EUGENE M. SHOEMAKER 1928–1997

Carolyn and Gene Shoemaker in front of the Alumni House during Commencement weekend in June 1997.

Eugene M. Shoemaker, one of the world's foremost planetary scientists, was killed in an automobile accident in Australia on Thursday, July 17. His wife, Carolyn, was also injured in the accident.

Shoemaker first came to Caltech as an undergraduate, and earned his bachelor's degree in 1947 and his master's in 1948. He received a second master's degree and his doctorate from Princeton University, and returned to Caltech in 1962 as a visiting professor. He served as a research associate in astrogeology here from 1964 to 1968, as professor of geology 1969–1980, and professor of geology and planetary science 1980–85. Shoemaker served as chairman of the Division of Geological and Planetary Sciences from 1969 to 1972.

He also worked for many years with the U.S. Geological Survey, and was affiliated with the Lowell Observatory at the time of his death. He was a principal investigator for geological field investigations for the Apollo lunar programs from 1965 to 1970, and was also involved in the Ranger and Surveyor missions.

After leaving Caltech for Flagstaff, Arizona, in 1985, Shoemaker focused his studies on impact craters, asteroids, and comets. His observing team, which included his wife, Carolyn, discovered several thousand asteroids and 33 comets, including Comet Schoemaker-Levy 9, which crashed into Jupiter in 1994.

Shoemaker's many other scientific accomplishments included setting up the Interplanetary Geological Time Scale, based on crater densities on planetary surfaces. This allows age estimates to be made for terrains from other planets based on space photographs.

His other research included exploration for uranium deposits and salt structures in Colorado and Utah, research on the geology and geochemistry of the Colorado plateau country, studies of the structure and mechanics of meteor craters, the search for planet-crossing asteroids, and studies of the magnetostratigraphy of sedimentary rocks.

He codiscovered the mineral stishovite, which is a high-pressure form of quartz produced only during large impact events. This discovery established the extraterrestrial origin of many cryptoexplosion structures.

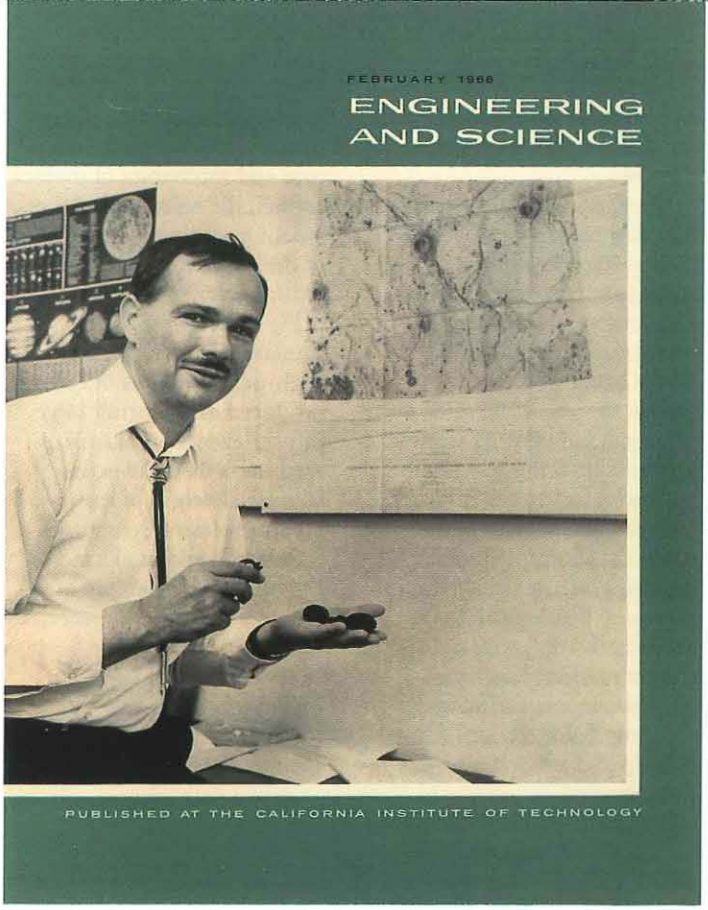
Shoemaker was elected to the National Academy of Sciences in 1980; he received the National Medal of Science in 1992, and the Bowie Medal (the highest award of the American Geophysical Union) in 1996.

