animals evolved from the sea to the land. As President Nixon said of Apollo: "Few events have ever marked so clearly the passage of history from one epoch to another." Many agree that when the history of the 20th century is written it will be remembered above all else as the time when man broke the gravitational chains that bound him to the earth and began the exploration of space.

A frontier has been reached whose potential cannot yet be realized. It is known only that the objectives and findings will be different from those of the more familiar frontiers of the past that produced homesteads, gold, and other treasures. Despite claims that the benefits of the space program are its practical spin-offs in such things as the miniaturization in electronics and seismology—and they are benefits—the real treasures are yet to be found. They may include much more knowledge about the solar system, a more enlightened sense of human values, and perhaps even the discovery of life elsewhere in the universe.

We can hope that America, which has played such a key role in the pioneering push to get man into space, won't let the challenge drop. At this time its value cannot be

by Graham Berry

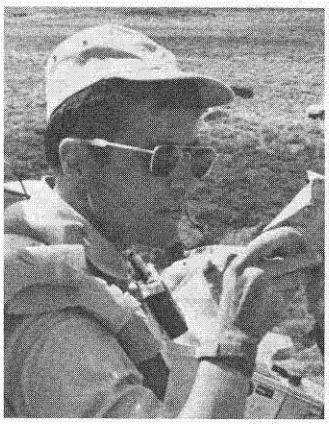
determined on how much revenue it will bring in. It is not for people whose feet are in the clouds and whose heads are in the cash register.

The magnificent torch of the space program will continue to be carried by institutions like Caltech, whose head has been the clouds for several generations. One of Caltech's founders, George Ellery Hale, lifted the Institute's eyes above the horizon long ago in pioneering the building of such great instruments as the 200-inch Hale telescope at Palomar and the 100-inch at Mt. Wilson.

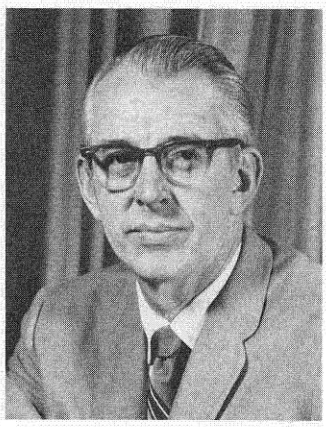
As they should, Caltech and Caltech people have played leading roles in America's space program since the start—only 13 years ago. Under Director William Pickering, Caltech's Jet Propulsion Laboratory led this country into the space age with the flight of Explorer I, launched from what was then Cape Canaveral, on January 31, 1958. Today at Cape Kennedy the Explorer I launch pad is marked with a plaque commemorating that milestone.