A Celebration of Life for Eugene Shoemaker was held in Flagstaff October 11. Harrison "Jack" Schmitt (BS '57, Apollo 17 astronaut, and former senator from New Mexico) delivered the main address, from which the following is adapted.

When I received the phone call about this celebration of life for Gene, I was reading *Undaunted Courage*, Stephen Ambrose's remarkable narrative about Meriwether Lewis, Thomas Jefferson, and the opening of the American West. I could not absorb Ambrose's words without relating those events, people, and consequences to our own experiences in the 1960s.

As I reached the end of the book, I was reminded particularly of Gene's most unique quality during those heady days. I could not help but compare Gene as leader, as well as a scientific explorer, to Captain Lewis and an earlier Corps of Discovery. Paraphrasing just a little, as Ambrose said of Lewis: "How he led is no mystery. His techniques were time-honored. He knew his [people]. He saw to it that they had [regular inspiration, neces-sary resources, sufficient tools]. He pushed them to but never beyond the breaking point. He got out of them more than they knew they had to give. His concern for them was that of a father for his son. He was head of a family."

Many of us saw our lives moved forward professionally because of Gene's knack for inspiring people to go far beyond what any of us believed we could do. We knew then as we know now that we worked with one of the truly great scientists and visionaries of this latest age of exploration. Like Lewis, "[h]is intense curiosity about everything new he saw around him was infectious.



On the February 1966 cover of *E&S*, Gene Shoemaker holds a handful of tektites, which he thought were remnants of lunar material ejected from the Moon's surface during impact from a high-speed object. Such objects (meteorites, asteroids, comets) Shoemaker believed, also created the craters visible on the Moon, Mars and Earth, a theory now universally accepted.

Certainly he would be anyone's first choice for a companion on an extended camping trip."

Before I arrived on the Shoemakers' doorstep in Flagstaff in 1964, Gene and I wrote two letters that had literally crossed in the mail. He was contacting people on the Geological Survey's list of those who had passed its 1963 employment exam, and I was looking for a job.

Interesting and adventurous jobs in geology seemed nonexistent to this new PhD in 1964—none in academia, and the ongoing slump in metal prices didn't help in other areas where "hard-rock" and field experience might be applied. Fortunately, I remembered that in 1960, after helping line up a trip to look for West Coast eclogites, Bob Coleman had taken me down a dark hallway in the Survey's Menlo Park facility and introduced "Gene Shoemaker, who is doing weird things like mapping the Moon. Danny Milton is even working for him," he added. Well, I had no idea who Gene Shoemaker might be, but Danny and I had overlapped at both Caltech and Harvard. If Danny thought what Gene was doing was interesting, it almost certainly was!

Not having any idea what I was getting into, I headed out of Cambridge in my '55 Chevy Business Coupe for Route 66, Flagstaff, and the old Astrogeology Branch Headquarters. I became a little suspicious only when Danny and others in Menlo decided not to relocate in Flag. What did they know that I didn't know? Exciting things, however, were about to happen.

After arrival at the old museum offices in the pines at the north edge of town, and JoD Swann's enthusiastic welcome, Gene provided me with a tough choice between joining Don Elston, Ray Batson, and others on the ongoing Surveyor television project, or heading up work on a new NASA contract to develop lunar field geological methods. Surveyor was very real and had exciting science potential. Lunar field work was in the misty, undefined future, but there was really no choice: as important as Surveyor was and would turn out to be, in Apollo lay the emotion, the excitement, and, we believed, the science of the future. A few days later, Gordon Swann and others arrived and, with Gene's daily inspiration, an eclectic group went to work.

We began learning our new lessons by trial and error, mostly error—lessons that ultimately were to become part of the foundations of Gene's Apollo field geology experiment, underpinning almost everything Apollo accomplished scientifically on the Moon. With Arizona freshmen, Spence Titley, long hours, and Jim Beam, we set about answering questions never asked before.

How do you communicate detailed geologic notes by radio across the 240,000 miles of space, when Swann keeps stepping on your lines? How should the lunar surface debris, later to be defined by Gene as the now famous lunar regolith, be sampled, when the old International Travel-Alls can't get us to Tom McGetchin's Mexican Hat kimberlite location? How do you photographically document a sample location and orientation without using more than an absolute minimum of extraordinarily valuable time, when Schmitt can't keep the Polaroid film out of the Hopi Buttes' dust? What

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training vocabulary do you use when your field men are not geologists but rather are headstrong test pilots? Ultimately, all our questions had answers, but none was obvious when Gene started geology down this path of lunar exploration and stardom.

Also during this period, November 1964 to be more exact, NASA and the National Academy of Sciences jointly asked for applicants for the first selection of scientist-astronauts. The geological horizon Gene had seen so clearly for so long had suddenly brightened for others. Even though, as graduate students in 1963, some of us had joked about the possibility of going to the Moon, when an Academy report stated that "the first person on the Moon should be a hard-rock geologist," no significant thought or relevant action had followed.

After one and only one conversation with Gene on a fall afternoon in 1964, and after a few more seconds of consideration, I decided to volunteer to be an astronaut. Gene clearly knew what he would have done, having decided this point many years before anyone else. I was concerned about my commitment to Gene and the Survey. The question I asked myself, however, was, "If someone actually does land on the Moon, and if I passed up a chance to try to be that person, would I regret it?" The answer being obvious, the rest is history—helped along, I strongly suspect, by Gene's position as chair of the Academy's scientist-astronaut selection committee.

Some time coincident with this astronaut selection process, Al Chidester assigned me, along with Newell Trask, to do the final work for publication of Gene's Copernicus lunar quadrangle map. No single study affected the course of lunar science more than Gene's early telescopic and photographic examination of the crater Copernicus. Building on his skillful field and theoretical work on Meteor Crater, and his pioneering definition of a stratigraphic system for the Moon, Gene created the scientific base for mapping the Moon and now, by extension, mapping humankind's third home, Mars. As Don Wilhelms has written, Gene, "more than any other individual, was responsible for the incorporation of geology into the American space program." We might add that, more than any other individual, he was responsible for our present consideration of the Moon and Mars as places for future settlements of our children and grandchildren.

Gene's influence within the space agency in the 1960s was far greater than even he imagined. He become a looming spirit behind the most critical managers of the Apollo program—George Low, Bob Gilruth, Gene Krantz, and Sam Phillips. They knew that Apollo could do more than meet John Kennedy's challenge "to put men on the Moon and return them safely to Earth." Gene's continuing enthusiastic presence and his pressure for NASA to take advantage of this extended capability, led to the inclusion of the Field Geology Team as part of the Apollo Mission Team, from equipment selection to crew training to mission control activities. It wasn't everything we wanted or could have done, but it was there, and it was of critical importance.

Thinking back on this pervasive and unprecedented experiment in lunar field geology, and on Gene's pivotal influence on the plans for lunar sample analysis, brings Meriwether Lewis and Thomas Jefferson to mind again. Gene provided the intellectual foundation for this history of science to record that for the first time we had gained a first-order understanding of another planet.

In 1992, Gene joined a University of Wisconsin team as chief scientist on a proposal to operate two scientific rovers simultaneously and cooperatively on the surface of the Moon. Our objectives were to unravel the three-dimensional nature of the regolith and to define the basis for bringing its energy resources back to Earth. Who would have thought when we first gathered in Flagstaff in the '60s that Gene's legacy would include the potential for providing for the long-term energy and environmental needs of humankind? Gene would have. Yes, indeed! With the usual unbounded enthusiasm, he joined in our preparations, saying to the group during a luncheon pep talk, "I've waited 30 years to do this!"

With a vigor, joy, and wisdom beyond that ever expected of anyone, Gene celebrated his own life and the lives of those around him. □

Harrison H. Schmitt