Caltech men have played leading roles in the space program from the start

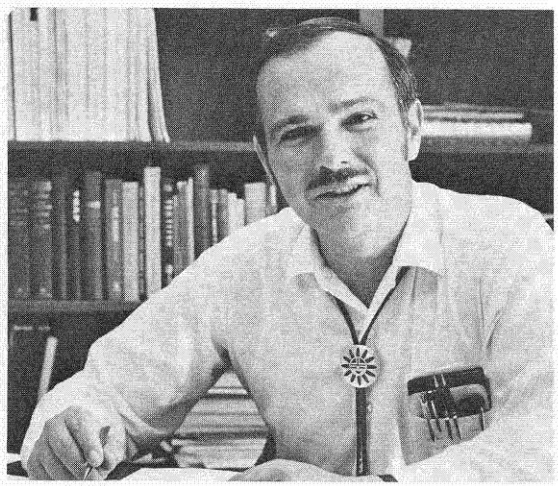
Pickering



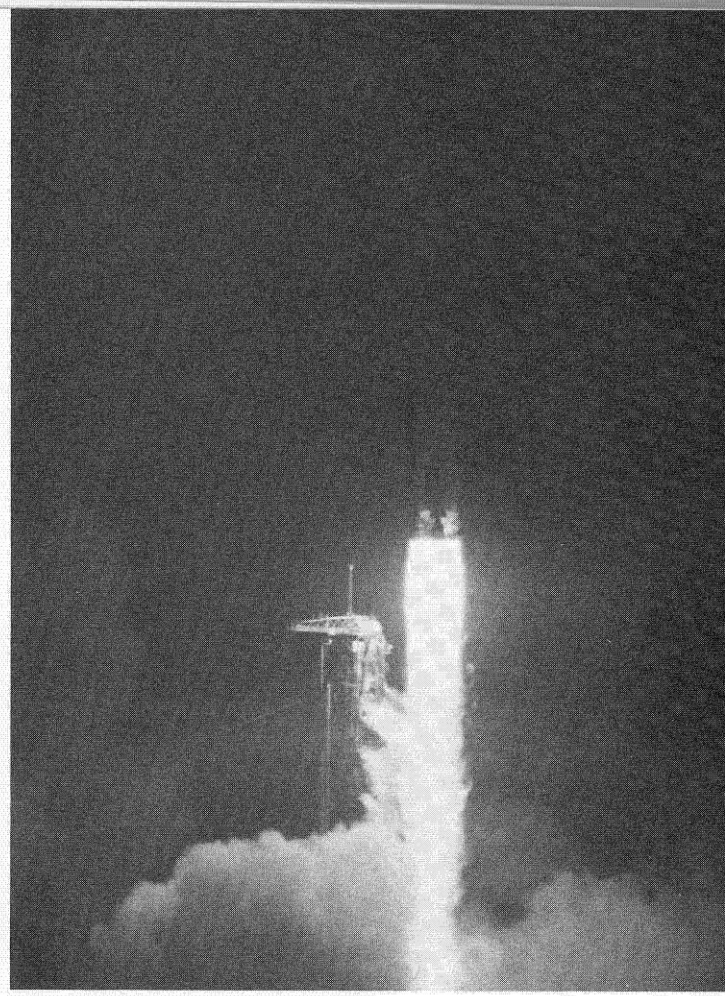
Schmitt



Fletcher



Shoemaker



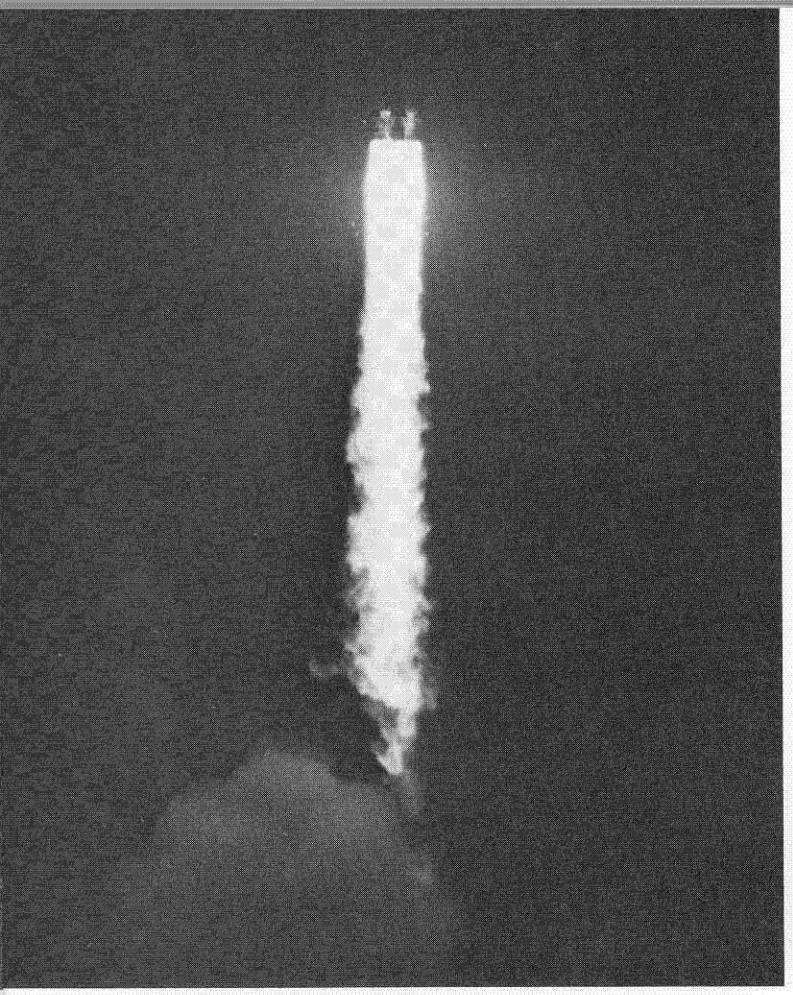
In addition to managing the successful Mariner flights to Mars and Venus, JPL directed the Ranger and Surveyor spacecraft programs. They paved the way for the Apollos by determining that the lunar soil would support the weight of a man so that he wouldn't sink into a sea of dust. The Rangers and Surveyors, along with Orbiter, helped locate suitable sites for Apollo landings.

Many more Caltech people than can be listed here are intricately woven into America's space effort. NASA Administrator James C. Fletcher (PhD '48) is a Caltech alumnus, as are many other NASA executives, astronauts, scientists, and engineers. And Caltech faculty members have been active in the space program since its inception.

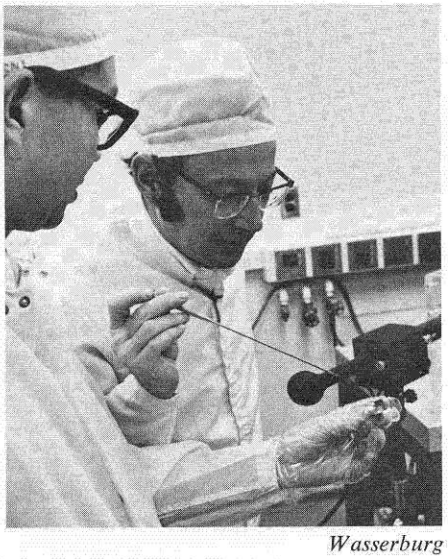
One Caltech alumnus, Harrison H. Schmitt (BS '57), was the first scientist on the moon, as a member of the Apollo 17 crew along with Eugene A. Cernan and Ronald E. Evans. ("Our Man on the Moon"—*E&S*, November-December 1972.)

Another Caltech alumnus, Frank Borman (MS '57) was a member of the Apollo 8 crew that in 1968 made the first flight from the earth to another body in space. Apollo 8 orbited the moon ten times, as planned, and included earth and lunar photography and live telecasts.

Caltech even has a frustrated astronaut. He is Eugene Shoemaker (BS '47, MS '48), professor of geology, who



Silver



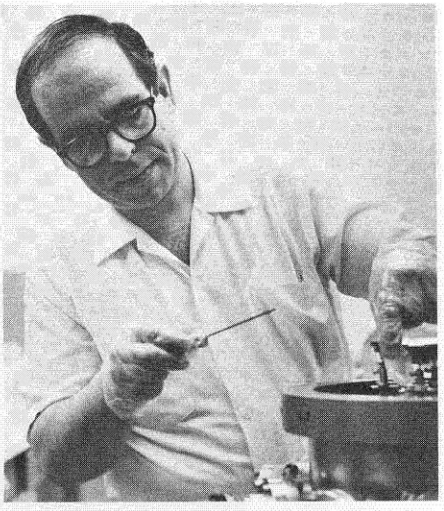
Wasserburg

admits he was born too soon to go to the moon. Shoemaker conducted a long, uphill, and not always smooth struggle to bring science into the Apollo program, and he directed the field geology operations for several of the missions.

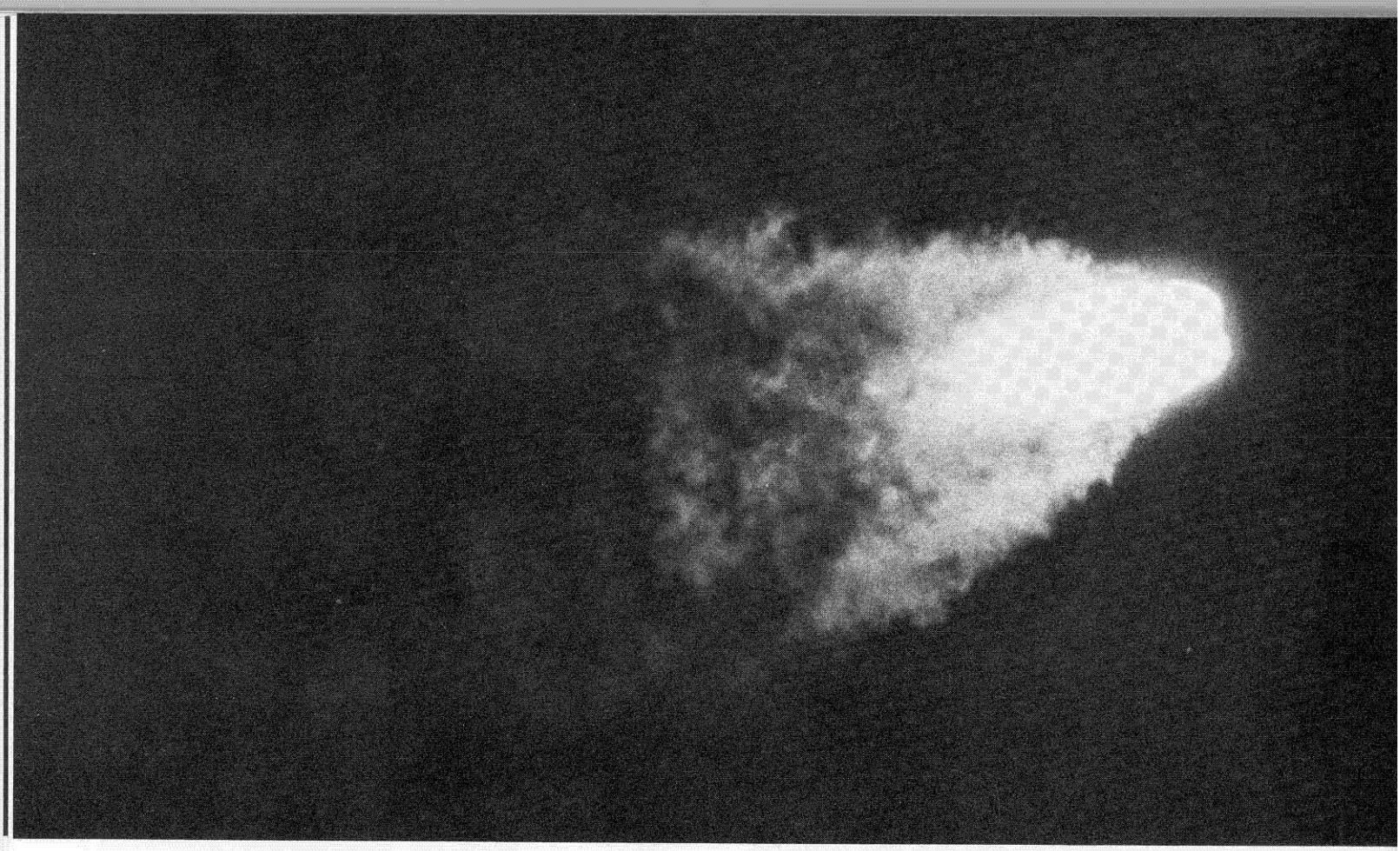
The man who pioneered in teaching geology to the astronauts is Caltech's Leon Silver (PhD '55), professor of geology. He quietly and effectively performed this task for three years, beginning in 1969, when one of his former students, astronaut Jack Schmitt, suggested the idea. ("Geology on the Moon"—*E&S*, November 1971.)

Energetic, red-haired Silver found the astronauts to be apt students because as jet pilots they were already good observers. He trained them in lunar-like landscapes—the Atomic Energy Commission's Nevada test site; the desert east of Indio, California; and New Mexico's Rio Grande Gorge. At Caltech Silver also heads a group that is age-dating lunar rocks and dust, and he has determined that, in some instances, lunar material shows an older age than it really is because of the presence of lead in the form of gas on the lunar surface.

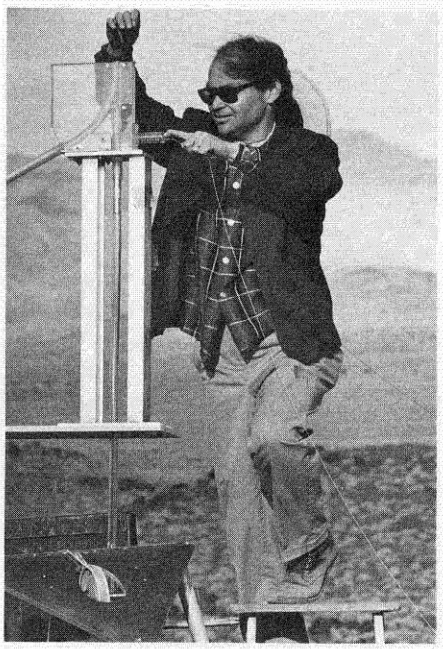
The largest group of scientists working on lunar material is under the direction of Gerald Wasserburg, professor of geology and geophysics, in his surgically clean Lunatic Asylum. This group has established the date of the moon's formation at 4.6 billion years ago and



Papanastassiou



The Apollo flights are ended –but the exploration of the moon will go on for years to come

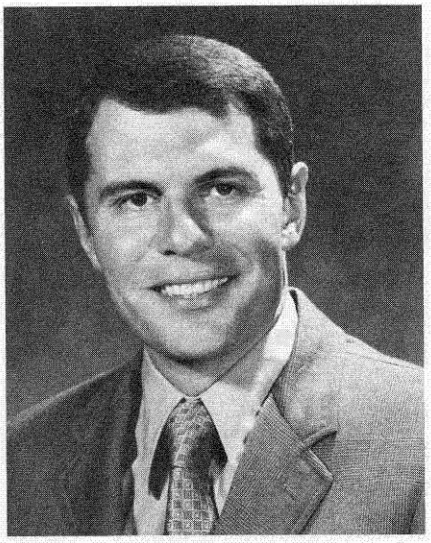


Burnett

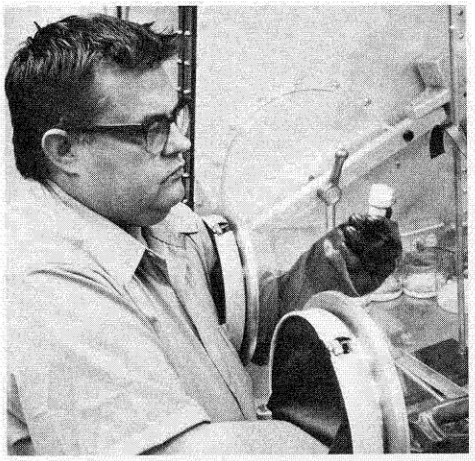
has found evidence of remelting on the lunar surface between three and four billion years ago.

Wasserburg recently was awarded NASA's Distinguished Public Service Medal for his leadership in helping plan the Apollo missions and for his planning of the handling and distribution of lunar samples. The geophysicist, who has worked with the Apollo program for five years, has served on a number of NASA committees and is currently a member of the physical sciences committee and the advisory committee to NASA headquarters.

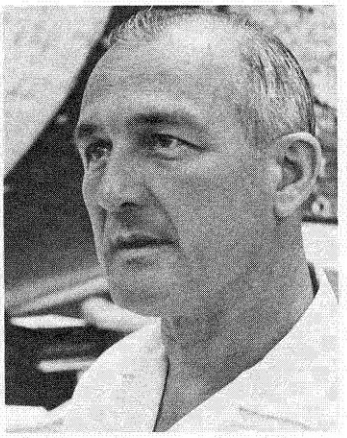
Wasserburg has developed a mass spectroscope that is more sensitive than any other for the chemical analysis of lunar material. He and his group use three age-dating techniques, based on the known decay rates of radioactive minerals into their decay products or "ashes." Dmitri Papanastassiou (BS '65, PhD '70) works with rubidium-strontium; Fouad Tera with uranium-thorium-lead; and Frank Podosek and John C. Huneke with potassium-argon. Podosek and Huneke also look for rare gases in lunar soils. According to theory, some rare gases such as argon, krypton, and xenon come out of the moon at low concentrations and are pushed back into the soils and rocks. Arden Albee, professor of geology, specializes in petrographic and mineral studies of lunar material.



Parker



Taylor



Muehlberger

Another Wasserburg associate, Donald Burnett, associate professor of nuclear geochemistry, had an experiment on Apollo 17. It was a sensitive neutron probe designed to help determine the rates at which material on the moon's surface has been deposited and eroded by meteorites over millions of years. The probe also will make it possible to date meteorite impacts on the moon. The instrument was developed by Burnett; Dorothy Woolum, Caltech research fellow in geology and physics; and research engineer Curtis Bauman.

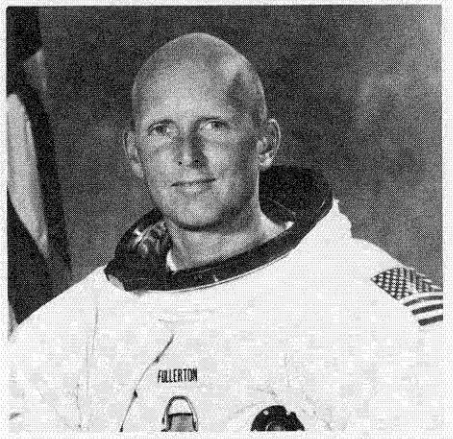
Two other Caltech professors, Sam Epstein and Hugh Taylor, are analyzing the isotopic geochemistry of lunar samples.

The list of Caltech alumni involved in Apollo is a long one. It includes Robert L. Kovach (PhD '62), now at Stanford, who was principal investigator of an Apollo 17 experiment, a seismic study to determine the geological characteristics of the moon down to a depth of nearly two miles. William R. Muehlberger (BS and MS '49, PhD '54), on leave from the University of Texas, was principal investigator of field geology for Apollos 16 and 17. Robert Parker (PhD '62) and Charles G. Fullerton (BS '57, MS '58) were capsule communicators for Apollo 17.

Although the Apollo flights are ended, they leave a rich legacy to scientists. Carefully stored in vaults at NASA's Manned Spacecraft Center in Houston is more than 90 percent of the lunar material brought back by the astronauts. Including the 250 pounds just collected by Gene Cernan and Jack Schmitt, more than 800 pounds are in the trust of Michael Duke (BS '57, MS '61, PhD '63), who is curator of lunar samples at Houston.

Thus, as the lunar samples continue to be distributed to laboratories at Caltech and elsewhere, the exploration of the moon will go on for years to come.

Epstein



Fullerton